NOVA SCOTIA POWER DEVELOPMENT LIMITED (NSPDL)

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE PROPOSED 80MW$_{AC}$ SOLAR PHOTOVOLTAIC (PV) PLANT PROJECT IN DUTSE LGA, JIGAWA STATE.

FINAL REPORT

Submitted to

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MARCH 2016

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FINAL ESIA REPORT

FOR THE

PROPOSED DEVELOPMENT OF 80MW$_{AC}$ SOLAR PHOTOVOLTAIC (PV) PLANT PROJECT IN DUTSE LGA, JIGAWA STATE

PREPARED BY

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LIST OF ABBREVIATIONS AND ACRONYMS

A	Average
AC	Alternating Current
ANSI	American National Standards Institute
AIDS	Acquired Immune Deficiency Syndrome
AOI	Area of Influence
AP	Angle Point
a-Si	Amorphous Silicon
BC	Before Christ
BMP	Biodiversity Monitoring Plots
BOD	Biochemical Oxygen Demand
BPS	Business Process Solutions
BS	British Standard
C	Control
CBO	Community Based Organizations
CCDI	Community Conservation and Development Initiatives
CCTV	Closed Circuit Television
CDA	Country Development Associates
CDIL	CPCS Development International Limited
CDM	Cleaner Development Mechanism
CdTe	Cadmium telluride
CHEW	Community Health Extension Worker
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CIS/CIGS	Copper Indium Gallium Selenide
CITES	Convention on International Trade in Endangered Species
CLO	Community Liaison Officer
COD	Chemical oxygen demand
C of O	Certificate of Occupancy
COREN	Council for the Regulation of Engineering in Nigeria
CSP	Concentrated Solar Power
CSR	Corporate Social Responsibility
DC	Direct Current
DisCos	Distribution Companies
DO	Dissolved Oxygen
EC	Electrical Conductivity
ECN	Energy Commission of Nigeria
ECP	Erosion Control Plan
EEE	Electrical/Electronic Equipment
EHA	Environmental Health Areas
EHO	Environmental Health Officer
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMFs	Electromagnetic Fields
EMP	Environmental Management Plan
EMTS	Emerging Markets Telecommunication Services
ENA	Energy Network Association

EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
EPFI	Equator Principles Financial Institution
EPSR	Electric Power Sector Reform
ESA	Environmentally Sensitive Area
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESPR	Electric Power Sector Reform
FAO	Food and Agriculture Organization
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FGN	Federal Government of Nigeria
FMARD	Federal Ministry of Agriculture and Rural Development
FMC	Federal Medical Centre
FMEnv	Federal Ministry of Environment
FML	Federal Ministry of Labour
FMP	Federal Ministry of Power
FRSC	Federal Road Safety Corporation
FS	Feasibility Study
FUDC	Federal University Dutse Clinic
GHG	Green House Gas
GIIP	Good International Industry Practice
GIS	Geographic Information System
GPS	Global Positioning System
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
HIV	Human Immunodeficiency Virus
HSE	Health, Safety and Environment
HTF	Heat Transfer Fluid
HV	High Voltage
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical Electronics Engineer
IFC	International Finance Corporation
ILO	International Labour Organization
IMM	Impact Mitigation & Monitoring
IPP	Independent Power Producers
ISO	International Organization for Standardization
ISSS	International Society of Soil Science
IUCN	International Union for Conservation of Nature
IVMP	Integrated Vegetation Management Plan
JAMB	Joint Admission and Matriculation Board
JISEPA	Jigawa State Environmental Protection Agency
JSME	Jigawa State Ministry of Environment
KWW	Kentucky Water Watch
LEMP	Labour and Employment Plan
L&FS	Life and Fire Safety
LGA	Local Government Area

LGC	Local Government Committee
LPS	Lightning Protection System
LV	Low Voltage
MC	Moisture Content
mc-Si	Multi-crystalline Silicon
MD	Managing Director
MDAs	Ministries, Departments and Agencies
MDGs	Millennium Development Goals
Mono-Si	Monocrystalline Silicon
MSDS	Material Safety Data Sheet
MTN	Mobile Telephone Network
MV	Medium Voltage
MWP	Modified Whittaker Plot
NAAQS	National Ambient Air Quality Standards
NBET	Nigerian Bulk Electricity Trading Plc
NEEDS	National Economic Empowerment and Development Strategy
NEP	National Energy Policy
NEPA	National Electric Power Authority
NEPP	National Electric Power Policy
NEPU	Northern Element Progressive Union
NERC	Nigerian Electricity Regulatory Commission
NESIS	Nigerian Electricity Supply and Installation Standards
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGO	Non-Governmental Organization
NIMET	Nigerian Meteorological Agency
NIPP	National Integrated Power Project
NSCDC	Nigeria Security and Civil Defense Corps
NSPDL	Nova Scotia Power Development Limited
O & M	Operations and Maintenance
OHS	Occupational Health and Safety
OSH	Occupational Safety and Health
OHSP	Occupational Health and Safety Plan
OPC	Organic Photovoltaic Cells
PAC	Performance Acceptance Certificate
PAP	Project Affected Persons
PCB	Polychlorinated biphenyls
PHC	Primary Health Care
PHCN	Power Holding Company of Nigeria
poly-Si	Polysilicon
PM	Project Manager
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
PS	Performance Standard
PSD	Particle Size Distribution
PV	Photovoltaic
QA/QC	Quality Assurance & Quality Control
QHSE	Quality, Health, Safety and Environment
RALRP	Resettlement Action and Livelihood Restoration Plan
RAM	Risk Assessment Matrix

REMP	Renewable Energy Master Plan
RFP	Request for Proposal
RMPSR	Road Map for Power Sector Reform
RoW	Right of Way
RSSH	Rasheed Shekoni Specialist Hospital
RTA	Road Traffic Accident
SCADA	Supervisory Control and Data Acquisition
SEP	Stakeholder's Engagement Plan
SIEP	Shell International Exploration and Production
SMP	Security Management Plan
SPERP	Spill Prevention and Emergency Response Plan
SPM	Suspended Particulate Matter
SPV	Special Purpose Vehicle
STD	Sexually Transmitted Disease
STI	Sexually Transmitted Infection
STG	Stream Turbine Generator
SS	Sampling Station
TB	Tuberculosis
TBC	Total Bacterial Count
TCC	Total Coliform Count
TCN	Transmission Company of Nigeria
TDS	Total Dissolved Solution
TFSC	Thin-film Solar Cell
THB	Total Heterotrophic Bacteria
THC	Total Hydrocarbon Content
TMP	Traffic Management Plan
ToR	Terms of Reference
TS	Technical Standard
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Emergency Fund
US	United States
USD	United State Dollar
USDA	United State Department of Agriculture
VCT	Voluntary Counselling and Testing
VECs	Valued Ecosystem Components
WASH	Water, Sanitation and Hygiene
WBCSD	World Business Council for Sustainable Development
WEEE	Waste Electrical/Electronic Equipment
WHO	World Health Organization
WMP	Waste Management Plan

UNITS OF MEASUREMENT

%	Percent
$\mu g/m^3$	Microgram per meter cubed
µm	Micrometer
µS/cm	Micro seconds per centimeter
cfu/g	Colony forming unit per gram
cm	Centimeter
dB (A)	A-weighted decibels
GW	Gigawatt
ha	Hectares
ha	Hectares
KgDW	Kilogram Dry Weight
Km	Kilometer
Km^2	Square kilometer
Kv	Kilovolts
Kw	Kilowatt
kWh	Kilowatt hour
m	Meter
m^3	Cubic meter
mgDW	Milligram Dry Weight
mg/kg	Milligram per kilogram
mg/l	Milligram per liter
mg/m^3	Milligram per cubic meter
Mm^3	Cubic millimeter
MW	Megawatt
ppm	Part per Million
V	Volts
Wp	Watts Peak
^0C	Degree celsius
^0F	Degree Fahrenheit

CHEMICAL ELEMENTS AND COMPOUNDS

As	Arsenic
Ca^{2+}	Calcium
Cd	Cadmium
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2	Carbon Dioxide
Cu	Copper
Fe	Iron
H_2S	Hydrogen Sulphide
HCN	Hydrogen Cyanide
K^+	Potassium
Mg^{2+}	Magnesium

Mn	Manganese
NH_3	Ammonia
Ni	Nickel
NO_2	Nitrogen dioxide
NO_3^-	Nitrate Ion
Pb	Lead
PO_4^{3-}	Phosphate Ion
Se	Selenium
Si	Silicon
SO_2	Sulphur dioxide
SO_4^{2-}	Sulphate Ion
VOC	Volatile Organic Compound
Zn	Zinc

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EXECUTIVE SUMMARY

INTRODUCTION

Background Information

Nova Scotia Power Development Limited (NSPDL) is planning to develop a ground-mounted 80 MW_{AC} Solar photovoltaic (PV) plant. The proposed site for the project known as Dutse-2 is located at a distance of about 5 km from the town of Dutse in Dutse Local Government Area (LGA) of Jigawa State, Nigeria. The area covering approximately 200 hectares of land has a lower left boundary coordinate of 11.673638^{0}N, 9.380721^{0}E and an upper right boundary coordinate of 11.688521^{0}N, 9.392996^{0}E. The project location also include the 3.66 km Right of Way (RoW) for the transmission route through which electricity generated will be transmitted to the Dutse substation for onward connection to the national grid. The transmission route extends from Latitude 11.68728^{0}N, Longitude 9.38058^{0}E to Latitude 11.69109^{0}N and Longitude 9.35066^{0}E.

Nigeria's deficient power sector supply has been a challenge that past administrations have steadfastly sought to address. The electricity supply – demand gap in Nigeria has continued to increase with expanding economy and rapidly increasing population, thereby leaving an estimated 50% of Nigerians without grid connected electricity. In a bid to address the deficiency in electricity supply, the Federal Government adopted the National Electric Power Policy (NEPP) and promulgated the Electric Power Sector Reform Act (EPSRA) in 2001 & 2005 respectively for the reform of the sector. A key thrust of the reform is the transfer of the control and operation of the industry from public to the private sector.

The Renewable Energy Master Plan (REMP) for Nigeria of 2006 further articulates a roadmap for national development through the accelerated development and exploitation of renewable energy. It aims to increase the contribution of renewable energy to account for 10% of Nigerian total energy consumption by 2025. In pursuant of the reforms, a roadmap for power sector reform which outlines the plans and strategies to finalize the drive to complete power sector reform and set the nation on a steady course to produce clean and efficient electricity for its citizens at competitive rates was developed in 2010.

The proposed project is NSPDL's response to various governments' policy initiatives and call for private sector investment in the power sector. NSPDL has therefore commissioned an Environmental Impact Assessment (EIA) (also known as Environmental and Social Impact Assessment - ESIA) study for the proposed development in compliance with the provisions of the EIA Act No 86 of 1992 (as amended by EIA Act Cap E12 LFN 2004) and requirement of key international development partners. The overall goal of the ESIA is to identify and assess the potential impacts of the proposed project, evaluate alternatives and propose appropriate measures to mitigate the significant adverse effects and enhance potential benefits in order to ensure that the proposed project is environmentally and socially sustainable.

Project Proponent

The project proponent is Nova Scotia Power Development Limited. NSPDL is a limited liability company incorporated in Nigeria by a consortium comprising CPCS Development International Ltd (CDIL) (Barbados) and Business Process Solutions (BPS) Consult Ltd (Nigeria) with 80% and 20% shares respectively.

Administrative, Policy and Legal Framework
The ESIA was carried out in accordance with applicable environmental, social and power sector policies, standards, regulations and legislation in Nigeria as well as relevant international conventions and standards. These include EIA Act No 86 of 1992 (as amended by EIA Act Cap E12 LFN 2004), EIA Sectoral Guidelines for Power Sector, 2013; NEPP, 2001; EPSR Act 2005; World Bank Safeguard Policies and Environmental Health & Safety (EHS) Guidelines, IFC Performance Standards on Environmental and Social Sustainability and Equator Principles.

PROJECT JUSTIFICATION

The Need for the Project
The provision of regular, affordable and efficient electricity is crucial for the growth, prosperity, national security as well as the rapid industrialization of any society. However, the current status of electricity generation in Nigeria with regards to its population is grossly inadequate. With an estimated 50% of Nigeria's population living without grid connected electricity, this issue has been identified as the underlying challenge hampering economic development and productivity in Nigeria. The proposed project is thereby necessary as it will generate and supply additional 80 MW_{AC} of renewable electricity to boost national power supply and specifically provide the Jigawa State and surrounding areas with indigenous carbon free source of electricity to promote economic development in line with REMP and NEP.

Benefits of the Project
The potential benefits of the proposed project include but are not limited to the following:
- Generation of clean renewable energy with minimal greenhouse gas (GHG) emissions.
- Increased electricity generation.
- Stimulation of local and regional economic activities thus promoting industrial growth.
- Job creation, improved livelihood and poverty reduction through the provision of employment and improved economic opportunities.
- Acquisition of new skills through technology transfer.
- Boost in local and regional economy through award of contracts.
- Increased revenue generation to government through the payment of taxes.

Value of the Project
The total project cost is estimated to be One Hundred and Ninety Three Million, Eight Hundred Thousand Dollars (USD 193.8 million). The project cost comprises of development costs (8.5%), construction costs (77.6%) and other costs (13.9%) respectively. A substantial part of these costs will be spent in Nigeria and will thus improve the overall national and regional socioeconomic conditions, trade and revenue generation.

Envisaged Sustainability

Environmental Sustainability
The project entails generation of electricity using energy from the sun, a renewable and infinite source that cannot be depleted, thereby making the project a sustainable development. The project will boost electricity generation in Nigeria and reduce dependency on hydrocarbon and other non-renewable sources. In addition, the effective

implementation of mitigation measures contained in Chapter Six of this Report for negative impacts of proposed project will further enhance environmental sustainability.

Economic Sustainability
The availability of raw material (freely available solar energy), high demand for electricity in Nigeria and proposed project's long life span of more than 20 years which guarantees a high return on investment will ensure economic sustainability of the project.

Social Sustainability
A stakeholders' engagement process commensurate with project impacts and tailored to the characteristics and interest of the affected communities and stakeholders has been designed for the proposed project covering the entire project life cycle. The effective implementation of the engagement process as well as employment of local labour and implementation of Corporate Social Responsibility (CSR) programs will ensure social sustainability of the project.

Technical Sustainability
The construction of the solar PV plant to the most stringent Nigerian and international standards using tier-one equipment and experienced Engineering, Procurement and Construction (EPC) contractors will ensure technical sustainability of the project.

Project Alternatives and Development Option
Various alternatives were considered for the proposed projects in terms of project site, solar technology, PV panel technology, Electricity generation technology and RoW for the transmission line. The analysis of these alternatives and preferred project options are presented in Chapter Two of this Report. The project development options considered include "No Project, Delayed Project and Immediate Project implementation" Options. The immediate project implementation was adopted as this option will ensure the realization of the numerous benefits of the project especially the addition of 80 MW_{AC} renewable energy to boost electricity generation and supply in Nigeria.

PROJECT DESCRIPTION

Project Overview
The project will involve the development of a utility scale solar power plant involving the installation of ground-mounted PV solar modules capable of generating 80MW_{AC} using fixed tilt system configurations. The PV modules will convert sunlight to direct current (DC) power. The modules will be connected together to form arrays of panels, which in turn will be connected to inverters to convert the DC power to alternating current (AC) power. The voltage of the power will be stepped up by a transformer to the required voltage of the nearby electricity grid. The generated power from the project site will be evacuated through a dedicated 132 kV overhead transmission line that will connect the solar plant to the Dutse substation located approximately 3.66 km northwest of the project site.

Project Components
The key components of the proposed solar PV plant are as follows:

- PV Modules (Solar Panels)
- Mounting Structures (and tracking motors where applicable)

- Cabling and Combiner Boxes
- Direct Current - Alternating Current (DC-AC) Inverters
- Transformers
- Medium Voltage (MV) & High Voltage (HV) Switchgear
- Electrical Connection Cabin
- Supervisory Control and Data Acquisition (SCADA) System
- Transmission to Grid
- Associated infrastructure and utilities, including:
    - Site security, including fencing and CCTV.
    - Buildings, including onsite substation, connection building, control building etc.
    - Access road and internal road network.
    - Storm water infrastructure and drainage system.
    - Water supply infrastructure (boreholes).

Project Development

The project will be implemented in 4 phases, namely; pre-construction, construction operation and decommissioning. It is anticipated that the pre-construction and construction activities phase will take up to 12–14 months and once the facility is complete and operational, it is expected that it will have a lifespan of approximately 20 years. The PV power facility may be decommissioned at the end of its projected 20 year operational life time. Alternatively, with regular maintenance, the facility could be upgraded, with the useful lifespan of the project extending beyond the design lifespan.

DESCRIPTION OF ENVIRONMENT

Introduction

The baseline description of the existing project environment is based on primary information obtained directly from a one season (wet season) field data gathering exercise carried out from 9th – 12th October, 2015 and secondary data obtained through desktop studies and review of literature including existing report of environmental assessments carried out in the project area (EIA of EMTS Base Stations in Jigawa State, 2012). The components covered include: climate & meteorology, ambient air, soils/land, geology/hydrogeology, hydrology & groundwater, vegetation (flora) & wildlife (fauna), socioeconomic and health. The methods employed included reconnaissance survey, a mandatory first step of extensive literature search, field data gathering, laboratory analysis and stakeholder consultations.

Project Area of Influence

The project Area of influence (AoI) also known as the study area is the area likely to be affected by the project, including all its associated infrastructures. This represents the geographical area where the project induced changes to the biophysical and social environment will occur. This is defined as the area within 5km radius drawn from the centre of the project site.

Environmental and Social Setting of the Study Area

- ***Climate and Meteorology***

The climate experienced in the study area is semi-arid characterized by two predominant climatic conditions annually. These include a very hot and long dry season and a warm, humid and short wet season influenced by two air masses: the tropical maritime or south-west trade winds and tropical continental or north-east trade winds.

The average annual rainfall ranges from 510mm – 1000mm in the study area. The highest average monthly temperature of 36.6 - 39.2°C is experienced between March and May while the average monthly temperature can be as low as 13.4°C between November and February. The average monthly relative humidity ranged from 52.8% to 78.6% during the rainy season (May to September), with its peak usually recorded in the month of August the same month of highest rainfall. The average monthly wind speed in the study area ranged from 6.63 to 10.09 Knots. The average range of sunshine hours is between 6.88 hours per day in March to about 8.57 hours per day in November with an approximate average of 7.71 sunlight hours for each day.

- ***Ambient Air Quality & Noise Level***

The parameters measured during the wet season include carbon monoxide (CO), total suspended particulate (TSP), volatile organic compound (VOC), nitrogen dioxide (NO_2), carbon dioxide (CO_2), hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) . Ambient air quality of the area during the assessment was good as all parameters measured were within the FMEnv permissible limits and guideline values recommended by World Health Organization (WHO). Ambient noise levels ranged between 45.5 - 66.1 dB (A) with a mean value of 51.69 dB (A). These levels were also within FMEnv permissible noise levels and WHO guideline value.

The concentration values for all air quality parameters as well as noise levels during the dry season were within the FMEnv permissible limits.

- ***Soil Quality***

Soil sampling was carried out at 14 stations in the study area during the wet season. At each station, composite soil samples were collected from 0 – 15cm (top soil) and 15 – 30cm (sub soil) depths respectively. The soils are predominantly fine sand with silt. The recorded mean percentage for sand, silt and clay were approximately 70%, 25% and 5%. The soils are moderately acidic with mean pH value of 5.99. The moisture content of the soils ranged from 3.0% – 9.5%, with a mean value of 7.98%. The nitrates levels in soils ranged from 1.12 – 8.2mg/kg with a mean of 2.59mg/kg, the sulphates level ranged from 42 - 50mg/kg with a mean of 45.3mg/kg. Heavy metal concentrations are generally low with slight elevated levels of manganese, nickel, iron and lead in some soil samples with values of 0.2 mg/kg - 6.60 mg/kg, 0 mg/kg - 0.17 mg/kg, 0.5 – 4.5 mg/kg and 0.9 – 44.2 mg/kg respectively. The total heterotrophic bacteria (THB) count ranged between 2.0 x 10^3cfu/g and 3.2 x 10^5cfu/g. The predominant fungal species were yeast and mold with counts that ranged between 3.0 x 10^0cfu/g and 1.10 x 10^2cfu/g. The total coliform count (TCC) ranged between 1.5 x 10^0cfu/g and 5.4 x 10^5cfu/g. The high value of coliform in soil is probably due to possible human defecation on farmlands and bushes around the area. The soils in the study area showed similar trend in the distribution of measured soil quality parameters during the dry season.

- ***Geology and Hydrogeology***

Dutse is located in the northwestern part of Nigeria and it falls within the Chad formation that consist predominantly of recent Aeolian deposits. The rocks underlying this area are made up of 95% ancient crystalline basement complex formations. The basement complex rocks consists mainly of gneiss migmatites schists quartzites and marble but locally granite or syenite and intrusion of amphiobolites and olive rich dykes are found. Sandy beds are formed over impervious clay of the chad formation. Within the proposed project site, the Chad sediments are concealed by sand dunes with no surface outcrops. The soils are generally sandy at the top and compact at depth with often hard pans.

The depth of aquifers (fed by precipitation and river infiltration) is 25-30 meters for the upper ones and 90-100 meters for the lower ones. Groundwater is obtained from the river valleys and from the upper and lower sub-artesian aquifers. Due to the nature of the Chad formation, with high infiltration rate and the openness of the semi-arid vegetation zone, most of the limited run-off from the rainfall is captured in local depressions and fadama and lost to evapo-transpiration. The water table is usually independent of the fluctuation in the annual rainfall, but related to extensive deforestation/cultivation of vast areas, which increases surface run-off.

- ***Hydrology***

Jigawa State is blessed with both surface and subsurface water resources, with its greatest potential based on underground. The drainage basin of the region is determined by the Hadejia river system which flows from the high plateau of northern Nigeria. The Hadejia river meanders for 828 km (about 300 km within Kano and Jigawa states) across the old lake bed with many ox-bow lakes and numerous channels spread over a wide area. The river thus contributes immensely to a very vast underground aquifer in Jigawa State. There are 2 main rivers within the Dutse LGA, the Duddurin Gaya and Warwade rivers that are seasonal and more than 10 km away from the proposed project site. There are however no surface water bodies in the study area.

- ***Groundwater Quantity and Quality***

The amount of groundwater available in the study area is determined by the amount of rainfall each year. Information from Reports of past environmental studies in the project area revealed that the maximum yield from borehole range from 3 – 5 litres/sec. Available data from the Jigawa State Ministry of Water Resources revealed that a total of 3555Mm^3 of groundwater are available for utilization in Dutse LGA. Considering the present sub-surface demand of 599Mm^3 for both domestic and agricultural usage, the groundwater potential of the area can be said to be promising.

The results of the analysis of the groundwater sampled from two existing hand dug wells and a borehole during the wet season show that the pH values ranged between 7.75 – 7.78 while temperature ranged between 26.4 ^oC and 26.6^oC. The recorded conductivity which is an index of the total dissolved solids in water ranged from 167.3 to 598µS/cm. The concentrations of chloride, nitrate, phosphate and sulphate, magnesium, copper and zinc were all within permissible limits while barium, cadmium and lead were not detected.

However, the following parameters with indicated concentration levels were slightly above limits in some sampling stations: Turbidity (2.0-6.0NTU), total hardness (70mg/l - 280mg/l), total suspended solids (8.70mg/l - 19.9mg/l), biological oxygen demand (8.0 - 12.0mg/l), chemical oxygen demand (18.50mg/l - 25.0mg/l), dissolved oxygen (6.7mg/l-

7.5mg/l), calcium (28.0mg/l and 110.55mg/l), iron (0.15mg/l - 1.02mg/l) and manganese (0.67 to 2.86mg/l). The levels of total bacterial count (TBC) in the collected groundwater samples were 200 and 300 Cfu/100/ml. The levels of total coliform count were 5.0 and 10 Cfu/100/ml. Faecal coliform was detected in all the groundwater samples. These values coupled with the detection of E.coli indicate faecal contamination which could pose harmful health effects.

The comparative analysis of wet and dry season's groundwater samples showed little variability as most of the parameters analysed for both seasons were consistent and largely within acceptable FMEnv and WHO limits for drinking water. For both seasons, there was evidence of bacteria isolates including the coliforms indicating bacterial contamination in drinking water in the study area.

- ***Ecology and Biodiversity***

Vegetation: The study area falls within the Sudan Savannah vegetation belt of Nigeria. The regional vegetation is a mixture of grasses and low growing shrubs and trees. The terrestrial plant life in the study area is typically a mixture of herbaceous flora especially of members of the grass family- the Poaceae and low growing woody species, with the herbaceous species being more abundant. Common grasses are *Setara pallid-fusca*, *Chloris gayana, Digitaria exilis and Eragrostis atrovirens.* Common woody species are *Azadirachta indica, Acacia Senegal, Vitellaria paradoxa*-all trees of economic importance.

A total of 122 species of plants cutting across 37 plant families and 107 genera were recorded from all the sampling points in the study area. The most dominant families with more than ten species are Fabaceae (27 species), Poaceae (22 species) and Asteraceae (14 species). Other dominant families were Malvaceae (9 species), Rubiaceae (6 species) and Euphorbiaceae (5 species). The families Commelinaceae and Cyperaceae were represented by three species each while other families were represented by either one or two species.

The predominant habitat within the project site and the entire study area is the modified habitat. The indigenous natural vegetation has over the years been largely converted by agricultural related practices such as farming and grazing. Although, there are fallow fields with shrubs and scattered woody vegetation particularly outside the boundaries of the project site, it is instructive to note that there are no rare communities, endangered species, riparian areas and wetlands within and around the boundaries of the project site.

Wildlife: A total of 72 species of animals comprising of 26 invertebrates and 46 vertebrates were recorded. Dominant families of the invertebrates with more than one species across all sampled plots were Pyrgomorphidae, Lygaeidae, Nymphalidae and Pieridae which were represented by two species each. For the vertebrates, the dominant families were Columbidae represented by four species, Laniidae and Ploceidae represented by three species each as well as Elapidae, Varanidae, Agamidae, Scincidae, Testudinidae, Phasianidae and Accipitridae represented by two species each respectively.

- ***Land Use/Land Cover***

The SPOT 5 satellite image of the study area shows that the predominant land use classes within the 200 hectares proposed project site are farmland and fallow field. Farmland covers an estimated 86.49 ha, representing 43% of the total area covered by the project site. Fallow field covers an estimated area of 83.039 ha, representing 41% of the total project site area. Built-up area constitutes the least land use area covered within the project site at 0.01% of the project site area. Water body class is not represented within the project site. The Footpath class represents the major route network within the project site with roads contributing to less than 1ha. For the study area, the predominant land cover is fallow field, which covers about 46% of the total area. This is followed by farmland, representing approximately 35% of the total area. The least land cover type observed in the area is Water body, which covers an estimated 0.02% of the study area.

- ***Socioeconomics***

Demography: The population of the study area is 5180 in which the ratio of male to female is 52: 48. About 46% of the populations of married persons are married with at least two wives, while the average number of children per household is 6.

Amenities and Utilities: The study area lacks good access road, safe drinking water and electricity. The area however has a few primary schools most of which lack both the spatial and infrastructural capacity to absorb the huge population of school aged children. There are no healthcare facilities within the villages except in the Dutse town which is approximately 5km away. The area is however adequately covered in terms of telecommunication facility and is flanked by the Federal University, Dutse. Well and borehole are the sources of drinking water; motor cycle is mostly used for transport while lantern and woods are used for domestic energy.

Educational Status

Up to 69% of the people are without the formal basic education (primary to junior secondary school attainment) while only 3% have attained tertiary education. However, about 28% of the population including some of those without formal education have been involved in Islamic/Koranic education.

Employment, Livelihood and Income

Farming is the main livelihood plied by the people of the study area; and they produce predominantly at subsistence level - rice, maize, guinea corn and millet. Other livelihood activities performed but at small scale levels are cattle and sheep rearing and menial trading. Although unemployment level in the area is not readily known as it appears to be high, given cheap labour characterized by the abundant unskilled labour force that exists in the area. In spite of the involvement of the people in farming and livestock, about 62% of households earn less than N30,000 per month and this equates to an average disposable income per head of N120 per day or equivalently USD 0.6 which puts the area in the classification of “extreme poor” based on United Nations standard. As a function of the extreme poverty situation, the level of vulnerability is high with 89 vulnerable persons (those above 60 years old, orphans, unemployed and persons of physically disability) were recorded, including 52 males and 37 females.

Land Tenure, Culture, Governance and Conflict Resolution Mechanism

Land in the study area is owned by inheritance. There are no cultural heritages or archeological monuments to be disturbed by the proposed project activities. There is a homogenous traditional administrative system in the villages that make up the study area.

The Emir is Head/Chairman of the Dutse Emirate Council and is supported by Councilors, District Heads, Village Heads and Ward Heads. All affected villages have common cultural procedures that govern the way civil cases and grievances including land disputes are resolved.

Perception of the People regarding the Proposed Project
The people of the project communities and stakeholders support the proposed project which they believe will create employment and stimulate business activities. In addition to employment, they expect the project sponsor to deliver safe drinking water, primary health care and access road to the villages.

Concerns about Proposed Project
The most expressed concern is loss of land. In particular, the affected households and communities are worried about how and who will compensate for their loss agricultural land. Their opinion converged around best compensation measures where their compensation entitlement is not paid through a third party to avoid elite capture and denial or shortchange. Other fears expressed by the communities are:

- Fears that the project will worsen their health conditions;
- Dust will be generated during the construction phase of the project and could cause upper respiratory infectious diseases;
- Fear that farms will be destroyed while they are not certain that the project will be implemented; and
- Fear of loss of source of income.

- ***Community Health Status***

Morbidity Pattern: Information obtained from respondents during the household survey showed that common sicknesses and diseases in the study area include cholera, cough and catarrh, diarrhea, dysentery and pneumonia with malaria, skin rashes and typhoid being the most common with high risk of re-occurrence. This was also consistent with available data from the health facility used by the affected communities.

Health Needs and Concerns: The health concerns of the affected communities in the study area include lack of health facilities, health personnel, sanitation services and poor nutrition. To remedy these concerns the respondents requested the following from project sponsor or government:

- Provision of medical facility and personnel such as health care center in their communities;
- Supply of infrastructure such as water, electricity and road. The demand for electricity ranked high, followed by water and road.
- Reduction in poverty level through employment creation and livelihood support that will boost their income in order to better improve on their nutrition.

STAKEHOLDERS ENGAGEMENT
In line with international best practice, consultations were held with relevant government Ministries, Department and Agencies (MDAs) as well as communities and social groups within the study area. These included a scoping workshop, focus group discussions, in-depth interviews and a public consultation forum.

The scoping workshop was held on 8th September 2015 at the State Library Complex, Dutse, while the public consultation forum took place at the same venue on the 28th of October 2015. The plan for engaging stakeholders throughout the lifecycle of the proposed project is described in Section 4.6.3. The aim of this plan is to have a clear cut plan/guideline that the project developer and/or those carrying out services on its behalf can follow to maintain social inclusion and responsiveness.

Concerns and Questions

The highlights of concerns and questions during consultations are presented below while the details of the various consultations held are presented in Chapter Four. Participants expressed concerns about:

- The privilege to enjoy free electricity from the project when completed.
- The future of the communities in terms of energy/electricity supply after 25 years of project life cycle.
- Functioning of the solar panels during harmattan period.
- Compensation payment.
- When and how compensation will be paid.
- Employment and the kind of employment that community members can get since many of their youths are not well educated or skilled.
- Assurance that NSPDL will comply/ implement ESMP to the letter.

CORPORATE SOCIAL RESPONSIBILITY

Specifically, for the proposed project, NSPDL shall allocate funds for the development and implementation of CSR related projects for the benefit of the local communities. Such funds shall be managed by a body that is representative of the affected communities as well as vulnerable groups. All CSR programs shall also be handled in a transparent manner that maximizes the benefits to the local communities. For example such funds could be used for:

- Installation of PV systems for use by community buildings; and
- Improving local social infrastructures such as schools, health facilities and water supply.

ASSOCIATED AND POTENTIAL IMPACTS

The proposed development will be a source of renewable electricity production and thus it is expected to have highly positive environmental and social impacts for the affected communities, people of Jigawa State and Nigeria at large. However the project will inevitably have some adverse impacts on the biophysical and social environment particularly during pre-construction, construction and decommissioning phases. The adverse impacts will largely be localized in spatial extent, short term and occurring within less sensitive environmental areas. These adverse negative impacts are manageable through the application of appropriate mitigation measures and can largely be avoided by sound design, good construction practices, effective maintenance and adequate supervision and enforcement during the project life cycle. The significant environmental and social impacts of the proposed project are highlighted below:

Potential Positive Environmental and Social Impacts

- ✓ Cost effective, renewable and clean energy generation;
- ✓ Employment opportunities, increased economic activity, improved livelihood and poverty reduction;
- ✓ Infrastructural development including improved access road;
- ✓ Generation and improved electricity supply and reliability;
- ✓ Increased revenue generation and cost savings for government.

Potential Negative Environmental and Social Impacts

❖ **Impact on Air Quality and Noise Level**

- Deterioration of local air quality due to the release of fugitive dusts & gaseous pollutant emissions during the preconstruction, construction and decommissioning phases.
- Noise disturbances from equipment & truck traffic during pre-construction and construction phases.

❖ **Impact on Soil**

- Soil erosion from activities such as site clearing, excavation, soil stockpiling and vehicular traffic during preconstruction and construction phases.
- Soil contamination from accidental leakages or spills of hazardous materials such as fuels, oils and lubricants and improper disposal of waste during construction, operation and decommissioning phases.
- Generation of non-hazardous and hazardous wastes during construction, operation and decommissioning phases.

❖ **Impact on Ecology and Biodiversity**

- Loss of vegetation/habitat fragmentation resulting from site clearing activities.

Potential Negative Social Impacts

The significant potential negative social impacts of the proposed project are highlighted below.

- Loss/depletion of farm land.
- Loss of land based livelihood and exacerbated poverty.
- Loss of economic trees including medicinal herbs.
- Grievance & conflicts over land resettlement & compensation.
- Loss of ecosystem provisioning services e.g. economic trees
- Traffic congestion & increased risk of RTA and injuries.
- Risk of security breaches and threat to lives and properties.
- Change in land use pattern from agro-forestry to industrial use.
- Risk of communicable & vector-borne diseases such as STDs including HIV/AIDS.
- Increase demand on existing health & sanitation infrastructure in affected communities.
- Increased social vices/crimes & dilution of indigenous culture in nearby communities.
- Risks of exposure to occupational health and safety hazards, accidents and injuries.

MITIGATION AND ENHANCEMENT MEASURES

The approach adopted for selecting appropriate mitigation measures followed a mitigation hierarchy that favours the avoidance of impacts over minimization, and where residual impacts remain, compensate/offset for impacts to workers, affected communities and the environment, wherever technically and financially feasible. The mitigation measures will be included in the bid documents for the EPC contractor to implement. The mitigation measures proffered for the significant potential negative environmental and social impacts of the proposed project are described below:

Mitigation Measures for Potential Negative Environmental Impacts

To address the significant potential negative impacts on the biophysical environment, NSPDL through its EPC Contractor shall inter-alia undertake the following measures accordingly:

❖ ***Mitigation Measures for Air Quality Deterioration***

- Implement dust suppression techniques such as, use of (i) water suppression for control of loose soil materials on unpaved surfaces and (ii) covered trucks for transporting loose materials that may generate dust.
- Pave access roads with gravel to minimize release of dust.
- Implement routine preventative maintenance including tune-ups on all heavy equipment to meet the manufacturer's specification in order to ensure efficient combustion and minimal emissions.
- Ensure speed limits are reduced and enforced especially on unpaved roads to minimize airborne fugitive dusts.
- Train drivers/ workers on proper operation of vehicles and equipment to include fuel efficiency and anti-idling techniques.
- Limit soil disturbance activities & travel on unpaved roads during periods of high wind.
- Reroute access roads away from immediate outskirt of communities as much as possible.

❖ ***Mitigation Measures for Noise***

- Restrict all haulage and noise generating activities to working hours during the day when noise is better tolerated.
- Site stationary noise generating construction equipment with consideration of distances from the noise sources to nearby communities and sensitive receptors.
- Select and use (where feasible) vehicles and equipment with lower sound power levels.
- Install suitable mufflers on engine exhausts and compressor components.
- Ensure the maintenance of all equipment in accordance to manufacturer's specifications.
- Ensure vehicle travelling within and around project area are operated in accordance with speed limits to reduce vehicle noise levels.
- Develop a mechanism to record and respond to noise complaints.
- Provide and enforce the usage of hearing protection devices (ear plugs/muffs) for workers exposed to noise levels >90 dB(A) for a duration of more than 8 hours/day.
- Institute a Hearing Protection Program for workers in work areas with noise in excess of 85 dB(A).

❖ ***Mitigation Measures for Soil Erosion***

- Avoidance of vegetation and trees removal to the extent possible.
- Restriction of vegetation removal to construction site only in order to minimize the footprint of disturbed areas.
- Protection of all vegetation not required to be removed against damage.
- Re-vegetation of all bare and exposed soils with native vegetation immediately after construction to prevent erosion.
- Implement soil conservation measures such as stockpiling topsoil or gravel for the remediation of disturbed areas.
- Usage of erosion protection structures such as sediment traps, riprap, gabions, etc. wherever possible to capture run-off sediments.
- Usage of gravel to cover unpaved access road surface for added protection against erosion and run-off.

❖ ***Mitigation Measures for Soil Contamination***

- Ensure compliance with all applicable national and international laws and regulations and conform to relevant industry standards.
- Prepare and implement a Spill Prevention and Emergency Response Plan (SPERP) to address the possibility of accidental releases of all hazardous materials stored on-site.
- Ensure that vehicle refueling and maintenance as well as storage of diesel and oil shall conform to best practices to ensure there are no spillages or leakages.
- Ensure all vehicles are in proper working condition to avoid leaks of motor oil, hydraulic fluid and other hazardous materials.
- In case of suspected or confirmed soil contamination, shall ensure identification of the root cause of the uncontrolled release and correction to avoid further releases and associated adverse impacts.

❖ ***Mitigation Measures for Solid Waste Generation***

- Ensure compliance with all applicable national and international laws and regulations on non-hazardous and hazardous waste management.
- Develop and Implement a site-specific Waste Management Plan (WMP) that addresses issues linked to waste minimization, generation, transport, disposal, and monitoring.
- Establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- Implement feasible waste prevention, reduction, reuse, recovery & recycling measures.
- Identify and implement pollution prevention opportunities such as use of material substitution for less hazardous alternatives, recycling and waste minimization.
- Minimize hazardous waste generation by segregating hazardous from nonhazardous wastes.
- Ensure that hazardous wastes are stored in properly labelled closed containers and provide secondary containment to the extent feasible.
- Ensure hazardous materials and waste storage areas are formally designated and access restricted to authorized persons.
- Ensure proper disposal/treatment of waste by government approved waste vendor.

❖ ***Mitigation Measures for Liquid Waste/Wastewater***

- Ensure water use efficiency to reduce the amount of wastewater generation.
- Ensure the use of non-toxic detergent for panel cleaning to avoid the release of hazardous substances in wastewater.
- Ensure adequate drainage system are constructed around the site to ensure smooth flow of storm water/waste water
- Ensure proper monitoring and disposal of wastewater including sanitary waste

❖ ***Mitigation Measures for Ecology and Biodiversity***

- Avoid the removal of natural vegetation and trees, especially species of *Acacia senegal* and *Phoenix dactylifera* which mostly occur in isolation.
- Restrict the removal of natural vegetation to construction site only.
- Retain all short (<18 cm) native vegetation to the maximum extent possible.
- Retain native root structure within the project area to facilitate recovery of vegetation cover, retain soil stability and minimize erosion.
- Ensure work personnel limit their activities within the RoW during erection of pylons and laying of overhead transmission line.
- Revegetate temporary disturbed areas with native species immediately following the completion of construction activities to ensure all temporary use areas are restored.
- Develop and implement a project specific Integrated Vegetation Management Plan (IVMP) to revegetate part of the solar array area.
- Relocate any reptile or amphibian species found in harm's way away from construction activity.

Mitigation Measures for Potential Negative Social Impacts

❖ ***Mitigation Measures for Land Acquisition and Involuntary Resettlement***

- Develop and implement a Resettlement Action and Livelihood Restoration Plan (RALRP) to compensate affected persons and/or communities.
- Avoid forced eviction of farmers from their farmlands.
- Ensure all issues relating to compensation are handled in a transparent, consistent and equitable manner.
- Ensure adequate engagement with affected persons and communities throughout the process of land acquisition.
- Ensure disclosure of relevant information and participation of affected communities and persons continue through implementation, monitoring and evaluation of compensation payments.
- Ensure affected land owners are adequately compensated for loss of land and economic crops at full replacement cost.
- Provide opportunities to affected persons and communities to derive appropriate development benefits such as employment, from the project.
- Establish a grievance mechanism to receive and address specific concerns about compensation.

❖ ***Mitigation Measures for Road Traffic Related Impacts***

- Engage drivers with appropriate class of driving license and at least three years of driving experience.

- Train drivers on defensive driving techniques, haulage safety and pedestrian safety.
- Develop and implement a Traffic Management Plan (TMP) and safe traffic control measures to include: Establishment and strict enforcement of speed limits; Employment of appropriate road safety signages and on-site trained flag-men with high-visibility vests to direct traffic and warn of dangerous conditions; and Minimization of movement at peak hours of the day.
- Ensure coordination with emergency agencies to ensure that appropriate first aid is provided in the event of accidents.
- Where possible, use locally sourced materials to minimize transport distances.

❖ ***Mitigation Measures for Community Health, Safety and Security Issues***

- Institution of HIV prevention program to include peer education, condom distribution and Voluntary Counselling and Testing (VCT).
- Undertaking health awareness and education initiatives on STIs amongst workers and in affected communities.
- Restriction of unauthorized access to all areas of high tension potential to prevent electrocution.
- Establishment of "No Approach" zones around or under high voltage power lines in conformance with TCN requirements.
- Use of proper signages (in English and local languages) and engineering barriers (e.g. fencing) to limit access to electrically energized equipment and conductors in order to prevent access to electrical hazards by unauthorized individuals and wildlife.
- Fencing of solar facilities from surrounding communities.
- Installation of CCTV surveillance system.
- Deployment of competent security personnel to secure project site.
- Adequate training of security personnel.
- Disclosure of on-site security arrangements to the public especially members of nearby communities.

❖ ***Mitigation Measures for Occupational Health and Safety Related Impacts***

The objectives of mitigation measures for avoiding, minimizing and controlling occupational health and safety potential impacts of the proposed project will be based on a comprehensive hazard analysis and the development of a project specific Occupational Health and Safety Plan (OHSP). The OHSP will inter-alia entail: Provision of health and safety orientation training and hazard specific training; OHS responsibilities; Site health and safety rules and instructions; Safe work practices; Daily toolbox talks; OHS Communication including Incident/Accident reporting; Emergency contingency plan; Provision and enforcement of use of PPE.

❖ **Enhancement Measures for Potential Positive Environmental Impacts**

Most of the positive environmental impacts of the proposed project are those related to the utilization of renewable resources and avoidance of fossil fuel with attendant reduced GHGs and other pollutant gas emissions during operation. To enhance these impacts, NSPDL shall ensure peak electricity generation from the solar plant through proper maintenance of the facility and prompt replacement of damaged/faulty PV panels and other equipment.

❖ Enhancement Measures for Potential Social Impacts

Enhancement Measures for Direct Employment

The measures to be implemented to enhance the impact of direct employment during preconstruction, construction and operation phases of the project in order to improve local economy shall include the following:.

- Development and implementation of a Labour and Employment Plan (LEMP) in line with international employment guidelines and IFC Performance Standard 2: Labour and Working Conditions. The Plan shall detail percentages and numbers of workforce to be sourced from the local areas and various demographics.
- Notification of Community representatives and Dutse LGA of the specific jobs and skills required for the project prior to commencement of recruitment.
- Initiation of training and skills development programs prior to the commencement of construction to ensure members of local workforce are up-skilled and can be employed on the project or other industrial developments in the area.
- Ensuring construction jobs are targeted to the local people.
- Ensuring technology transfer by training indigenous people on solar plant management, operation and maintenance.
- Promotion of fair treatment, nondiscrimination, and equal opportunity of workers.
- Protection of workers, including vulnerable categories of workers e.g. women
- Promotion of safe, healthy working conditions & the health of workers.
- Provision of a grievance mechanism for workers to freely raise workplace concerns.
- Prohibition of employment of minors and avoidance of the use of forced labor.

❖ *Enhancement Measures for Procurement and Indirect Employment*

The construction and operation of the proposed solar PV power facility will create opportunities for the supply of goods and services to the project and in turn, indirect employment will be created in the supply chain. The following enhancement measures will be implemented to ensure that business opportunities emanating from the project are maximized:

- Local and regional procurement targets will be included in the project's LEMP
- NSPDL shall include requirements for local employment in the contract that they establish with the EPC/O&M Contractors and require that the contractor recruits in accordance with the NSPDL's recruitment policy.

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

An ESMP is a management tool used to ensure that undue or reasonably avoidable adverse impacts of proposed project are prevented and that benefits of the project are enhanced. It helps to ensure that the management actions (mitigation and enhancement measures) arising from the ESIA process are clearly defined and implemented through all the phases of the project lifecycle.

The ESMP for the proposed project has been developed and will be implemented using the Environmental and Social Management System (ESMS) approach, which draws on the elements of the established business management process of "plan, do, check and act" similar to the ISO 14001 EMS. The key elements that are necessary in managing the environmental and social impacts of the proposed solar PV project and achieve the desired economic, environmental and social outcomes are included the ESMP. These elements include Policy; Significant associated and potential environmental and social impacts of the proposed project; Environmental and Social Management Programs; Organizational Capacity and Competency; Emergency Preparedness and Response; Stakeholder Engagement; as well as Monitoring and Review.

NSPDL shall be responsible for the implementation of the ESMP and ensuring that the environmental and social requirements are satisfied by its EPC/O&M contractors. The roles and responsibilities of persons and institutions that will be involved in the implementation are included in the ESMP. As part of the ESMP, a project specific monitoring plan has been designed. This plan establishes environmental and social action plans with well defined desired outcomes and actions to address all significant impacts identified for the proposed project. The Plan is presented in Chapter Seven. The total estimated cost for the implementation of ESMP is N45,100,000. The cost of mitigation by the EPC Contractor shall be included in the contract as part of the project implementation cost.

ABANDONMENT, DECOMMISSIONING AND REMEDIATION PLAN

The design and planned life span for the proposed solar plant is approximately 20 years. However, the life span of the plant can be considerably extended well beyond that limit with proper maintenance to sustain the facility. NSPDL through the O&M contractor shall develop a comprehensive abandonment, decommissioning and remediation plan that is specific to the project taking into account the most cost-effective and practicable methods, environmental considerations, legal requirements and industry practices at that time.

CONCLUSIONS

The ESIA study for the proposed 80 MW_{AC} solar PV plant near the town of Dutse, Jigawa State has been carried out in line with the EIA Act Cap E12 LFN 2004, EIA Sectoral Guidelines for Power Sector, 2013 as well as other relevant national and international standards including the IFC Performance Standards on Environmental and Social Sustainability and Equator Principles.

The proposed project is expected to have highly positive social impacts on the affected communities, people of Jigawa State and Nigeria at large. Specifically, the proposed project will be most beneficial to the local economy as it will promote industrial growth and provide direct and indirect employment opportunities and thereby improve livelihood and enhance poverty reduction especially in affected communities.

The most notable negative social impacts are those related to land acquisition for the project while significant negative environmental impacts include air quality deterioration, loss of vegetation, soil erosion and waste generation. Negative environmental impacts are largely localized in spatial extent, short term and occurring within less sensitive environmental areas. They can be easily managed by the application of appropriate mitigation measures proposed in this ESIA Report. In consideration of the above therefore, there is no major environmental or social issue to impede the implementation of the proposed development of solar PV project.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Nova Scotia Power Development Limited (NSPDL) is planning to develop a ground-mounted 80 MW_{AC} Solar Photovoltaic (PV) plant. The proposed site for the project known as Dutse-2 is located at a distance of about 5 km from the town of Dutse in Dutse Local Government Area (LGA) of Jigawa State, Nigeria. The area covering approximately 200 hectares of land falls within Latitude 11.6815N and Longitude 9.3858E. The project location also include the 3.66 km Right of Way (RoW) for the transmission route through which electricity generated will be transmitted to the Dutse substation for onward connection to the national grid. The transmission route falls within Latitude 11.68728N to 11.69109N and Longitude 9.38058E to 9.35066E.

Nigeria's deficient power sector supply has been a challenge that past administrations have steadfastly sought to address. The electricity supply – demand gap in Nigeria has continued to increase with expanding economy and rapidly increasing population, thereby leaving an estimated 50% of Nigeria's population without grid connected electricity. In a bid to address the deficiency in electricity supply, the Federal Government in 2001 adopted the National Electric Power Policy (NEPP) for the reform of the sector. This was followed by the promulgation of the Electric Power Sector Reform Act (EPSRA) in 2005. A key thrust of the sector reform is the transfer of the control and operation of the industry from public sector to the private sector. The Renewable Energy Master Plan (REMP) for Nigeria of 2006 further articulates a roadmap for national development through the accelerated development and exploitation of renewable energy. It aims to increase the contribution of renewable energy to account for 10% of Nigerian total energy consumption by 2025.

In pursuant of the reforms, a roadmap for Power Sector Reform was developed in 2010. The roadmap, amongst other things, outlines the plans and strategies to finalize the drive to complete power sector reform and sets the nation on a steady course to produce clean and efficient electricity for its citizens at competitive rates.

The proposed project is NSPDL's response to various governments' policy initiatives and call for private sector investment in the power sector. NSPDL plans to develop an independent solar power plant to generate and supply additional 80 MW_{AC} of renewable electricity to boost national power supply and specifically provide the Jigawa State and surrounding areas with indigenous, carbon free electricity.

In compliance with the provisions of the Environmental Impact Assessment (EIA) Act No. 86 of 1992 (as amended by EIA Act Cap E12 LFN 2004), and requirements of key international development partners, NSPDL has commissioned an EIA (also known as Environmental and Social Impact Assessment - ESIA) study of the proposed development. The overall goal of ESIA is to identify and assess the potential environmental and social[1] impacts of the proposed project, evaluate alternatives and

1. Social impact includes impacts on economy, culture, labour and community health

propose appropriate measures to mitigate the significant adverse effects and enhance potential benefits in order to ensure that the proposed project is environmentally and socially sustainable. This document is the Draft Report presenting the outcome of the ESIA study for the proposed development of 80 MW_{AC} PV solar plant facility.

1.1.1 Project Proponent

The project proponent is Nova Scotia Power Development Limited (NSPDL). NSPDL was incorporated in Nigeria under the Companies and Allied Matters Act 1990, on the 12th of September, 2013 with registration number RC 1141701. The registered address of the company is 15 Buchanan Crescent, Wuse 2, Abuja.

NSPDL is a consortium comprising CPCS Development International Ltd (CDIL) (Barbados) and Business Process Solutions (BPS) Consult Ltd (Nigeria) with 80% and 20% shares respectively. The company is set up as a Special Purpose Vehicle (SPV) specifically to develop, finance, construct and operate solar parks such as the proposed 80 MW_{AC} solarPV facility in Jigawa State, Nigeria.

1.2 Terms of Reference of the ESIA Study

The Terms of Reference (ToR) for the ESIA study was prepared and submitted to the Federal Ministry of Environment (FMEnv) in line with the requirements of the National EIA Procedural Guidelines. The ToR defined the objectives and highlighted the scope, approach, methodology and reporting format for the ESIA study. The detailed approved ToR for the proposed project is attached as Appendix 1.1 of this Report.

1.3 Objectives of the ESIA Study

The main objective of this ESIA is to evaluate proactively the potential environmental and social impacts of the proposed project with a view to ensuring that it exerts minimum or no adverse impact on the physical, biological and social environment. The goal is to ensure that all project activities, throughout the life cycle of the project, are environmentally and socially sound and sustainable.

The specific objectives of the ESIA are to:

- Comply with applicable national laws and other international requirements for environmental and social sustainability;
- Identify all environmental aspects of the proposed project that may interact positively or negatively with the environment and the socioeconomic wellbeing of the local communities within the project area of influence (AoI);
- Acquire all necessary environmental and socioeconomic baseline data that will form the basis for mapping the existing state of the environment in the project area (before the installation of PV panels);
- Identify and evaluate the potential risks and impacts of the proposed project activities on the physical, biological and social environment;
- Recommend appropriate measures to avoid, minimize, compensate for or offset potential negative impacts and enhance positive impacts of the proposed project during its preconstruction, construction, operation and decommissioning phases;
- Develop an appropriate and project specific Environmental and Social Management Plan (ESMP) that includes a monitoring plan for the proposed project;
- Provide all necessary answers to stakeholders including local communities that are likely to be directly affected by the proposed project (affected communities),

regulators, donors and other interested parties on the environmental and social compatibility and sustainability of the project;
- Provide means for adequate engagement with affected communities throughout the project life cycle; and
- Ensure relevant environmental and social information is disclosed and disseminated to affected communities and other stakeholders.

1.4 Scope of the ESIA Study

The scope of work for the ESIA study included the following:

- Reconnaissance survey to acquaint the ESIA team with the environmental and social nomenclature of the project AoI;
- Review of project-specific background documents and other relevant literatures;
- Identification and review of pertinent national and international policies, laws, regulations and guidelines governing environmental quality, environmental assessment and the project;
- Scoping exercise to determine the scope and establish the boundaries for the ESIA study;
- One Season field data gathering (in accordance with the ToR approved by FMEnv) and laboratory analysis to obtain environmental and socioeconomic baseline data to fill information/data gaps;
- Description of the existing bio-physical and social environment of the project AoI including the Right of Way (RoW) for the transmission route/corridor;
- Full description of project activities and identification of potential impacts associated with preconstruction, construction, operation and decommissioning phases;
- Qualification of potential impacts, their prediction and evaluation of their significance using appropriate models;
- Identification of effective measures to avoid or reduce the effect of identified impacts on the environment and affected communities;
- Identification of interested and affected parties within the project AoI for effective consultation and engagement;
- Development of a comprehensive ESMP; and
- Preparation of ESIA Report.

1.5 Administrative, Policy and Legal Framework

The ESIA study was carried out in accordance with FMEnv's relevant policies, laws, regulations and guidelines particularly the EIA Procedural Guidelines and Sectoral Guidelines for the Power Sector, International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability, Equator Principles of Financial Institutions, applicable World Bank safeguard operational policies and other relevant international treaties and agreements to which Nigeria is a party. This section provides an overview of the administrative framework as well as the laws and key regulations that apply to the proposed project.

1.5.1 Administrative Framework

The relevant Ministries, Departments and Agencies (MDAs) primarily responsible for regulation of the Environment and Power sectors at the federal and state levels are presented below.

1.5.1.1 Federal Ministry of Environment

The Federal Ministry of Environment (FMEnv) formerly the Federal Environmental Protection Agency (FEPA) which was established through Decree No. 58 of 1988 as amended by Decree No. 59 of 1992 is the statutory government institution mandated to coordinate environmental protection and natural resources conservation for sustainable development in Nigeria. The Ministry's mandate inter alia is to:

- Protect the environment and conserve natural resources, including procedure for environmental impact assessment of all developing projects;
- Advise the Federal Government on national environmental policies and priorities, the conservation of natural resources and sustainable development and scientific and technological activities affecting the environment and natural resources; and
- Prescribe standards for and make regulations on water quality, effluent limitations, air quality, atmospheric protection, ozone protection, noise control as well as the removal and control of hazardous substances.

1.5.1.2 National Environmental Standards and Regulations Enforcement Agency (NESREA)

National Environmental Standards and Regulations Enforcement Agency (NESREA) was established by NESREA Act No 25 of 1997 as a parastatal of the then Federal Ministry of Environment, Housing and Urban Development (now FMEnv). By the NESREA Act, the FEPA Act Cap F 10 LFN 2004 was repealed. NESREA is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria. It also has the responsibility to enforce compliance with provisions of international agreements, protocols, conventions and treaties on the environment to which Nigeria is signatory.

1.5.1.3 Federal Ministry of Power

The Federal Ministry of Power (FMP) has the overall responsibility for the provision of power in the country. The Ministry is empowered to provide the nation with adequate and reliable power supply by implementing generation, transmission and distribution projects in the sector and facilitating the emergence of a private sector led competitive and efficient electric power industry. The Ministry in discharging this mandate is guided by the provisions of the National Electric Power Policy (NEPP) of 2001, the Electric Power Sector Reform (EPSR) Act of 2005, and the Roadmap for Power Sector Reform (RMPSR) of August 2010. It currently has four (4) parastatals, namely, the Energy Commission of Nigeria (ECN), Nigerian Electricity Regulatory Commission (NERC), Transmission Company of Nigeria (TCN) and the Rural Electrification Agency (REA).
FMP functions include but are not limited to:

- Initiating and formulating broad policies and programmes on the development of the power sector (electricity) in general;
- Initiating concessions in the power sector of the economy;
- Implementing renewable energy programmes/initiatives (solar, wind, biomass, small hydro etc); and
- Coordinating activities of power sector.

1.5.1.4 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency established under the EPSR Act of 2005. The Commission has developed business objectives that are mapped to each of its key goals on uninterrupted electricity, private sector participation, consumer protection and fair regulation. NERC's functions inter-alia are to:

- Create, promote, and preserve efficient industry and market structures, and ensure the optimal utilization of resource for the provision of electricity services;
- Maximize access to electricity services, by promoting and facilitating consumer connections to distribution systems in both rural and urban areas;
- Ensure that an adequate supply of electricity is available to consumers;
- Ensure that the prices charged by licensees are fair to consumers and are sufficient to allow the licensees to finance their activities and to allow for reasonable earnings for efficient operation; and
- Ensure the safety, security, reliability, and quality of service in the production and delivery of electricity to consumers.

Under the EPSR Act, NERC is empowered to license and regulate persons engaged in the generation, transmission, system operation, distribution and trading of electricity.

1.5.1.5 Nigerian Bulk Electricity Trading Plc (NBET)

The Nigerian Bulk Electricity Trading Plc, (NBET) (otherwise known as the ***Bulk Trader***) was incorporated on July 29, 2010 as the SPV for carrying out, under license from NERC, the bulk purchase and resale function contemplated by the EPSR Act. As such, NBET has been set up to "engage in the purchase and resale of electric power and ancillary services from Independent Power Producers (IPP) and from the successor generation companies". NBET purchases electricity from the generating companies through Power Purchase Agreements (PPAs) and sells to the distribution companies (DisCos) and eligible customers through Vesting Contracts. NBET's mandate includes:

- To put in place an effective transaction environment which minimizes risk and allocates it fairly to the parties best able to manage it.
- To implement a procurement process that is transparent and will result in the economic procurement of needed power.
- To enter into contracts that are well structured and managed in a manner that precludes recourse to any credit guarantee instrument.
- To novate contracts and wind up as soon as the DISCOs are ready to take on their own procurement.

1.5.1.6 Transmission Company of Nigeria (TCN)

Transmission Company of Nigeria (TCN) was incorporated in November 2005. 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. Being one of the 18 unbundled Business Units under the Power Holding Company of Nigeria (PHCN), the company was issued a transmission license on 1st July, 2006. TCN licensed activities include: electricity transmission, system operation and electricity trading which is ring fenced.

1.5.1.7 Jigawa State Ministry of Environment

The Jigawa State Ministry of Environment (JSME) was created in September 2007. The mandate of the Ministry inter-alia include to:

- Ensure sustainable development of the environment of the State.

- Ensure a qualitative and healthy environment thereby ensuring the well-being of the people of Jigawa State.
- Conserve, protect and enhance the environment, the ecosystem and ecological processes essential for the preservation of biological diversity.
- Control and monitor all forms of environmental degradation.
- Ensure sustainable management of the State forest to meet economic, social and ecological needs of the people of the state.
- Cooperate and collaborate with the Federal, Local Governments and Non-Governmental Organizations (NGO), private sector and individuals on environmental matters.

1.5.1.8 Jigawa State Environmental Protection Agency (JISEPA)

The Jigawa State Environmental Protection Agency (JISEPA) was established in August, 2009 by the Jigawa State Environmental Protection Agency Law of January 2009. The functions of the Agency amongst others include to:

- Promote a healthy environment by ensuring sanitary solid waste management;
- Minimize waste generation and promote sorting at source, re-use, recycling and energy recovery;
- Ensure safe and nuisance free disposal of urban and rural domestic and industrial waste in order to adequately protect public health;
- Prevent or stop illegal felling of trees, encroachment into pavements, forest reserves and plantation without the Agency's approval; and
- Issue permits, liscences, and approvals and to administer certification system and operation procedures as may be required by law.

1.5.1.9 Jigawa State Ministry of Lands, Housing, Urban Development and Regional Planning

The Ministry was established to ensure proper land administration and management in the State. The responsibilities of the Ministry amongst others include the following:

- Establishment of a sustainable land information system that will ensure easy access to land related data on all parcels of land in the state towards easing the preparation of Certificate of Occupancy (C of O) on Government land at all levels and all owned by individuals and corporate bodies.
- Ensuring access to land for any infrastructural development.
- Operation of a smooth land administration system that is customer-friendly and one that is capable of enhancing and promoting the socio-economic growth of all.
- Provision of survey plans on all land parcels owned by Governments, individuals and corporate institutions all over the state.

1.5.1.10 Dutse Local Government

Dutse Local Government where the proposed project will be sited is one of the 27 LGAs in Jigawa State. The LGA has a Local Government Committee (LGC) on Environment and a Water, Sanitation and Hygiene (WASH) Department that are responsible for environmental issues within the LGA. Environmental matters at the local government level are essentially guided by the JISEPA law.

1.5.2 Policy and Legal Framework

The section describes environmental and social policies and legislation that are applicable to the proposed project.

1.5.2.1 Nigerian Environmental Policy and Legislation

The relevant Federal and State environmental policies, legislation, guidelines and regulations that are applicable to the proposed project are discussed below.

❖ ***National Policy on the Environment 1989 (Revised 1999)***

The National Policy on the Environment describes the conceptual framework and strategies for achieving the overall goal of sustainable development in Nigeria. It underscores the need to put in place policies, strategies and management approaches that will ensure amongst others that:

- Environmental concerns are integrated into major economic decision- making process;
- Environmental remediation costs are built into major development projects;
- Economic instruments are employed in the management of natural resources;
- Environmentally friendly technologies are applied;
- Environmental Impact Assessment is mandatorily carried out before any major development project is embarked upon; and

The goal of the Policy in particular is to:

- Secure a quality of environment adequate for good health and well-being;
- Conserve and use the environment and natural resources for the benefit of present and future generations;
- Restore, maintain and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of living natural resources and ecosystems;
- Raise public awareness and promote understanding of the essential linkages between the environment, resources and development, and encourage individual and community participation in environmental improvement efforts;
- Co-operate with other countries, international organizations and agencies to achieve optimal use of trans-boundary natural resources and effective prevention or abatement of trans-boundary environmental degradation.

❖ ***EIA Act No 86 of 1992 (as amended by EIA Act Cap E12 LFN 2004)***

The EIA Act No. 86 of 1992 as amended by EIA Act Cap E12 LFN 2004 is the principal legislative instrument relating to activities that may likely or to a significant extent affect the environment. The Act sets the goals and objectives of EIA and procedures including the minimum requirements for the conduct of EIA of public or private projects. The Act makes EIA mandatory for all major development projects likely to have adverse impacts on the environment and gives specific powers to FMEnv to facilitate environmental assessment of projects in Nigeria.

❖ ***Forestry Act, 1994***

The Act provides for the preservation of forests and the setting up of forest reserves. The Act makes it an offence, punishable with up to 6 months imprisonment to cut down trees over 2 feet in girth or to set fire to forest except under special circumstances.

❖ ***Endangered Species (Control of International Trade and Traffic) Act No. 11 of 1985***

In pursuant to the Convention on International Trade in Endangered Species (CITES) of wild fauna and flora, to which Nigeria is a signatory, the Federal Government of Nigeria enacted the Endangered Species (Control of International Trade and Traffic) Act No. 11

of 1985. The Act amongst others provides for the conservation and management of Nigeria's wild life and the protection of some of her species in danger of extinction as a result of over-exploitation.

❖ ***Harmful Wastes (Special Criminal Provisions etc.) Act No. 42 of 1988***
An Act to prohibit the carrying, depositing and dumping of harmful waste on any land, territorial waters and matters relating thereto. Specifically, Section 1 of the Act prohibits all activities relating to the purchase, sale, importation, transit, transportation, deposit, storage of harmful wastes. Section 6 of the Act spells out the penalty for offences under the Act to include life imprisonment for individual and appropriate punishment for corporate bodies.

❖ ***NESREA Act No. 25, 2007***
The NESREA Act No. 25 of 30th July, 2007 established NESREA and empowers her with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria. The Act spells out the functions, powers, structure, staffing of the Agency as well as financial and other miscellaneous provisions.

❖ ***JISEPA Law, 2009***
The JISEPA Law promulgated on the 6th of January, 2009, established the JISEPA to be responsible for ensuring a sustainable environment in Jigawa State. The Law spells out the powers and functions of JISEPA and makes provision for the establishment of a Board for the Agency as well as State and Local Committees on Environment.

❖ ***EIA Procedural Guidelines, 1995***
In furtherance to its mandate of protecting the environment and conserving natural resource, the FMEnv developed procedural and sectoral guidelines for developmental projects in major sectors of the nation's economy in order to ensure the environmental sustainability of these sectors through the EIA Act. The Procedural Guidelines indicate the steps to be followed in the EIA process from project conception to commissioning in order to ensure that the project is implemented with maximum consideration for the environment. The Guidelines also include the categorization of environmental projects.

Projects are classified into three categories as follows:

- Category I projects: Projects that will require a full EIA.
- Category II projects: Projects that may require only a partial EIA, which will focus on mitigation and environmental planning measures, unless the project is located near an "Environmentally Sensitive Area" (ESA) in which case a full EIA is required.
- Category III projects: Projects that are considered to have "essentially beneficial impacts" on the environment, for which an Environmental Impact Statement (EIS) will be prepared by the FMEnv.

The proposed project has been classified by the FMEnv into Category I requiring mandatory EIA studies and a panel review meeting.

❖ ***EIA Sectoral Guidelines for Power Sector, 2013***
The EIA Sectoral Guidelines for Power Sector apply to this project. These guidelines were designed to assist project proponents in conducting detailed environmental assessment of projects with emphasis on the significant associated and potential impacts of such projects on the environment. Mitigation plans and measures for

minimizing or alleviating any adverse impacts as well as future monitoring programme for ensured sustainability of project area are also contained therein for guidance. The guidelines cover the present and future forms of energy (electricity) production in Nigeria including hydropower, thermal (fossil fuel), solar power, biomass and nuclear power plants. Power transmission and distribution projects are also covered by the guidelines.

❖ **Guidelines and Standards for Environmental Pollution Control in Nigeria, 1991**

The Guidelines and Standards for Environmental Pollution Control in Nigeria, was promulgated in March 1991 to serve as a basic instrument for monitoring and controlling industrial and urban pollution. They relate to six areas of concern, namely:

- Effluent limitations
- Water quality or industrial water uses at point of intake
- Industrial emission limitations
- Noise exposure limitations
- Management of solid and hazardous wastes
- Pollution abatement in industries

Specifically, it provides effluent limitation guidelines for various categories of industries as well as water quality requirements for various industries and processes. It adopts the World Health Organization (WHO) limits for domestic water use. It also provides gaseous emissions and ambient air quality limitations as well as guidelines for the management of solid and hazardous wastes. It provides interim permissible limits as protective measures against indiscriminate discharge of particulate matter and untreated industrial effluents.

❖ ***National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991 (S.I.No.9)***

The Regulations impose restrictions on the release of toxic substances and stipulates requirement for pollution monitoring units, machinery for combating pollution and contingency plan by industries; requirement of permit by industries for storage and transportation of harmful toxic wastes; the generators liability; strategies for waste reduction; solid wastes to be disposed of in environmentally safe manner; protection of workers and safety requirements; and penalty for contravention.

❖ ***National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991 (S.I.No.15)***

The Regulations make provisions for the handling and management of solid hazardous waste. It defines the objectives of hazardous waste management, the functions of appropriate Governmental agencies and the obligations of industries. It also contains the dangerous waste lists and guidance on the management of spills and discharges into the environment. It requires a manifest system for waste that should include information on packaging, labeling and marking. It defines the requirements of ground water protection, surface impoundment, land treatment, waste piles, etc. It also describes the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituent. It also states the requirements and procedure for inspection, enforcement and penalty.

- **National Environmental (Sanitation and Wastes Control) Regulations, 2009, (S.I. No.28)**

The purpose of the Regulation is the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution. The Instrument amongst others makes provisions for the control of solid wastes, hazardous wastes and effluent discharges. It in addition, spells out roles and responsibilities of State and Local Government Authorities.

- **National Environmental (Electrical/Electronic Sector) Regulations, 2011. (S. I. No. 23)**

The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the Electrical/Electronic Sector. This Regulation covers both new and used Electrical/Electronic Equipment (EEE). The principles of the Regulations are anchored on the 5Rs which are Reduce, Repair, Re-use, Recycle and Recover as the primary drivers of the sector. The Regulations encompass all the categories and EEE lists specified in Schedule I of the Regulations.

- **National Environmental (Soil Erosion and Flood Control) Regulations, 2011 (S.I. No.12)**

The purpose of these Regulations is to establish technically feasible and economically reasonable standards and procedures to achieve appropriate level of management and conservation practices to abate soil erosion, siltation and sedimentation of the waters of Nigeria, due to soil erosion and flood aggravated by non-agricultural earth-disturbing activities. Part I of these Regulations apply to general information on soil erosion and flood, while Parts II and III apply to regulated activities to enforce soil erosion and flood control.

- **National Environmental (Noise Standards and Control) Regulations, 2009 (S.I. No. 35)**

The objective of the Regulations is to ensure maintenance of a healthy environment for all people in Nigeria, the tranquility of their surroundings and their psychological wellbeing by regulating noise levels and generally to elevate the standard of living of the people. The Instrument prescribes maximum permissible noise levels of a facility or activity to which a person may be exposed; and provides for the control of noise mitigating measures for the reduction of noise.

- **National Environmental (Surface and Ground Water Quality Control) Regulations, 2011 (S.I. No. 22)**

The purpose of these Regulations amongst others is to protect groundwater sources by regulating the discharge of hazardous wastes, fossil fuels energy and any other substances having the potential to contaminate groundwater. The Regulations also include amongst others, the application and general provisions of water quality standards for various uses such as agriculture, industrial, aquatic life and recreation.

- **National Guidelines and Standards for Water Quality in Nigeria, FMEnv**

The National Guidelines and Standards for Water quality in Nigeria was developed by FMEnv to guide water management with regards to maintaining safe quality of water for various uses throughout the country. It sets out water quality guidelines and standards for various uses in order to prevent pollution and regulate the availability of good water for multipurpose uses. It covers major uses of water such as drinking, recreational, fresh water aquatic life, agriculture and industrial.

1.5.2.2 Nigerian Social Policy and Legislation

- **National Policy on Occupational Safety and Health, 2006**

The National Policy on Occupational Safety and Health (OSH) is government's approach for achieving, inter alia, a National Development philosophy of building a united, self-reliant and egalitarian economy through minimizing so far as is reasonably practicable, the causes and effects of hazards inherent in the working environment. The OSH policy recognizes the role of the different stakeholders in achieving a safe and healthy work environment. The objectives of the policy are to:

- Create a general framework for the improvement of working conditions and the working environment.
- Prevent accidents and departures from health arising out of or the course of the work.
- Ensure the provision of occupational safety and health services to workers in all sectors of the economy.

The OSH policy applies to all Nigerian workplaces including formal and informal sectors.

- ***Land Use Act 1978 (Modified 1990)***

The Land Use Act 1978 reviewed under Cap 201, 1990 is the legal framework for land acquisition and resettlement in Nigeria. The following are selected relevant sections:
Section 1: Subject to the provisions of this Act, all land comprised in the territory of each State in the Federation are hereby vested in the Governor of that State and such land shall be held in trust and administered for the use and common benefit of all Nigerians in accordance with the provisions of this Act.
Section 2: (a) All land in urban areas shall be under the control and management of the Governor of each State; and (b) all other land, subject to this Act, shall be under the control and management of the Local Government within the area of jurisdiction in which the land is situated. The Act gives the government the right to acquire land by revoking both statutory and customary rights of occupancy for the overriding public interest. In doing so, the Act specifies that the State or Local Government should pay compensation to the current holder or occupier with equal value.

- ***Factories Act (CAP F1), 2004***

The Factories Act (CAP. F1), 2004 establishes a legal framework to provide for the registration of factories, factory workers and a wider spectrum of workers and other professionals exposed to occupational hazards but for whom no adequate provisions had been formerly made; to make adequate provisions regarding the safety of workers to which the Act applies and to impose penalties for any breach of its provisions. All workplaces are covered by this Act.

The Act is subdivided into eleven (11) parts which includes general and special provisions for Health, Safety and Welfare of workers as well as notification and investigation of accidents and industrial diseases. All industrial accidents and dangerous occurrences are expected to be reported to the Director of Inspectorate or the nearest factory inspector for proper investigations.

❖ ***Labour Act, 1990***

The Labour Act (1990) is the primary law protecting the employment rights of individual workers. The Labour Act makes general provisions for the protection of wages, contracts of employment as well as terms and conditions of employment. It also makes provisions for recruitment and identifies special classes of workers.

❖ ***Public Health Law, 1958***

This provides justification for the execution of developmental projects under guidelines that promote health by protecting the environment and safeguarding the humans' health. The Public Health Laws empower Medical Officers of Health (operating at the local government council, under the supervision of the State and Federal Ministries) to ensure the promotion of good health.

1.5.2.3 Nigeria Power Sector Policy and Legislation

❖ ***National Electric Power Policy, 2001***

The National Electric Power Policy (NEPP) developed in March 2001 sets the go-forward framework for power reform in Nigeria. The key objectives of the policy are to:

- ensure a system of generation, transmission, distribution and marketing that is efficient, safe, affordable and cost-reflective throughout the country;
- ensure that the power sector attracts private investment both from Nigeria and from overseas;
- develop a transparent and effective regulatory framework for the power sector;
- develop and enhance indigenous capacity in electric power sector technology;
- participate effectively in international power sector activities in order to promote electric power development in Nigeria, meet the country's international obligations and derive maximum benefit from international cooperation in these areas;
- ensure that the Government divests its interest in the state-owned entities and entrenches the key principles of restructuring and privatization in the electric power sector;
- promote competition to meet growing demand through the full liberalization of the electricity market; and
- review and update electricity laws in conformity with the need to introduce private sector operation and competition into the sector.

❖ ***National Energy Policy, 2003***

A National Energy Policy (NEP) was approved by the Government in 2003 with the overall thrust of optimal utilization of the nation's energy resources; both conventional and renewable, for sustainable development and with the active participation of the private sector. The NEP highlights strategies for systematic exploitation of the energy resources, the development and effective use of energy manpower, supply of rural energy needs, efficient energy technology development and use, energy security, energy financing and private sector participation. The strategies are harmonized and grouped into short, medium and long – term measures for easier implementation. Specifically, for solar energy, the policy emphasizes that the nation shall aggressively pursue the integration of solar energy into the nation's energy mix and shall keep abreast of worldwide developments in solar energy technology.

Some of the overarching objectives of the policy regarding solar energy are summarized as follows:

- To develop the nation's capability in the utilization of solar energy.
- To use solar energy as a complementary energy resource in the rural and urban areas.
- To develop the market for solar energy technologies.
- To develop solar energy conversion technologies locally.

❖ ***Electric Power Sector Reform Act 2005***

The EPSR Act which was passed into law in March 2005 gives effect to the principles of the NEPP and now serves as the platform for the enabling legal and regulatory framework for power sector operations in Nigeria. The Act provides for the licensing and regulation of the generation, transmission, distribution and supply of electricity in Nigeria. Part III of the Act establishes the Nigerian Electricity Regulatory Commission (NERC) and empowers it to license and regulate persons engaged in the generation, transmission, system operation, distribution and trading of electricity. Part IV of the Act contains requirements for licensing and stipulates that no person shall construct, own or operate an undertaking or in any way engage in the business of electricity generation (excluding captive generation) electricity transmission, system operation, electricity distribution or trading in electricity without a license except for generating electricity not exceeding 1 megawatt (MW) in aggregate at a site or distribution of electricity with a capacity not exceeding 100 kilowatts (kW) aggregate at a site. Part V of the Act makes special provisions for acquisition of land and access rights as it relates to generation, transmission and distribution companies.

❖ ***Nigerian Electricity Regulatory Commission (Acquisition of land and Access Rights For Electricity Projects) Regulations, 2012***

These Regulations apply to acquisition of land and access rights for electricity projects in Nigeria, including projects related to generation, transmission and distribution of electricity. The objectives of these Regulations are to provide a legal and regulatory framework for the;

- Acquisition of land and access rights for electricity projects in Nigeria;
- Payment of compensation and resettlement of persons affected by the acquisition of their land for the establishment of electricity projects; and
- Monitoring and evaluation of project designs of licensees to ensure compliance with environmental standards.

❖ ***Nigerian Electricity Supply and Installation Standards (NESIS) Regulations 2015***

The Regulations provide guidance, license terms and conditions to any person engaged in the generation, transmission, distribution, system operation, and trading in electricity or in any aspect in the value chain of electricity supply, including but not limited to engineering designs, installations, commissioning, decommissioning and maintenance of electric power systems for the purpose of achieving safe and reliable supply, and utilization of electricity in Nigeria.

❖ ***Roadmap for Power Sector Reform, 2010***

The Roadmap for the Power Sector Reform in Nigeria developed in August 2010 was built on the foundation laid down in 2001 by the adoption of the NEPP and in 2005 with the promulgation of the EPSR Act. The Roadmap chats the way for the attainment of a substantial increase in the total quantum of power delivered to electricity consumers across the country and to ensure that the supply of power will not only be significantly greater than ever before but that it will also be much less erratic and unpredictable. It outlines the plans and strategies to finalize the drive to complete power sector reform and sets the nation on a steady course to produce clean and efficient electricity for its citizens at competitive rates. The Roadmap contained two core and fundamental objectives at its launch. Firstly, to transition the Nigerian Power Sector into a private-sector led market by implementing the EPSRA 2005 transition ("The Reform Objective") and, secondly, to support and improve service delivery levels during this transition to the Nigerian public ("The Service Delivery Objective").

❖ **Renewable Energy Master Plan (REMP), 2006**

The Renewable Energy Master Plan (REMP) for Nigeria of 2006 aims to increase the contribution of renewable energy to account for 10% of Nigerian total energy consumption by 2025. The overall objective of the REMP is to articulate a roadmap for national development through the accelerated development and exploitation of renewable energy. The REMP articulates Nigeria's vision for sustainable development and sets out a road map for increasing the role of renewable energy in achieving this vision. The masterplan envisions:

- An economy that gradually move from a monolithic fossil economy to one driven by an increasing share of renewable energy in the national energy mix.
- Exploiting renewable energy in quantities and at prices that will promote the achievement of equitable and sustainable growth.
- An energy transition from crude oil to a less carbon intensive economy increasingly powered by gas and increasing role for renewable energy.

1.5.2.4 International Policy, Guidelines and Conventions

❖ ***World Bank Safeguard Policies***

The World Bank has 10+1 Environmental and Social safeguard policies, designed to help prevent and mitigate undue harm to people and their environment in the development process and ultimately ensuring that environmental and social issues are addressed throughout the project life cycle of a World Bank – financed project. Specifically, the proposed project has triggered the following policies:

i. OP/BP 4.01: Environmental Assessment
ii. OP/BP 4.12: Involuntary Resettlement
iii. OP/BP 4.04: Natural Habitat
iv. OP/BP 17.50: Disclosure of Information

Detailed description and applicability of the relevant policies is presented in Appendix 1.2

❖ ***IFC Performance Standards on Environmental and Social Sustainability***

The International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability describes IFC's commitments, roles and responsibilities related to environment and social sustainability. The performance standards are directed towards clients, providing guidance on how to identify risks and impacts and are designed to help avoid, mitigate and manage risks and impacts as a way of doing business in a sustainable way including stakeholder engagement and disclosure obligations of the client in relation to project level activities. IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced. It sets out eight (8) Performance Standards required by project proponents to meet throughout the life of an investment by IFC. The Performance Standards specifically triggered by this project are presented in Table 1.1

Table 1.1: Summary of IFC Performance Standards Triggered by Proposed Project

Standard	Summary of Requirement	Applicability to Project and ESIA Report Reference
Performance Standard (PS) 1: *Assessment and Management of Environmental and Social Risks and Impacts*	The PS 1 underscores the importance of managing environmental and social performance throughout the life of a project. The Standard applies to projects with environmental and/or social risks and/or impacts. The objective of the Standard include to identify and evaluate environmental and social risks and impacts of the project and to adopt a mitigation hierarchy to anticipate and avoid, minimize, and where residual impacts remain, compensate/offset risks and impacts to workers, affected communities and the environment,	In line with the requirements of PS 1, all potential significant impacts of the project throughout its life have been identified in Chapter 5. Mitigation measures in line with PS 1 hierarchy have also been recommended (Chapter 6) while a project specific ESMP to ensure systematic implementation of mitigation and other management actions have been prepared in Chapter 7.
Performance Standard (PS) 2: *Labor and Working Conditions*	The PS 2 recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. The Standard recognizes the workforce as a valuable asset and recommends a sound worker-management relationship as a key ingredient in the sustainability of a company. The Standard requires the proponent - to promote fair treatment, nondiscrimination, equal opportunity of workers, and promote compliance with national employment and labor laws; - to promote safe and healthy working conditions to protect and promote health of workers; and - to avoid the use of forced labor	The project will involve employment of skilled and unskilled labour. Chapter 5 of this report identified potential positive and negative impacts on workers during project implementation. The measures recommended in Chapter 6 to guide employment, protect workers and ensure sustainability are consistent with the requirements of PS 2 as well as Nigerian Labour Laws.
***Performance Standard (PS) 3*:** Resource Efficiency and Pollution Prevention	The Standard recommends that proponents should undertake their developments and economic activities in a manner that will enhance human health and protect the environment by avoiding or minimizing pollution to air, water, and land, and to also ensure sustainable consumption of finite resources and reduce project-related GHG emissions	Project will impact on land, air and water. Measures to promote sustainable resource use and prevent environmental degradation have been recommended in Chapter 7 in line with the requirements of PS 3.
***Performance Standard (PS) 4*:** *Community Health, Safety and Security*	The PS 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. The Standard therefore emphasizes the proponent's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups.	Project will pose risk to community health, safety and security. All potential risks and impacts on affected communities have been identified in Chapter 5 with management actions to avoid, minimize or compensate for the risks proffered in Chapter 6.

***Performance Standard (PS) 5**: Land Acquisition and Involuntary Resettlement*	The Standard emphasizes the avoidance of involuntary displacement by exploring alternative project designs and when avoidance is not possible, to minimize. The Standard further recommends the total avoidance of forced eviction and improvement, or restoration of livelihoods and living conditions of displaced persons.	Although the proposed project does not involve physical displacement of persons, it however entails acquisition of farmlands (economic displacement). The principles specified in PS 5 were adopted in Chapter 6 to ensure land take does not result in poverty exacerbation in affected communities.
***Performance Standard (PS) 6:** Biodiversity Conservation and Sustainable Management of Living Natural Resources*	The PS 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The Standard requires project proponents to sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle.	Land clearing for the proposed project will involve some disruption to biodiversity. Potential impacts have been identified in Chapter 5, Sustainable measures to mitigate impacts proffered in Chapter 7 while the ESMP to ensure implementation of management actions has been prepared in Chapter 7.

❖ ***The Equator Principles, 2003***

The 'Equator Principles' are a framework for determining, assessing and managing environmental and social risks in finance transactions for major projects. It comprises a set of principles adopted by the Equator Principles Financial Institutions (EPFIs) to ensure that the projects they finance are developed and implemented in a manner that is socially responsible and environmentally sound. These Equator Principles are a set of voluntary standards that commit the EPFI to the Environmental and Social Performance Standards of IFC.

❖ ***World Bank Group Environmental, Health, and Safety Guidelines;***

World Bank Group Environmental, Health and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of good international industry practice. The EHS guidelines contain the performance levels and measures that are normally acceptable to IFC and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. Two (2) sets of guidelines are used:

- ***The General Environmental, Health and Safety Guidelines***

These Guidelines contain information on cross-cutting environmental, health and safety issues potentially applicable to all industry sectors. They are divided into sections entitled: Environmental; Occupational Health and Safety; Community Health and Safety; Construction; and Decommissioning.

- ***The Industry Sector Guidelines***

These Guidelines contain information on industry-specific impacts and performance indicators, plus a general description of industry activities. The Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution is applicable to the proposed project. It provides guidance applicable to the project facilities that will transmit power from the power station to the nearby distribution substation.

❖ **Other International Treaties and Conventions**

- **International Treaties and Conventions on the Environment**

Some of the international treaties and conventions on environment to which Nigeria is a party are summarized in Table 1.2.

Table 1.2: International Treaties and Conventions on Environment to which Nigeria is a Party

S/N	Treaties and Conventions	Year	Agreement
1.	Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal	**1989**	The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as "hazardous wastes" based on their origin and/or composition and their characteristics, as well as two types of wastes defined as "other wastes" - household waste and incinerator ash.
2	The United Nations Environmental Guidance Principles	1972	Provide guidelines for protecting the integrity of the global environment and the development system
3	United Nations Convention on Biological Diversity	1992	Places general obligations on countries to observe sustainable use and equitably share the plants and animals of the earth
4.	United Nations Framework Convention on Climate Change	1994	It calls on developed countries and economies to limit her emissions of the greenhouse gases which cause global warming

- **International Labour Organization Conventions on Occupational Safety and Health**

Since its foundation in 1919, the International Labour Organization (ILO) has elaborated and adopted a large number of international labour Conventions directly concerned with Occupational Safety and Health (OSH) issues. The ILO Conventions on OSH provide essential tools for government and employers to establish practices that will protect workers from illness, disease and injury that may arise from the workplace, thereby ensuring maximum safety at work. ILO has adopted more than 40 conventions specifically dealing with OSH. However, the applicable conventions ratified by Nigeria include:

- ***Labour Inspection Convention, 1947 (No.81) –*** This priority convention sets out a series of principles respecting the determination of the fields of legislation covered by labour inspection, the functions and organizations of the system of inspection, recruitment criteria, the status and terms and conditions of service of labour inspectors, their powers as well as obligations.
- ***Tripartite Consultation (International Labour Standards) Convention, 1976 (No. 144) –*** This priority convention sets forth the meaning of "representative organizations" of employers and workers and requires ratifying states to operate procedures that ensure effective consultations between representatives of the government, of employers and of workers on matters regarding OSH. Employers and workers are to be represented on an equal footing on any bodies through which consultations are undertaken.
- ***Occupational Safety and Health Convention, 1981 (No. 155) –*** This convention provides for the adoption of a coherent national occupational safety and health policy, as well as action to be taken by governments and within enterprises to promote occupational safety and health and to improve working conditions.
- ***Occupational Health Services Convention, 1985 (No. 161) –*** This convention provides for the establishment of enterprise-level occupational health services which are entrusted with essentially preventive functions and which are responsible

for advising the employer, the workers and their representatives in the enterprise on maintaining a safe and healthy working environment.

Other applicable ILO OSH Conventions to which Nigeria is not signatory to include:
- *Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148)*
- *Chemicals Convention, 1990 (No. 170)*
- *Safety and Health in Construction Convention, 1988 (No. 167)*
- *Prevention of Major Industrial Accidents, 1993 (NO.174)*

1.6 NSPDL Health, Safety and Environment (HSE) Policy

NSPDL has established an integrated project specific policy on Health, Safety and Environment (HSE). This policy demonstrates the company's commitment towards ensuring the health and safety of employees that will be involved in the Jigawa solar PV project and protection of the environment during the project life cycle. The policy reflects the organization's mission, vision, core values and beliefs. NSPDL's HSE Policy for the proposed project is presented in Chapter Seven of this Report.

1.7 Structure of the EIA Report

In line with the FMEnv EIA Procedural Guidelines, this ESIA Report is structured into nine chapters as follows:

- Chapter One: Provides a background to the project and discusses the ToR, objectives and scope of the ESIA as well as the applicable administrative, policy and legal framework.
- Chapter Two: Provides justification for the project.
- Chapter 3: Presents the description of the proposed project and highlights the project objectives, components and activities of the different phases of the project.
- Chapter 4: Describes the existing environment and socio-economic characteristics of the project AoI.
- Chapter 5: Discusses the Potential and Associated Environmental and Social Impacts of the proposed project.
- Chapter 6: Discusses the mitigation and enhancement measures for identified impacts.
- Chapter 7: Discusses the implementation of the ESMP and the Monitoring program. It outlines the management and monitoring actions, roles, responsibilities and cost of ESMP implementation.
- Chapter 8: Discusses the abandonment, decommissioning and remediation plans.
- Chapter 9: Presents the conclusions.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Introduction

This Chapter discusses the need/rationale for the proposed project and enumerates the benefits to be derived from project implementation. It also discusses the envisaged sustainability of the project as well as the project alternatives and development options considered.

2.2 The Need for the Project

The provision of regular, affordable and efficient electricity is crucial for the growth, prosperity, national security as well as the rapid industrialization of any society. However, the current status of electricity generation in Nigeria with regards to its population is grossly inadequate. With an estimated 50% of Nigeria's population living without grid connected electricity, this issue has been identified as the underlying challenge hampering economic development and productivity in Nigeria.

There are numerous challenges facing the electricity sector in Nigeria but the most prominent ones include limited access to infrastructure, ineffective regulation, high technical losses and vandalism, inadequate generation as well as insufficient transmission and distribution facilities. This challenge has historically and consistently left a deficit in consumption and generated electricity in Nigeria. Thus, creating a grave imbalance in the demand and the supply of electricity (Awosope, 2014).

In response to this alarming situation, the Federal Government since 1999 has embarked on several initiatives including the initiation of National Integrated Power Project (NIPP) aimed at rapidly boosting electricity generation capacity from gas and privatization of the electricity sector to encourage investment from the private sector. These initiatives are in line with the worldwide consensus that the vertically-integrated public sector electricity market being operated in Nigeria cannot deliver the quantum of electricity at a pace capable of bridging the growing gap between demand and supply. This new thinking motivated the NEPP (2001), and culminated in the EPSR Act of 2005.

Since 2005, the Nigerian electricity sector has been deregulated by the EPSR Act, primarily to encourage the participation of investors in the sector and develop a competitive electricity market. Despite the efforts of Government, the Nigeria's electricity generation capacity has declined from the peak generation level of about 4,517.6 MW recorded in December, 2012 to about 3,670 MW in January, 2014 with per capita electricity usage of 136 kW/hour making Nigeria's electricity consumption on a per capita basis among the lowest in the world (Joseph, 2014). This is largely due to shortage of gas and vandalisation of electricity assets.

In order to ensure the sustainability of energy generation and supply to enhance sustainable economic development, the government has set up the framework for Nigeria to be less dependent on hydrocarbons and increase energy generation from the sun, biomass conversion, small hydro plants and wind through the REMP developed in 2006. The REMP targets the achievement of 500 MW solar energy generation by 2025.

In addition, one of the ongoing initiatives of the Federal Government as published in the NEP is to encourage the use of all viable energy sources for sustainable national development with the participation of the private sector to meet the demand.

The proposed project will generate and supply additional 80 MW_{AC} of renewable electricity to boost national power supply and specifically provide the Jigawa State and surrounding areas with an indigenous and carbon free source of electricity to promote economic development in line with REMP and NEP.

2.3 Benefits of the Project

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

- Generation of clean renewable energy with minimal greenhouse gas (GHG) emissions.
- Increased electricity generation.
- Stimulation of local and regional economic activities thereby promoting industrial growth.
- Job creation, improved livelihood and poverty reduction through the provision of employment and improved economic opportunities.
- Acquisition of new skills through technology transfer.
- Boost in local and regional economy through award of contracts for project development.
- Increased revenue generation to government through the payment of taxes.

2.4 Value of the Project

The total project cost is estimated to be One Hundred and Ninety Three Million, Eight Hundred Thousand Dollars (USD 193.8 million). The project cost is split into three key components: development costs (8.5%), construction costs (77.6%) and other costs (13.9%). A substantial part of these costs will be spent in Nigeria and will thus improve the overall national and regional socioeconomic conditions, trade and revenue generation. The project cost also includes cost of setting up and implementation of Corporate Social Responsibility (CSR) programmes to improve livelihood and make life better especially for the project's host communities.

2.5 Envisaged Sustainability

Sustainability is the ability of a development project to maintain or expand a flow of benefits at a specified level for a long period after project inputs have ceased (Hodgkin, 1994). The concept of sustainability means different things to different activities, organizations and developments. Specifically, for the proposed project, sustainability means, ensuring the project continues to maintain its operations, provide its services and deliver its long term benefits, highlighted in Section 2.3, during implementation and projected life span. The sustainability of the proposed project is evaluated and described below using the following dimensions/ factors, namely: environmental, social, economic and technical sustainability.

2.5.1 Environmental Sustainability

The project entails generation of electricity using energy from the sun, a renewable and infinite source that cannot be depleted, thereby making the project a sustainable development. According to Brundtland Commission (1987), "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

The project will boost electricity generation in Nigeria and reduce dependency on hydrocarbon and other non-renewable sources. Furthermore, the project will result in significant reduction of emission of GHGs in two major ways:

- Generation of 80 MW_{AC} electricity from the sun will not lead to emission of GHGs and thus offsetting emission which would have otherwise been emitted from the generation of equivalent amount of electricity from other sources such as hydrocarbon, coal etc.
- The electricity generated will be utilised by households and businesses who would have otherwise continued their reliance on off-grid petroleum powered generators contributing significantly to the release of GHGs and climate change.

In addition, environmental sustainability will be further assured by ensuring all envisaged negative environmental impacts identified during preconstruction, construction, operation and maintenance as well as decommissioning phases of the project are avoided, minimized, compensated for or offset through the effective implementation of mitigation measures contained in Chapter six of this Report.

2.5.2 Economic Sustainability

The economic sustainability of the project is examined as follows:

- **Availability of Raw Material**

The key benefit of the proposed project in terms of resource efficiency is the generation of electricity using freely available solar energy to produce electricity, reducing the dependence on fossil fuels for the generation of electricity and thereby reducing the carbon footprint associated with the Nigerian electricity network. The primary raw material for the generation of electricity is solar energy from the sun. Historically, there is an average of about 8 hours of sunshine per day in the project area suggesting that there will always be availability of raw material which is freely accessible to sustain the project throughout its life span thereby ensuring its economic sustainability.

- **High Demand for Electricity**

The endemic electricity crisis in Nigeria created by the ever-increasing demands for electricity and the inability of the existing generating plants to meet the need has created an existing market for the 80 MW_{AC} of electricity which will be generated by the proposed project. This will ensure its economic sustainability.

In addition, various industries and other consumers have abandoned the national grid and installed generators whose total capacity is estimated to be at least 50% of installed capacity of the national grid. A recent statistics revealed that about 60 million Nigerians spent N1.6 trillion on generators annually. (NEP, 2003; CMD, 2013). The figures show that Nigerians spend more on off-grid electricity than they would otherwise have spent on grid electricity. The proposed project will generate electricity which will be cheaper and steadily available to consumers providing huge market opportunities which will also ensure economic sustainability of the project.

- **Long Life Span**

The design life span of the proposed project is 20 years. However, with proper operations and maintenance (O&M) as well as certain equipment replacements, the useful life of the plant can be extended to 40 years or more. Although PV technology upfront cost may be higher than other energy technologies, the long-term costs are lower. With an average daily sunshine of 8 hours in the project area guaranteeing peak electricity generation, the project return on investment will be high and the payback period will be much less than 20 years.

2.5.3 Social Sustainability

A stakeholders' engagement process commensurate with project impacts and tailored to the characteristics and interest of the affected communities and stakeholders has been designed for the proposed project covering the entire project life cycle. Its effective implementation will ensure social sustainability of the project.

Furthermore, to ensure social sustainability of the project, NSPDL is committed to:

- Set aside funds to implement various Corporate Social Responsibility programmes targeted at improving the socioeconomic and health status in project affected communities. The programme will promote education, creativity and development of human capacity.
- Employ as many local inhabitants of Jigawa State as possible during all phases of the project, and to transfer replicable skills to Nigerians and inhabitants of Jigawa state to the greatest degree possible.
- Provide the State of Jigawa and surrounding areas with an indigenous source of electricity at a reasonable price, which will in turn enable further economic development.

2.5.4 Technical Sustainability

To ensure technical sustainability of the project, NSPDL will develop and construct the utility scale solar power plant to the most stringent Nigerian and international standards using tier-one equipment and experienced Engineering, Procurement and Construction (EPCs) contractors.

2.6 Project Alternatives and Development Options

This section describes the various alternatives and development options considered for the proposed project with respect to the site, RoW, technology and raw material alternatives.

2.6.1 Project Alternatives

2.6.1.1 Site Alternatives

Two possible sites were initially identified and assessed for the proposed 80 MW_{AC} solar PV power project in Dutse, Jigawa State. The two sites are: (i) Dutse-3 & Dutse-4 and (ii) Dutse-2 respectively.

- **Alternative Site 1: Dutse-3 and Dutse-4**

The initial site considered comprised of two locations known as Dutse-3 and Dutse-4 which are approximately 95 hectares of land each. Both plots of land are located near the town of Dutse with each capable of generating 40 MW_{AC}. Dutse-3 is located approximately 7 km from the Dutse substation while Dutse-4 is 3 km away. This leads to a cumulative distance of 10km from the substation as shown in Figure 2.1.

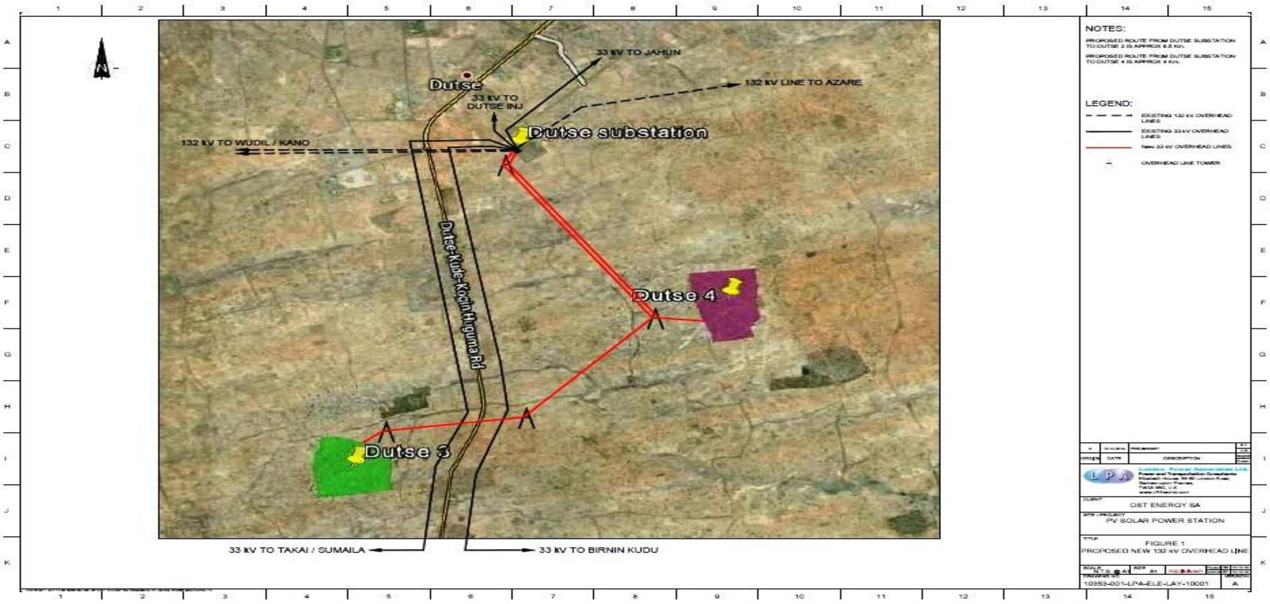

Figure 2.1: Map Showing Layout of Dutse 3, Dutse 4, Dutse Substation and Proposed Transmission Route.

- **Alternative Site 2: Dutse-2**

The alternative site considered is a single site known as Dutse-2 which is approximately 200 hectares of land. The site is 3.66 km away from the Dutse substation and is capable of generating $80MW_{AC}$. Dutse 2 is in close proximity (approximately 3 km away) to Dutse-4 and as such the site conditions are quite similar. The layout for site alternative 2 is shown in Figure 2.2. Dutse-2 site is considered more viable and has been chosen as the preferred site. This is because it is a single site likely to pose fewer environmental and social concerns as opposed to two separate sites which may have larger environmental, social and economic footprints.

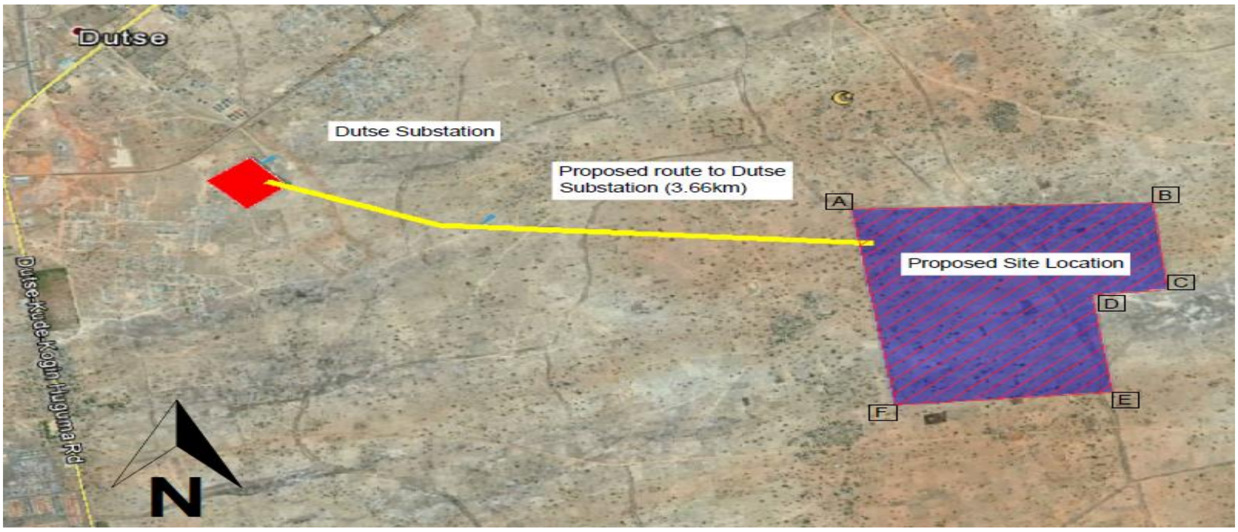

Figure 2.2: Map Showing Layout of Dutse-2, Dutse Substation and Proposed Transmission Route.

2.6.1.2 Solar Technology Alternatives

The technologies evaluated fall into two general categories, namely: Concentrating Solar Power (CSP) and Photovoltaic (PV). The CSP technologies are those that concentrate the sun's energy to produce heat; the heat then drives either a steam turbine or an external heat engine to produce electricity. Parabolic trough, power tower, and dish engine technologies fall into the CSP category.

- **Parabolic Trough**

The parabolic trough solar plant usually consists of long rows of parabolic solar panels lined with mirrors that focus the sun's energy on a central absorber tube containing a heat transfer fluid (HTF) which is usually a mix of synthetic organic oils. The HTF is heated in the solar field and flows to the power block, where its heat is transferred to steam via a heat exchanger and the steam is used to produce electricity via a steam turbine generator (STG). A typical parabolic trough facility is shown in Plate 2.1. Water is needed at parabolic trough facilities to run the cooling systems, as well as for mirror washing and other maintenance and sanitary uses to support the workforce. The total water use of a wet-cooled parabolic trough facility is about 800 gal/h/MW (3 m^3/h/MW). Only a very small proportion of about 2% is used for mirror washing while 98% is used for cooling (DOE 2009). The most obvious features of the parabolic trough solar plant are the usage of large quantity HTF (hazardous oils) and its parabolic-shaped mirrors or reflectors which are highly reflective and may lead to major impact of glint and glare in the project area.

- **Power Tower**

Power tower facilities consist of a central tower surrounded by hundreds or thousands of flat-plate reflectors (heliostats) that concentrate the sun's rays on a central point at the top of the tower, where an HTF can absorb the heat to generate electricity as shown in Plate 2.2. The typical height of towers is about 91 to 137 m. The HTF used in power tower facilities to date has been water, although future facilities may use molten salt. Similar to the parabolic trough systems, water use for tower facilities is for running the cooling system, heliostat washing as well as other maintenance and sanitary uses to support the workforce. The estimated water use is the same as was discussed for parabolic trough systems. Large quantities of HTF (hazardous oils) are required and the surface of the reflector will equally cause glint and glare due to its highly reflective nature.

- **Dish Systems**

Solar dish engine systems generate electricity through the action of an external heat engine, called a Stirling Engine, rather than through steam production. A typical dish system consists of a parabolic concentrator, a receiver, an external heat engine, and a generator as shown in Figure 2.3. Sunlight is concentrated onto the receiver, which transfers the heat to a gas (usually hydrogen or helium) contained in the sealed external heat engine. As the gas is heated, its increasing pressure drives a piston, thus powering the generator and producing electricity. Individual dish engines can be grouped together into facilities with widely varying power capacities. The sun's energy is converted directly to electricity at each individual dish engine. The dish engines are often used as smaller sources of power for remote areas or individual facilities and have not been widely explored for utility scale electricity generation. In comparison with other CSP technologies, dish engines have higher concentration ratios and consume less water. Water use is majorly for washing of mirrors and for miscellaneous industrial processes and sanitary uses to support the workforce as indicated in Table 2.1. The risk of glint and glare from dish system is similar to those of other CSP systems.

- **Photovoltaic Systems**

To produce electricity at utility scale, many individual solar cells are connected as a module; modules are combined to make individual solar panels; and solar panels are grouped into arrays producing direct current (DC) electricity. This modular nature of PV systems allows greater flexibility in sizing facilities based on factors such as the amount of power needed or the amount of land area available. Water use during operations for PV facilities is for washing of solar panels and for miscellaneous industrial processes and sanitary uses to support the workforce. Unlike the CSP technologies, solar PV panels are designed to absorb light and not reflect it and as such the risk of glint and glare from the surface is significantly reduced.

Plate 2.1: Typical Parabolic Trough Facility

Plate 2.2: Typical Power Tower Facility

Plate 2.3: Typical Dish Engines

- **Preferred Solar Technology**

The preferred solar technology for the proposed solar plant is the PV system. The PV technology is widely exploited around the world much more than the CSP technologies as it is cheaper and much favoured by investors. In addition, the associated environmental risks and impacts associated with the PV systems are lesser and easier to manage than those of the CSP technologies as summarized in Table 2.1.

Specifically, for the proposed project, the location is the northern Nigeria which is an arid region where water availability and use are key considerations. The water requirement for the PV systems is insignificant compared to those of the CSP especially the Parabolic Trough and Power Tower which require cooling as indicated in Table 2.1. There is no surface water in the project area and consequently there is absolute reliance on groundwater which may be depleted by the CSP technologies.

The hazardous materials peculiar to the PV system are enclosed within the panels and thus constitute low risk to the environment unlike the CSP systems requiring the use of hazardous oils and/or gases. The surface structures for the CSP systems are highly reflective as they are essentially made of mirror and thus may cause significant visual intrusions in the form of glint and glare to inhabitants of affected communities as well as greater disruption to natural landscape and aesthetics. The surface of the PV system is highly absorptive (not reflective) and more compatible thus more suitable with rural landscape.

TABLE 2.1 Technology-Specific Assumptions for Environmental Impact Analysis

#	Parameter	Parabolic Trough	Power Tower	Dish Engine	PV System
1.	Facility power capacities (MW)	Up to 400	Up to 400	Up to 750	Up to 750
2.	Land area requirements (acres/MW)	5	9	9	9
3.	Operational water use (m^3/yr/MW)				
	Wet cooling system	5,550 - 17,885	5,550 - 17,885	NA	NA
	Dry cooling system	247 – 1,233	247 – 1,233	NA	NA
	Hybrid system	1,110 – 3,577	1,110 – 3,577	NA	NA
	Mirror/ panel washing and others	617	617	617	62
4.	Chemicals/hazardous materials present on-site	• HTF (organic oils) • Water treatment chemicals.	• HTF (organic oils) • Water treatment chemicals.	• Hydrogen tanks	• Encased semi-conductor materials.
5	Risk of glint & glare from panel surface	High (highly reflective surface)	High (highly reflective surface)	High (highly reflective surface)	Low (highly absorptive surface)

Source: US Department of Energy (2009)

2.6.1.3 Photovoltaic Panel Technology Alternatives

Three different system configuration alternatives have been considered at this stage for the purposes of this comparison. These system designs provide a general comparison of the performance of various PV module technologies at the proposed site and are discussed below.

- **Alternative Technology I -** *Thin Film*

Thin-film solar cell (TFSC) technology consists of depositing one or several thin layers of a PV semiconductor material onto a substrate. TFSCs can be categorized based on the photovoltaic material used in its production, as follows:

- Cadmium telluride (CdTe)
- Amorphous silicon (a-Si)
- Copper indium gallium selenide (CIS/CIGS)
- Organic photovoltaic cells (OPC).

Of these types, the most commonly used TFSC material is CdTe with over 10 GW of CdTe installed to date. CdTe modules utilise a thin layer of semi-conductor in thin-film, fixed between front and back glass layers. Cadmium and Tellurium are both rare-earth materials of limited abundance. The CdTe layer is typically 1-3 microns thick and fixed between layers of thick glass, with no vapour or other hazardous products being produced by the solar PV module during its lifecycle. It should be noted that the principal manufacturer of TFSC CdTe panels takes back panels for recycling at the end of their life span or if damaged. Typical appearance of a Thin-Film CdTe Arrays is shown in Plate 2.4.

Plate 2.4: Typical Appearance of Thin-Film CdTe Arrays
Source: OST Energy (First Solar)

- **Alternative Technology II -** *Mono-crystalline Silicon*

Monocrystalline silicon (mono-Si) PV cells are made out of cylindrical silicon ingots. These are cylindrical in shape due to the '*Czochralski Process'*. This is a method of crystal growth, which involves melting silicon in a crucible before a rod-mounted seed crystal is dipped into the molten silicon. This is then slowly withdrawn, whilst being rotated, forming a large single-crystal cylindrical ingot, up to 2 m in length. In order to optimize performance and lower the cost of a single monocrystalline cell, four sides are cut out of the cylindrical ingot, which is then sliced into wafers. This gives monocrystalline solar panels their characteristic appearance

Monocrystalline PV panels tend to have higher efficiency ratings than poly-crystalline PV panels. However, as the wafer edges require cutting they have approximately the same level of operating power density as polycrystalline PV modules. They are considered to operate slightly better than polycrystalline solar PV modules in warmer temperatures, but are also slightly more expensive to produce. A typical mono-Si cell is shown in Plate 2.5.

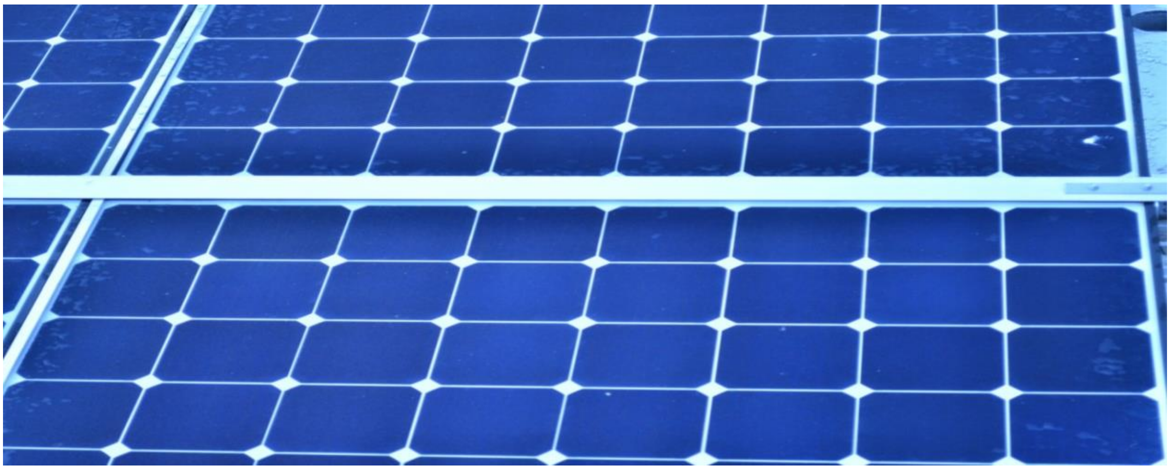

Plate 2.5: Typical Appearance of Monocrystalline Silicon PV arrays
Source: OST Energy

- **Alternative Technology III -** *Poly-Crystalline Silicon*

Panels based on polycrystalline silicon, also known as polysilicon (poly-Si) or multi-crystalline silicon (mc-Si), have been in the market since 1981, in which time the technology has been developed and improved. Essentially poly-Si modules are produced by pouring melted raw silicon into square moulds and then cut into square wafers after cooling. This process is simpler and cheaper compared to mono-Si PV cell production. Although the poly-Si has a slightly lower efficiency, the modules generally have similar operating power density as mono-Si modules since the wafers are truly square and can be packed together in a module with less wasted space. Poly-Si modules are recognizable due to their light or dark-blue colouring, which may vary across the module (Plate 2.6). In addition, each Poly-Si module has low-iron front glass with non-reflective coatings and tedler back cover and is placed in anodized aluminium alloy frame. The non-reflective coatings ensure that less light is reflected from the surface thereby making them efficient in absorbing solar energy and less varied in appearance thus preventing visual effects of glint and glare from panel surface. Poly-Si cells also tend to be slightly more sensitive to higher temperatures than mono-Si. However, their lower pricing in comparison to mono-Si modules and higher efficiency in comparison to thin-film technology make them by far the most commonly used solar PV module technology in the market today and thus the preferred technology of choice for the proposed project.

Plate 2.6: Typical Appearance of Polycrystalline Silicon PV Arrays
Source: OST Energy

2.6.1.4 Energy Generation Technology Alternatives

The technology of choice for power generation is often closely related to the source of the energy generation or the source of raw materials. Technology alternatives considered include those that rely on coal, gas, wind, water (hydro), nuclear materials and solar.

- **Energy Generation from Coal (Coal Fired Plant)**

A coal fired plant at the proposed site would require approximately 3000 tonnes of coal per day from the country's coal reserve. The raw material is not readily available in the project region and would have to be transported from other parts of the country and this activity will require a large fleet of vehicles daily transporting coal to Jigawa State. In addition, coal fired plant with capacity to generate 80 MW_{AC} of electricity will equally generate approximately 550 tonnes of ash per day posing significant risk to the environment. To manage the waste, a disposal area of about 1 km^2 will be required to allow for sufficient disposal space during the course of a 20 year plant lifetime. Creation of such a disposal site could potentially represent significant loss of agricultural land and decline in livelihood of farmers and food production.

Furthermore, coal fired plants are gradually being discouraged as a viable technology for energy generation due to its potential to emit significant amount of GHGs. This option was rejected due to the following considerations:

- Limited availability of raw materials (coal) needed for the operation of the system.
- Unavailability of the raw material (coal) in Jigawa State.
- Environmental implications of coal fired plants including significant waste generation and emission of GHGs.

- **Energy Generation from Gas (Gas Power Plant)**

Although a gas fired plant will generate lesser waste and GHGs per kWh of electricity generated than coal and oil fired plants using steam turbines and conventional boilers, however, the plant will operate using natural gas from the western gas region which will be supplied to Jigawa state via an 850km gas pipeline. Construction of pipeline over such a great distance will lead to significant environmental and socioeconomic impacts including loss of land and involuntary displacement. In addition, with the security situation in the country, a gas fired plant in the Northern region of Nigeria will face similar challenges of pipeline vandalisation and sabotage as other similar plants in Nigeria leading to inconsistent power supply and high cost of operation. This option was therefore rejected.

- **Energy Generation from Wind (Wind Power Plant)**

Wind power farm is one of the most environmentally sustainable technologies for renewable energy generation that is widely operated across the world. Similar to solar plants, operation of wind plants generates little or no GHGs, however, unlike solar, there is little or no long term wind studies in the region for potential to generate consistent electricity. This technology is therefore rejected as it represents a greater technical and economic risk to the project.

- **Energy Generation from Water (Hydropower Plant)**

Hydropower plant requires the construction of a dam to store adequate water for consistent electricity generation. Although the raw material for hydropower plants is from renewable sources and its operation leads to minimal impacts on the environment in terms of GHGs emission, however, construction of dam may have huge environmental and socioeconomic consequences. This may include involuntary population displacement, shortage of water downstream of dam with attendant impacts on riparian communities, vegetation as well as aquatic animals.

- **Energy Generation from Nuclear/Radioactive Materials (Nuclear Power Plant)**

The generation of electricity through nuclear energy reduces the amount of energy generated from fossil fuels (coal and oil). Consequently, less use of fossil fuels means lowering reduced GHGs emission. However, one of the main disadvantages of nuclear power plants is the difficulty in the management of nuclear wastes which are extremely hazardous if not managed properly. Such kind of waste emits radiations as it takes tens to hundreds of years to eliminate its radioactivity and risks.

Another practical disadvantage of using nuclear energy is that it needs a lot of investment to set up a nuclear power station. It is not always possible by the developing countries to afford such a costly source of alternative energy. Nuclear power plants normally take 5-10 years to construct as there are several legal formalities to be completed and mostly it is opposed by the people who live nearby due to the inherent risks posed by nuclear facilities. Furthermore, permissions of several international authorities are required before building a nuclear power plant. It is also instructive to note that nuclear energy uses uranium which is a scarce resource not found in many countries including Nigeria. Due to its hazardous effects and limited supply, it cannot be termed as renewable. Given the above, construction of nuclear plants in Nigeria is not a viable option for energy generation at this time; hence, this option was rejected.

- **Generation of Electricity from the Sun (Solar Power Plant)**

This technology option adopted for the proposed generation of 80 MW_{AC} electricity is the use of solar energy. This technology has numerous advantages over other sources of energy with the most significant ones discussed below:

- ***Renewable Energy Source:*** Solar energy is a truly renewable energy source. It can be harnessed in all areas of the world and is available every day. Unlike some of the other sources of energy, solar sources cannot be depleted and will remain accessible free of charge as long as the sun is in existence. Historically, there is an average of 8 hours of sunshine per day throughout the year in the project region making solar energy the most viable option.
- ***Low Maintenance Costs:*** Solar energy systems generally do not require a lot of maintenance other than to be kept relatively clean. The panels can perform optimally for up to **20 years**. In addition, there are no moving parts; hence, there is no wear and tear. The inverter is usually the only part that needs to be replaced after **5-10 years** because it is continuously working to convert solar energy into electricity. Consequently, solar plants require very little operational spending on maintenance and repair works.

2.6.1.5 Transmission Line Route Alternatives

For the RoW of the 3.66 km transmission line, the following alternatives were considered as described below:

- **Transmission Line Route Alternative I (Straight Line Route)**

This option consists of a straight line route from the proposed project site to the Dutse substation. This route alternative transverses Bakinjeji community as shown in Figure 2.3. This option is therefore not considered appropriate for the proposed project.

- **Transmission Line Route Alternative II**

This option consists of the introduction of a small angle point at AP2 to avoid Bakinjeji settlement and to allow the transmission line enter the proposed solar power plant project site at the appropriate place as indicated in Figure 2.3.

- **Preferred Transmission Line Route**

Option 2 has now been selected as the preferred option. The introduction of the angle point at AP2 on the transmission route as ensured the avoidance of Bakinjeji community. Adoption of transmission route Option I would have led to involuntary displacement and resettlement of the people of the community with associated socioeconomic issues.

Even though both options cross the existing 33 kV line around the Dutse substation, the crossing does not in any way pose a constraint to the corridor as the design will appropriately avoid the power line by maintaining the correct vertical clearance of 3.6m for communication and power line wires.

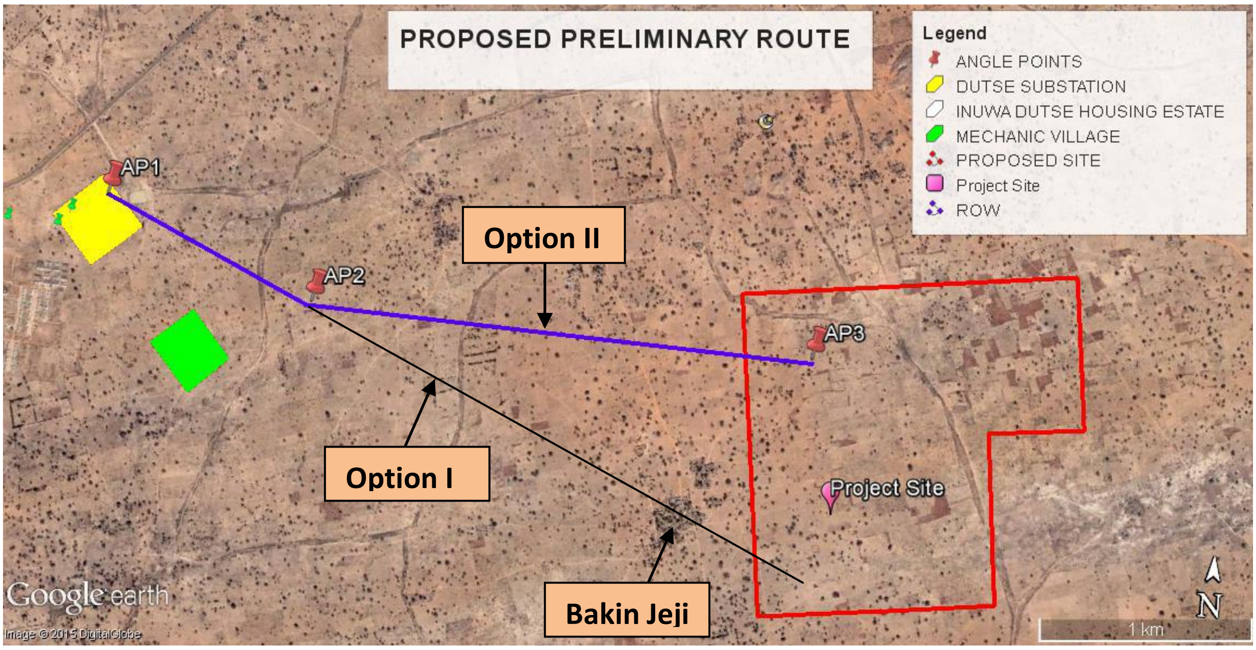

Figure 2.3: The proposed preliminary route from AP1 to AP3 showing the angle at AP2.

2.6.2 Development Options

- **No Project Option**

This option implies that the proposed project will not be implemented. This option if adopted will represent a major setback for the initiatives and efforts of government as contained in the NEP of 2003 and the REMP of 2006. These are frameworks that the

Nigerian government have put together to encourage private sector participation in the systematic exploitation of the energy resources, the development and effective use of energy manpower, supply of rural energy needs, efficient energy technology development and use, energy security and energy financing. The target set in the REMP specifies expected contribution of renewable energy to account for 10% of Nigerian total energy consumption by 2025. If the proposed project is not implemented, the nation will be denied the addition of 80 MW_{AC} to the national grid. The inherent economic benefits of the project enumerated in section 2.3 including job creation, improved livelihood, poverty reduction and increased revenue generation to government will be lost. In addition, adopting this option will lead to the loss of the initial investment made so far by the proponent. This option is thereby considered not socially, economically and environmentally favourable and therefore rejected.

- **Delayed Project Option**

The delayed project option implies that the project will be suspended and implemented in the future. This option may prolong the realization of target set in the REMP as indicated above. In addition, the situation of electricity in Nigeria will remain the same with grave implication for the economic development in Nigeria. Furthermore, this option is not economically sustainable as the initial financial spending on preliminary studies and investigations regarding the project will go to waste. The project cost may also increase significantly given the unstable currency and exchange rate around the world. This option is thereby rejected because it is socially and economically unsustainable.

- **Immediate Project Implementation**

This option implies that the project will go ahead as planned. Adoption of this option will ensure the realization of the numerous benefits of the project especially the addition of 80 MW_{AC} renewable energy to boost electricity generation in Nigeria, and the associated socioeconomic benefits to the project region and the nation as a whole.

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

This Chapter presents the description of the proposed project, including its location, components, design and technology as well as planned project activities throughout the project life cycle.

3.2 Project Overview

The project will involve the development of a utility scale solar power plant involving the installation of ground-mounted PV solar modules capable of generating 80 MW_{AC} using fixed tilt system configurations. The PV modules will convert sunlight to direct current (DC) power. The modules will be connected together to form arrays of panels, which in turn will be connected to inverters to convert the DC power to alternating current (AC) power. The voltage of the power will be stepped up by a transformer to the required voltage of the nearby electricity grid. The generated power from the project site will be evacuated through a dedicated 132 kV overhead transmission line that will connect the solar plant to the Dutse substation located approximately 3.66 km northwest of the project site.

3.3 Nature and Type of Project

The project is a renewable energy project entailing the generation of electricity using solar energy from the sun through the use of PV solar panels.

3.4 Site Location, Surrounding Areas and Access

The proposed site for the project is known as Dutse-2 and located near the town of Dutse in Jigawa State, Nigeria covering an area approximately 200 hectares. Figure 3.1 shows Map of Jigawa State and Dutse LGA, the proposed project location while Figure 3.2 shows the proposed project site within Dutse LGA. The site has a lower left boundary coordinate of 11.673638^{0}N, 9.380721^{0}E and an upper right boundary coordinate of 11.688521^{0}N, 9.392996^{0}E. The layout of the site including the geographical coordinates and boundaries are shown in Figure 3.3. The project location also include the 3.66 km RoW for the transmission route through which electricity generated will be transmitted to the Dutse substation for onward connection to the national grid.

There are no human settlements within the boundary of the site, however, Bakinjeji, Katangar Lafiya and Rahama villages are located close to the western, south western and southern boundary of the site respectively as shown in Figure 3.3. These three villages are all further than 200m away from their respective boundaries.

The surrounding area also includes the RoW for the proposed transmission route which is about 3.66 km to the Dutse substation. Although the RoW does not pass through any human settlements, however, some settlements including Gurungu and Mechanic villages are located adjacent either side of the proposed route (Figure 3.3). Access to the proposed site is via untarred roads that connect the site to the Dutse – Kude – Kogin - Huguma main road. These roads are sandy and will require rehabilitation prior to commencement of construction.

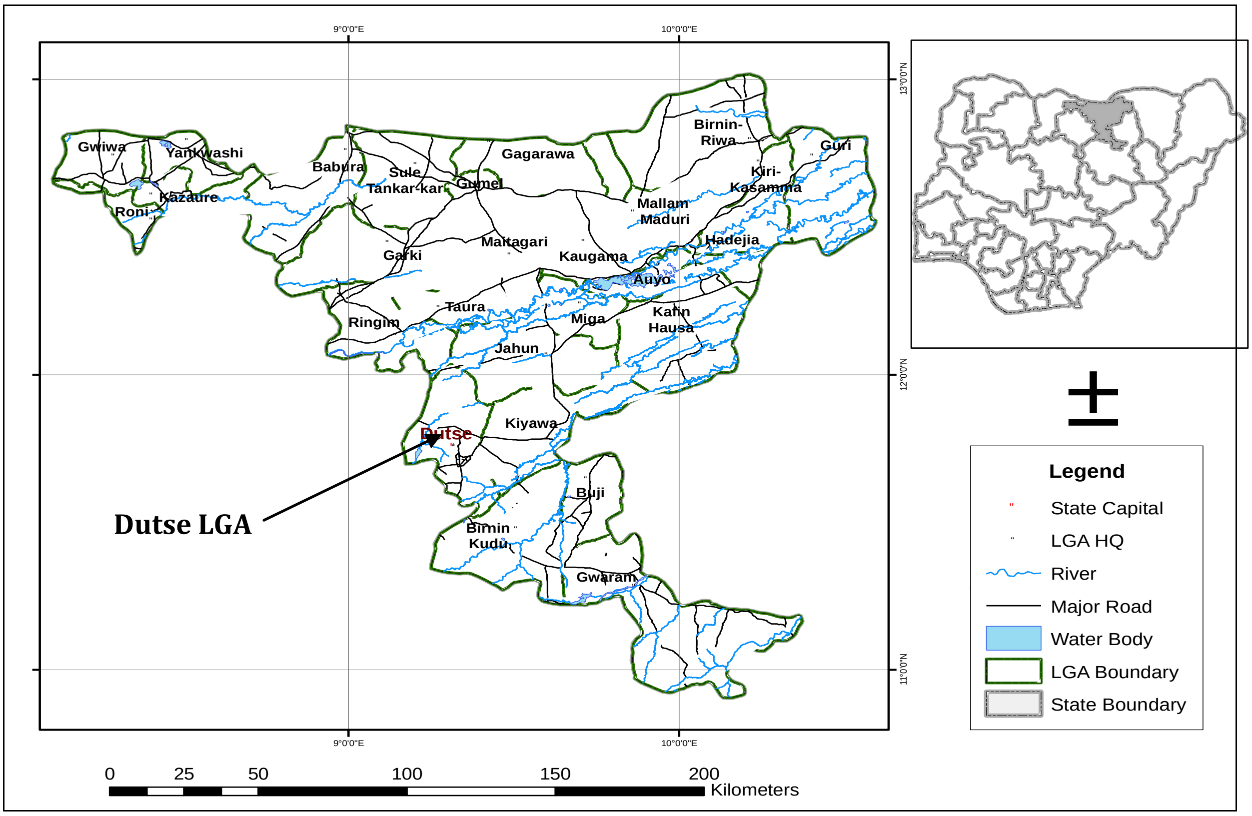

Figure 3.1: Map of Jigawa State Showing Dutse LGA, the Proposed Project Location

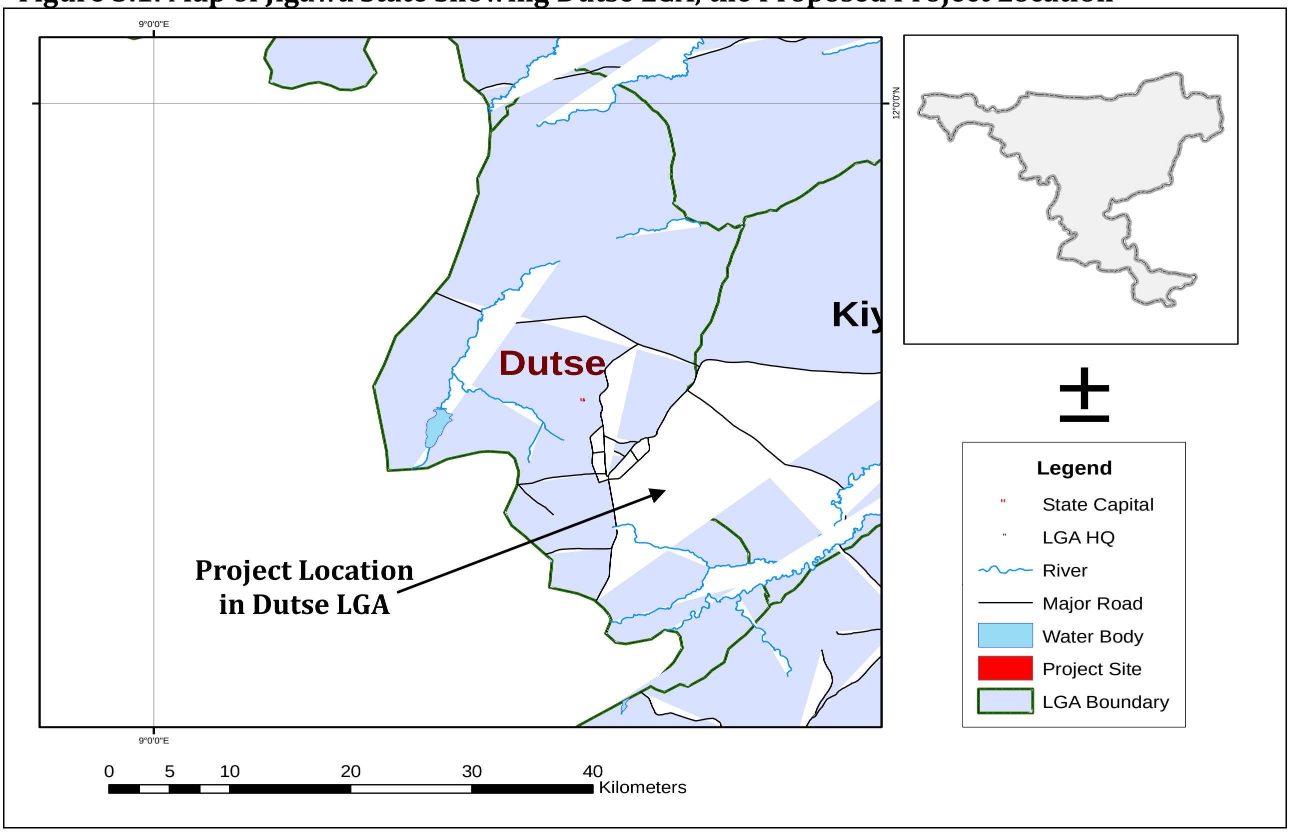

Figure 3.2: Map of Dutse Showing the Project Location

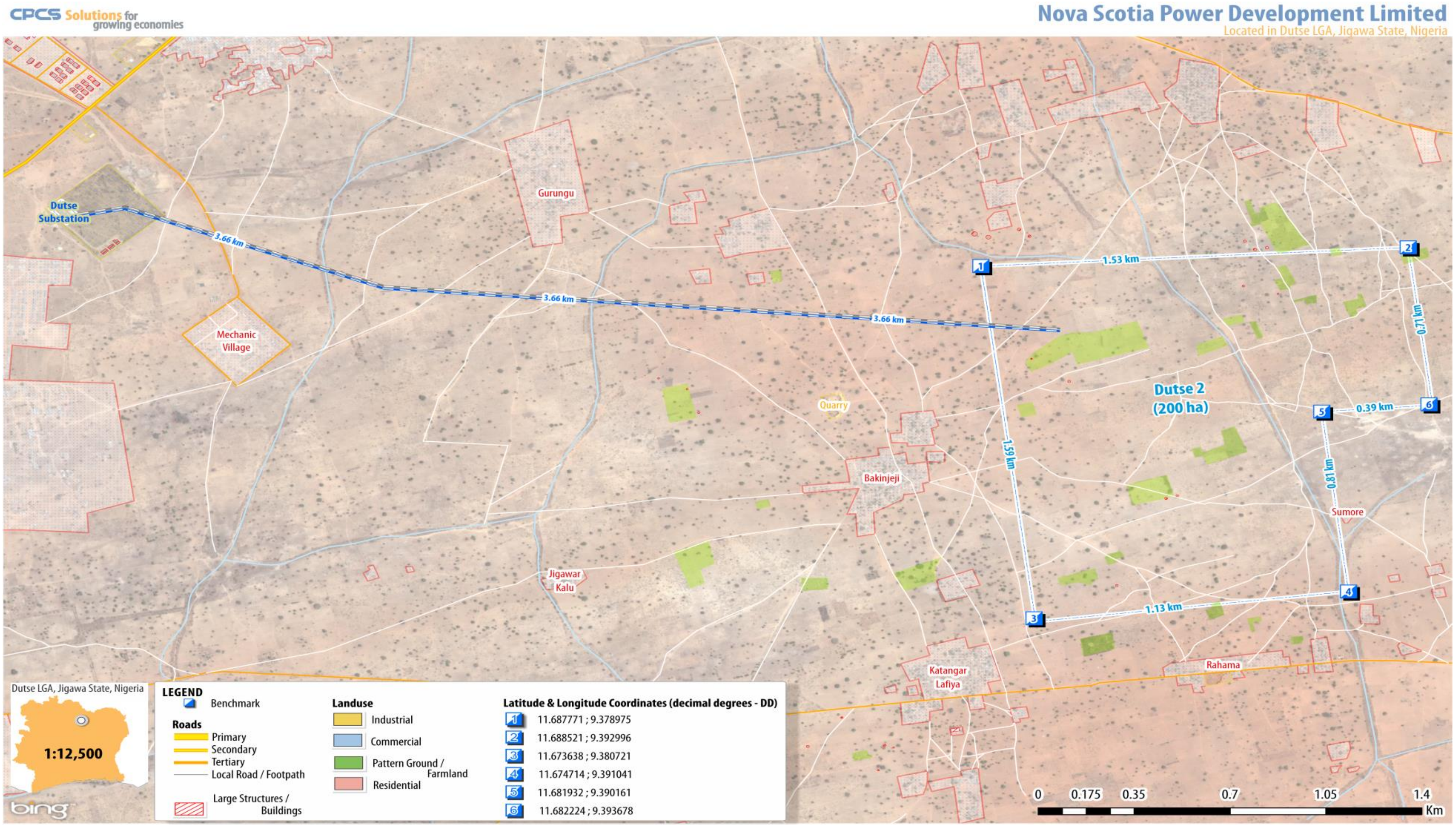

Figure 3.3: Proposed Project Site Layout, Transmission Route and Surrounding Settlements

3.5 Project Objectives

The primary objective of the project is to develop a large scale PV solar facility of a target energy generation capacity of 80 MW_{AC} in Jigawa State, Nigeria. The electricity generated will be fed into the national grid at the Dutse substation and sold as per an Independent Power Producer (IPP) Licence to NBET.

Specifically, the objectives of the project are to:

- Develop and construct a utility scale solar power plant to the most stringent national and international standards using tier-one equipment and experienced Engineering, Procurement and Construction (EPC) Contractor.
- Deliver a return to shareholders during both the development and operation period that adequately reflects the risk of their investment.
- Minimize wherever possible physical and/or economic displacement of local people in accordance with FMEnv Guidelines, IFC Performance Standards and the Equator Principles.
- Provide the State of Jigawa and surrounding areas with an indigenous source of electricity at a reasonable price, which will in turn enable further economic development.
- Endeavour to employ as many local inhabitants of Jigawa State as possible during all phases of the project, and to transfer replicable skills to Nigerians especially inhabitants of Jigawa State to the greatest degree possible.

3.6 Project Components

The key components of the proposed solar PV plant are as follows:

- PV Modules (Solar Panels)
- Mounting Structures (tracking motors, if applicable)
- Cabling and Combiner Boxes
- Direct Current - Alternating Current (DC-AC) Inverters
- Transformers
- Medium Voltage (MV) & High Voltage (HV) Switchgear
- Electrical Connection Cabin
- Supervisory Control and Data Acquisition (SCADA) System
- Transmission to Grid
- Associated infrastructure and utilities, including:
  - Site security, including fencing and CCTV
  - Buildings, including onsite substation, connection building, control building, guard cabin, and spare parts storage.
  - Access road and internal road network
  - Storm water infrastructure and drainage system
  - Water supply infrastructure (boreholes)

The summary of major project components is provided in Table 3.1 and discussed in Section 3.8.

Table 3.1: Summary of Key Project Components

Project Components	Description
Generation Capacity	$80MW_{AC}$
Technology Adopted	Photovoltaic (PV)
Power Rating and Type of PV Panel	300Wp polycrystalline
Area to be Occupied by PV Panels	200.0194 Hectares
Number of Modules	306,432
Capacity Per Module	300 Wp
Types of Inverter	SMA 800 CP XT
Inverter Power Rating	800kV
No of Inverters	115
Transmission Network	132kV Double circuit overhead line
Grid Substation	Dutse Substation

Source: GEHS 2015

3.7 Technical Layout of Project

It is typical for a single EPC Contractor to undertake the majority of the design, construction and management responsibilities for projects of this type. To this end, the detailed technical design of the project will be finalised once the EPC contract has been awarded. However, the project will abide by all equipment design, construction, installation tests and commissioning works that will satisfy standards and codes including but not limited to international standards presented in Appendix 3.1. A typical functional layout of a solar project is presented in Figure 3.4.

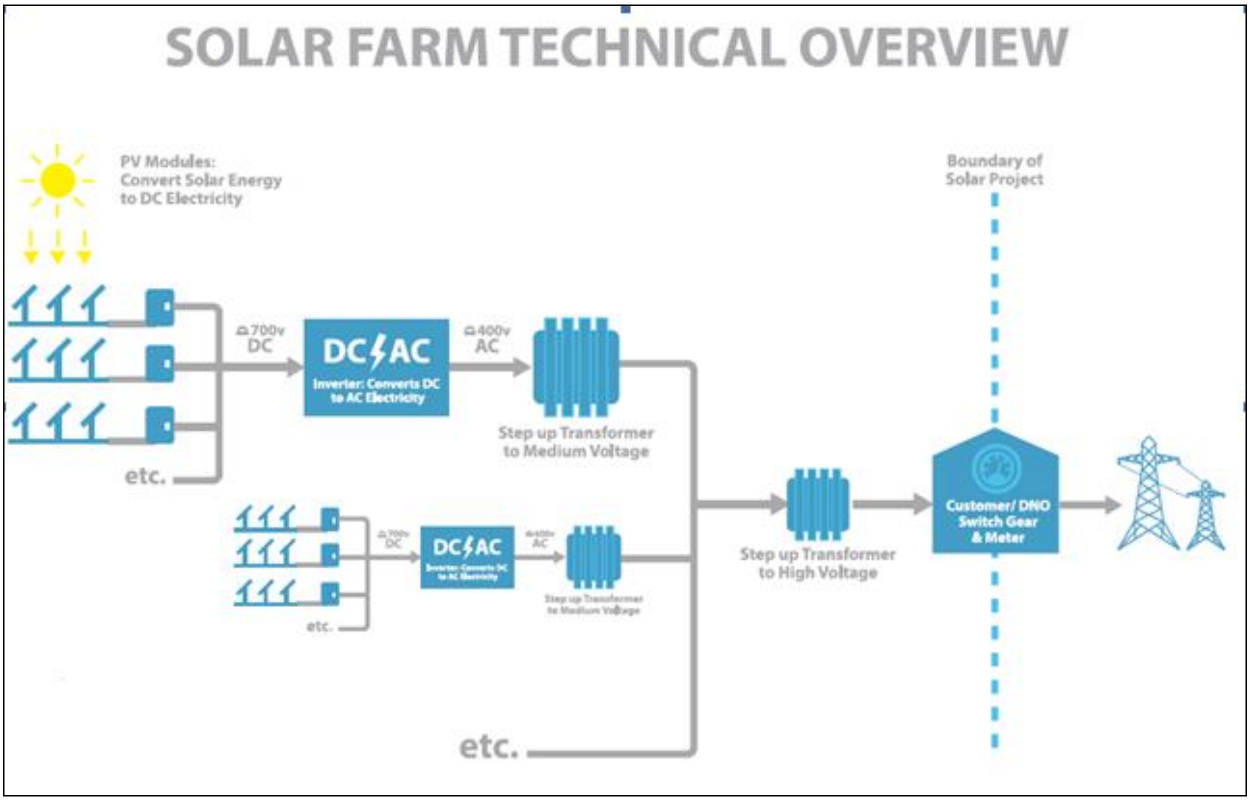

Figure 3.4: General Functional Overview of a Typical Solar Project showing Key Components
Source: OST Energy, 2015.

The conceptual layout for Dutse-2 and the proposed route for new 132 kV overhead line are presented in Figures 3.5 and 3.6 respectively.

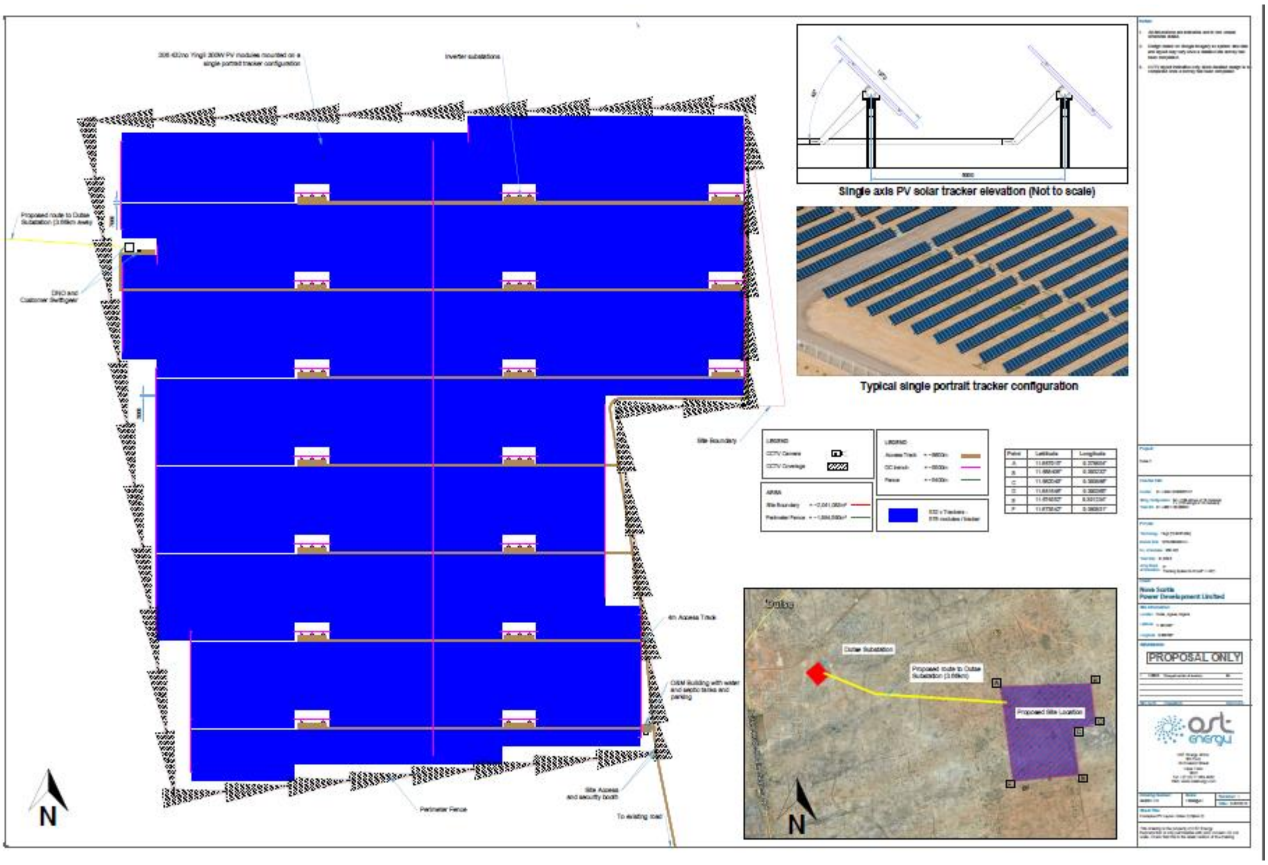

Figure 3.5: Conceptual PV Layout for Dutse -2

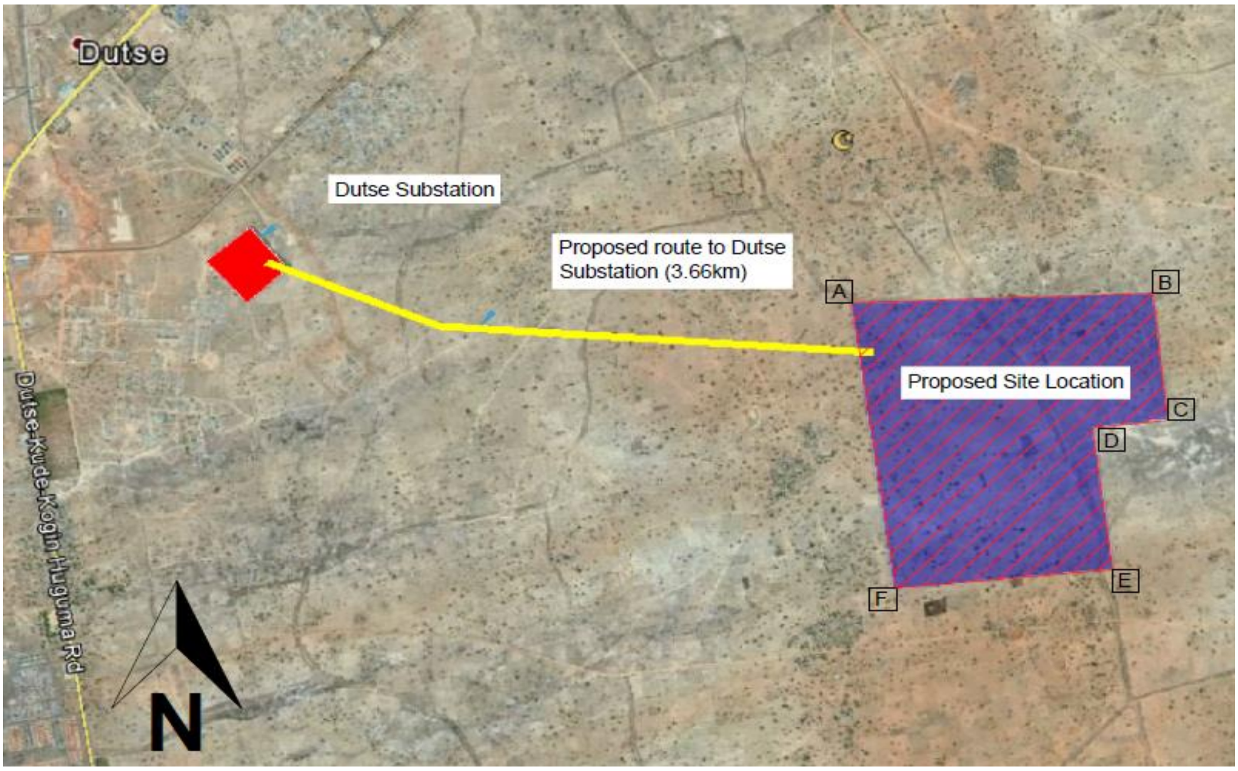

Figure 3.6: Project Site (Dutse-2) and Proposed Route for 132kV Overhead Line

3.8 Project Design and Technology

This section describes the design and technology adopted for the proposed project.

3.8.1 Photovoltaic Module

The proposed project will utilize PV technology to generate electricity. PV technology consists of two main components, namely, PV Cell and PV Module/Panels. These components are described below:

3.8.1.1 Photovoltaic (PV) Cell

The PV cell is a basic photovoltaic device, which generates electricity when exposed to solar radiation due to the photo-electric effect. The absorbed solar energy excites electrons inside the cells into a higher state of energy to produce electrical energy. PV systems are based on the use of semiconductors that can generate electric current when exposed to sunlight. Semiconductors are materials that hold their bonding electrons tightly in covalent bonds (and therefore act as insulators in their pure state), but have conducting properties when combined with small amounts of impurities called dopants. The most widely used semiconductor in PV panels is silicon as it is the cheapest and the earth's most abundant material after oxygen. PV cells are commonly constructed from mono or polycrystalline silicon or thin film technology. Impurities commonly used as dopants to enhance silicon conductivity for solar energy generation include boron and gallium. Compound semiconductor materials such as cadmium telluride are also used to increase the efficiency of solar cells for capturing the energy in sunlight. All photovoltaic cells produce direct current (DC).

3.8.1.2 Photovoltaic (PV) Module or Panel

The PV module or panel is the smallest common assembly of interconnected PV cells. To produce electricity at utility scale, many individual PV cells are connected as a module. The modules are combined to make individual solar panels which are then grouped into arrays producing DC electricity. This modular nature of PV systems allows greater flexibility in sizing facilities based on factors such as the amount of power needed or the amount of land area available. In the case of mono- or poly-crystalline silicon cells, after testing and sorting to match the current and voltage, the cells are interconnected in series and encapsulated between a transparent, anti-reflective front, and a backing material to provide environmental protection to the cells. The module is then typically mounted in an aluminium frame to provide mechanical strength to the assembly.

The power-producing components of utility-scale PV facilities are the solar field, which contains the PV panels and the Medium Voltage (MV) power unit. The MV unit contains an inverter to convert the produced DC to alternating current (AC) power, a transformer to boost voltage for feeding into the national grid and switchgear to sense grid destabilization and automatically disconnect the PV facility from the grid, if needed. The electricity will then be fed from the site to the Dutse substation which is the closest grid substation for distribution into the wider electricity grid.

The PV modules being considered for the proposed project are polycrystalline silicon, with each solar panel having a nominal power capacity of 300 Wp. The polycrystalline silicon technology is discussed extensively in Section 2.6.1.3 and shown in Plate 2.6.

3.8.2 Mounting Structures

The PV modules will be on fixed mounting structures which will allow them to be connected and arranged into a series of 'tables'. This helps to keep them oriented in the correct direction and provides them with structural support and protection. Typical tables for poly-Si will be 4 modules high (in landscape) by 19 wide, giving 76 modules per table. The tables supporting structures will be piled to a typical depth of around 1.5 – 2 m into the ground. Figure 3.7 shows the arrangement and row spacing for polycrystalline modules.

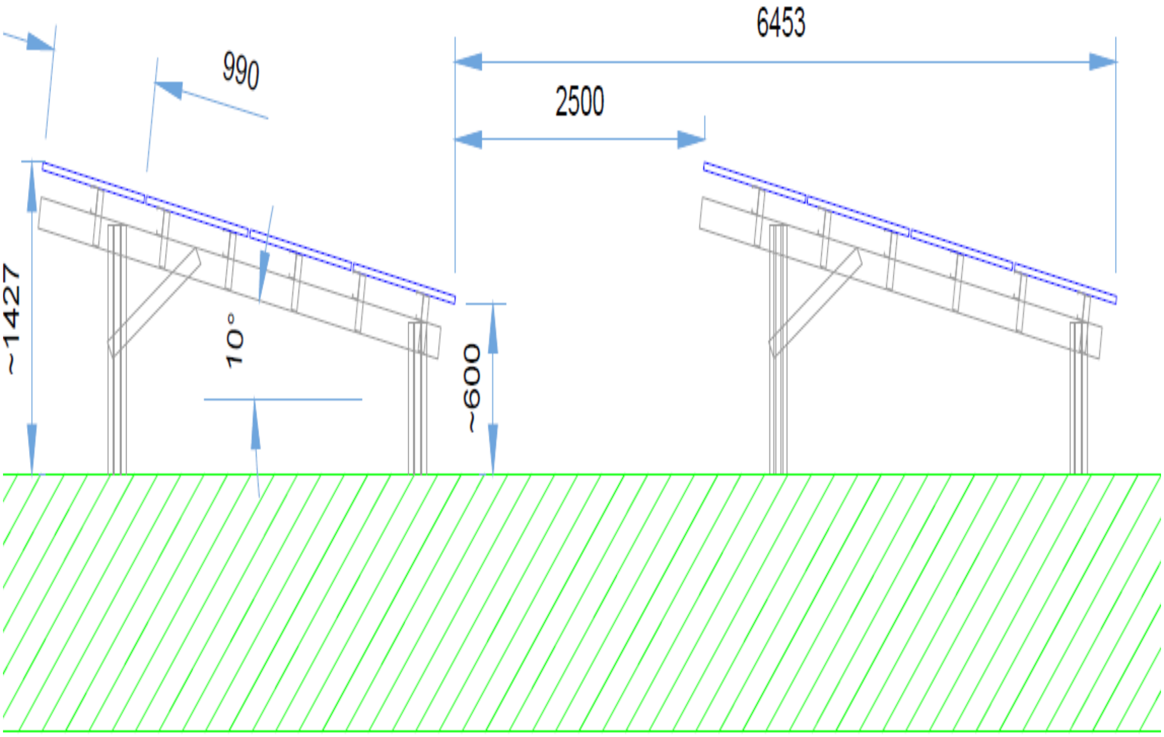

Figure 3.7: Arrangement and Row Spacing for Polycrystalline PV (in mm)

Mounting structures may be either fixed or tracking. Since fixed tilt mounting systems are simpler, cheaper and have lower maintenance requirements than tracking systems, they are the preferred option for the proposed project. The total area to be developed for the solar project will cover approximately 200 ha. The panels will be arranged in rows extending across the site facing due south. The collective term for a series of PV panels in rows is sometimes referred to as PV array.

3.8.3 Cabling and Combiner Boxes

The PV arrays will be connected via cables that run either under the PV arrays or underground (at a depth of approximately 1m) to combiner boxes. Combiner boxes combine the power generated by multiple arrays to larger cabling in order to transmit the power more efficiently to the MV power units where the inverter/transformer enclosures will convert the DC produced by the PV panels to AC. Figure 3.8 shows a combiner box attached to the mounting structure of a solar panel.

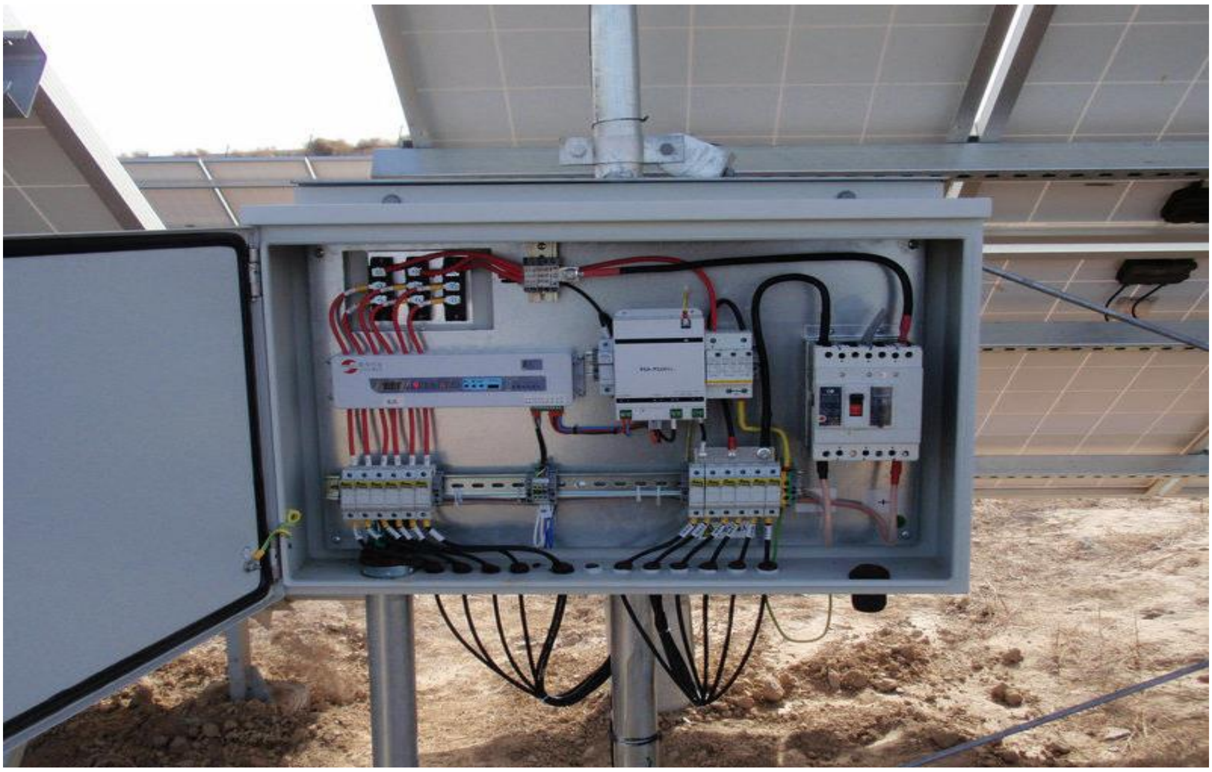

Figure 3.8: Combiner Box Attached to the Mounting Structure of a Solar Panel.

3.8.4 Medium Voltage (MV) Power Units

The Project will comprise a series of MV power units. Each MV power unit will have dimension of 6 m x 2.6 m by 2.4 m high and consist of the following components:

- 2 x inverters
- 1 x 400 V/33 kV transformer
- 1 x switchgear.

An indicative diagram of an MV unit is shown in Plate 3.1 below.

Plate 3.1: Medium Voltage Power Unit
Source: SMA MV Power Station

The poly-Si design has been based on 3,610 modules (47.5 tables) per inverter. Therefore, there will be a total of one MV Power Unit for around every 2.2 MWp of modules, equating to a total of 38 MV power units for the poly-Si modules. The function of each component of the MV power unit is described below.

3.8.4.1 Inverters

Inverters are solid state electronic device that convert the variable DC output of a PV solar module into a utility frequency AC suitable for supply to a commercial electrical grid or used by a local, off-grid electrical network. In addition, inverters can also perform a range of functions to maximize the output of a PV plant. Inverters are a core component in a PV system, allowing the use of ordinary AC-powered equipment. Solar inverters have special functions adapted for use with PV arrays, including maximum power point tracking, string current monitoring and anti-islanding protection. Each inverter unit will have power rating of 800 kV.

3.8.4.2 Transformers

A transformer is an electrical device that transfers electrical energy from one alternating circuit to another with a change in voltage, current, phase and/or impedance, allowing electricity to be distributed more efficiently over long distances. Each MV power unit will contain a 400 V/33 kV step-up transformer.

3.8.4.3 Switchgear

The MV power unit switchgear operates, isolates and controls the export power from each 2.2 MWp 'array' before feeding into a ring main within the site. Switchgear is an electrical system that provides disconnection, isolation, earthing and protection for the various components of the plant. Considering the size and set up of the electrical infrastructure in the proposed solar plant, one switchgear will be required on the output side of the inverters, as a means to isolate the PV array. As a minimum, the switchgear will be appropriately labeled to clearly show the "ON" and "OFF" positions, have remote switching capabilities and be provided with suitable earthing. HV switching is a hazardous procedure and safety measures to minimize risk are provided in Chapter Seven of this Report and shall be adopted as good practice.

3.8.5 Electrical Connection Cabin/On-Site Substation

The on-site substation will house the primary and secondary electrical equipment for the central operation of the solar plant and connection to the national electricity grid. The substation can also provide an operational base for staff required for operation and maintenance as well as stores or other auxiliary functions associated with the solar plant. Equipment such as the MV transformers, MV switchgear, SCADA systems, protection and metering systems can be placed within the substation depending on the site layout and plan.

The functions and components of the on-site electrical cabin are described below:

- Generation Meter: Tariff metering will be installed to measure the export of power. This may be provided at the on-site substation or at the point of connection to the grid. Current transformers and voltage transformers provided in the switchgear will be connected to metering points by screened cable.

- Project Power Transformer: this transformer will step up the voltage from 33 kV to the required utility grid voltage of 132 kV. The power transformer will be bespoke constructed and site specific to local grid code requirements.
- Auxiliary Transformer: this transformer will supply power to internal facilities within the project and steps down the electricity from MV to low voltage (LV) i.e. 33 kV/400 V.
- Project Control Room: this is where the SCADA operating system will be located and where an operator would control the project.
- SCADA System: SCADA systems provide control and status indication for the items included in the substation and across the solar plant.

3.8.6 Point of Connection Facility/Point of Common Coupling

On the high side of the step up transformer is where the ownership is transferred from the project owner to the TCN and from where the project will connect to the national transmission network. At this location, there will be the project's Export Meters (main meter and back up meter) and the TCN switchgear, which can isolate the project in order to protect the national transmission network.

3.8.7 Earthing and Lightning Protection

There will be a single earthing grid for the solar plant, which will act as an earthing grid for both the LV and the HV equipment. The earthing grid will consist of bare copper cable all along the electrical trenches and if necessary along the perimeter fence of the site. The final specification of the buried copper electrode will be according to BS 1432, and the System Operator's approved design requirements. Each inverter will have a perimeter earthing grid constructed with bare copper cable and copper earthing bars. The HV earthing system will be connected to the System Operator adopted circuit, and as such the design will comply with ENA TS 41-24. The short time current rating of the total earth rod installation shall be at least equal to the designed fault rating of the switchgear. The loop impedance of the earthing system shall be such as to ensure that all protective devices operate within the short time rating of the system and such that prospective values of touch potential do not approach unsafe values, it shall also comply with the requirements of the Grid Code.

The works shall provide for a fully protected robust grounding system for lightning protection. The design shall adhere to the engineering standards appropriate for the project. The internal and external lightning protection system (LPS) shall comply with IEC 62305, BS 7471, IEEE 80 and IEEE 665. Engineering and design of the lightning protection system; of overvoltage protection; and of the grounding system of the DC network shall be carried out according to applicable international standards for earthing and lightning protection in Appendix 3.2.

3.9 Evacuation Mode and Grid Connection

The proposed solar PV plant shall be connected through a double circuit transmission line to the National grid via the TCN Dutse Substation from where the 80 MW_{AC} electricity generated shall be transmitted to the bulk trader and eventually distributed to the end consumers. As part of the solar plant, NSPDL will be responsible for the construction of a suitable transmission line up to the connection point to the existing grid (i.e Dutse Substation). Specifically, for the proposed solar plant, the generated power will be evacuated through a dedicated high voltage (HV) 132 kV double circuit overhead transmission line. The line will be constructed in compliance with stipulations in the National Grid Code following the shortest possible route of 3.66 km that has already been identified.

3.9.1 Transmission Line

Transmission lines are used to transmit power, generally using high-voltage three-phase AC, over relatively long distances. The lines will be made of high voltage cabling conductor. The transmission of bulk electrical energy is done at high voltages to reduce energy losses in long-distance transmission. It is intended that the proposed transmission line will be a 132 kV double-circuit bear conductor. The transmission lines generally comprise the following components:

- **Support structures:** pylons/poles are used to keep the high voltage conductors separate from each other, and far from the ground and other obstructions. The distance between structures (span) and their height is largely determined by the topography and clearance requirements. Spans may range from 200 to 400 metres. Poles are fabricated in a range of heights but are between 25 and 34 metres, to allow optimum height of a structure to be provided at each site.
- **Conductors/transmission cables**: these conduct/transfer the generated electricity.
- **Optical fibre ground wires**, to provide protection from direct lightning strikes.
- **Insulators and fittings**, provide electrical insulation between the conductors and the (earthed) structure.

The majority of transmission infrastructure for the project is proposed to be dedicated on a new 132 kV transmission corridor, away from settlements, schools, hospitals and other sensitive receptors as much as possible. The strip of land that will be ultimately used to operate, maintain and repair the transmission line facilities is known as the transmission corridor RoW. The width of a RoW usually depends on the voltage of the line and the height of the structures. For a 132 kV power line associated with the proposed project, a 30 m clearance right of way will be established, i.e. 15 m from the centre on either side of the pylon as specified in Chapter Three of the Nigerian Electricity Supply and Installation Standards Regulations 2015. Once the transmission lines are constructed, both the lines and the RoW will be handed over to TCN who will be responsible for its operation and maintenance. A typical 132kV transmission line is presented in Plate 3.2.

Plate 3.2: Typical Transmission Line

3.9.2 Transmission Substation

A transmission substation forms an integral part of an electrical generation, transmission and distribution system, as it serves as the point where high voltage electricity is stepped down into lower voltage electricity suitable for distribution into commercial and residential areas through distribution lines.

For the purpose of this project, the existing Dutse substation will serve the purpose of efficiently distributing the electricity generated at the NSPDL solar plant. Analysis of the existing and planned transmission line network (grid map) in the project region revealed that the substation is the only reasonable option for the evacuation of power from the proposed solar PV power plant. The Grid Map is presented in Figure 3.9. Consequently, no new substation is planned to be constructed as part of the proposed project infrastructure/utilities. Plate 3.3 shows the existing Dutse substation which is 3.66 km away from the proposed project site. The 132 kV power line described in section 3.9.1 will be used to convey the power generated on site to the substation.

3.9.3 Load Flow Criteria and Harmonics

The Dutse substation is located in Zamfara zone that is already generating a high power level of 2,550 MW. Following the connection of the Dutse solar PV plant and subsequent injection of the 80 MW_{AC}, the electricity generation in the zone will rise to 2,630 MW which is about 3% increase to the initial level. The analysis carried out during evacuation study revealed that the introduction of the additional 80 MW_{AC} from the Dutse solar PV plant will not cause any adverse effects on the existing voltages on the 132 kV network in the zone. Hence, from the static point of view, the 80 MW_{AC} from the Dutse Solar PV plant is acceptable for the TCN grid integration on the 132 kV busbar of Dutse substation and will not present any problem for the grid. Furthermore, the losses on the transmission network in the zone will decrease by up to about 5 MW_{AC} when the Dutse solar PV power plant is operating at full capacity with the generation of 80 MW_{AC}.

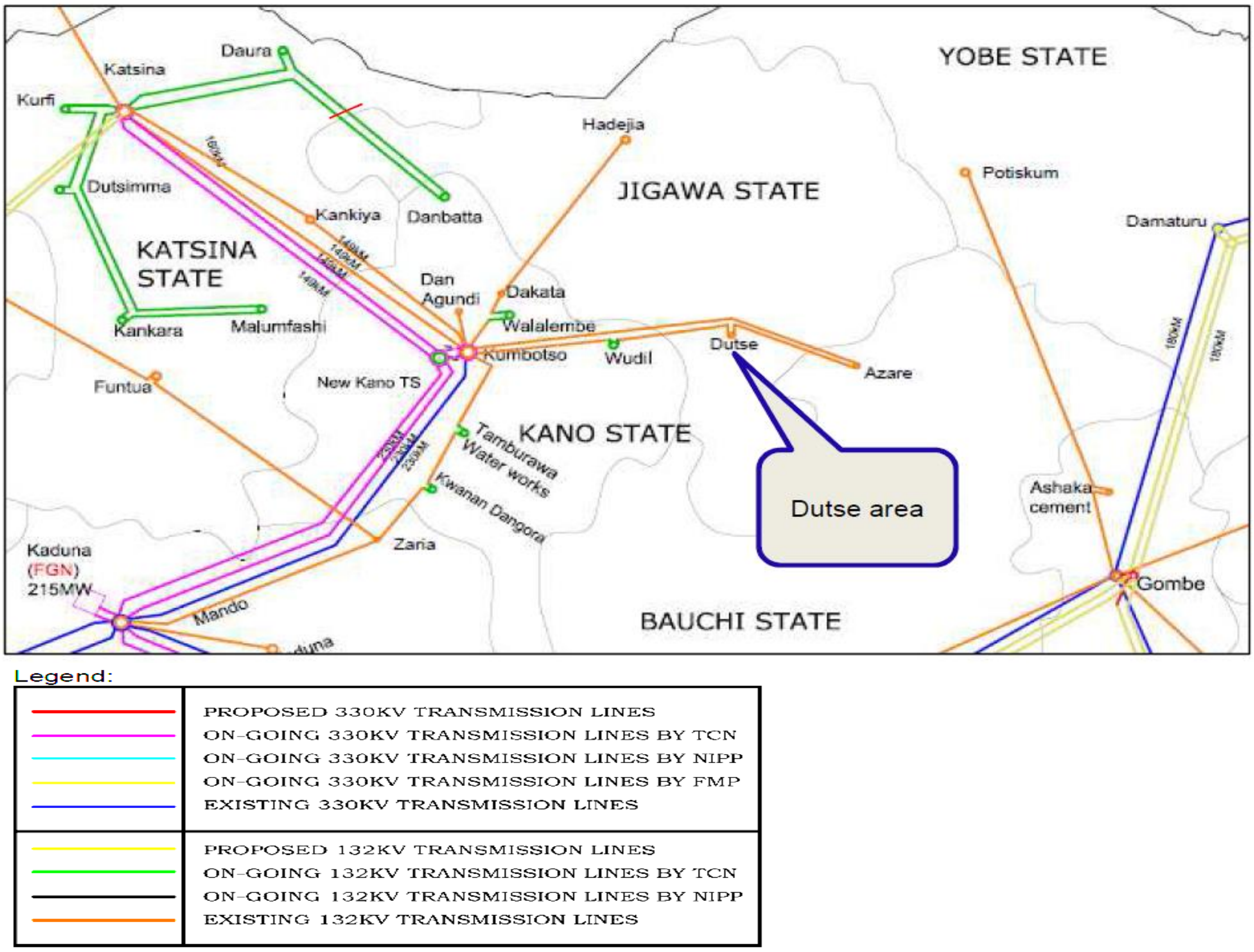

Figure 3.9: Harmonised Grid Map for the Existing and Planned Transmission Line Network for TCN 1000 MW for the North-Eastern Nigeria
(Source: NSPDL - 80 MW PV Solar Plant Power Evacuation Study, 2015)

Plate 3.3: A cross-sectional view of existing Dutse Substation

3.10 Associated Infrastructure and Utilities

The following additional infrastructure and electrical equipment will be required for the project:

- PV power facility monitoring equipment and associated telecommunication links;
- Meteorological stations to record irradiation and site conditions;
- Buildings required for the daily operation of the project, including:
  - administration/office/control room & security (gate house),
  - control room & workshop,
  - ablution/change room and
  - warehouse/storeroom.
- Site security system, including CCTV, fencing around the site, lighting and 2 security booths near the access points;
- Site access and internal road network to provide easy access to the arrays for operation and maintenance purposes;
- Water supply infrastructure, including groundwater well(s), pipe works and storage tanks;
- Stormwater/drainage system to control the movement of water across the site and prevent damage to equipment.

3.11 Project Development

The general development of a PV project can be broken down into the following phases:

- Pre-construction: Including activities such as land acquisition, mobilisation of personnel, equipment and materials to site, site preparation and installation of temporary structures for workers.
- Construction: Including civil works, electrical works, and equipment installation.
- Operation: Plant operation and routine maintenance.
- Decommissioning: Removal of PV panels and equipment, demolition of structures and evacuation as well as site remediation

3.11.1 Pre-construction Phase

The preconstruction phase will involve mainly land acquisition, mobilisation of personnel, equipment and materials to site, site preparation and installation of temporary structures for workers.

- **Land Acquisition**

The principal challenge pertaining to land acquisition for the proposed project was to identify land in close proximity to the Dutse substation that will not encroach on existing settlements. The economics of a utility scale solar farm decrease for each kilometer further away from a substation. As the substation at Dutse is close to a major urban centre, the capital of Jigawa State, finding land without significant settlement was a major challenge. Given that there is a significant wet season in Jigawa State, a second challenge was identifying land that is not prone to flooding.

In order to minimize these challenges, NSPDL took significant efforts to evaluate site options for both the potential for flooding and settlements. NSPDL used a two-step process, which took place after initial site evaluation. The first step involved a detailed Geographic Information System (GIS) mapping exercise of the site using high-resolution satellite imagery. The second step involved site survey to verify the desktop analysis of the satellite imagery. During this process, the officials from the Jigawa State Ministry of Lands were carried along in order to ensure they were in agreement with study conclusions. The identified land is 200.0194 hectares devoid of any human settlement and not prone to flooding. The land is currently being cultivated by local farmers to grow millets, ground nuts and maize.

The 200.0194 hectares of land for the installation of the solar PV panels has now been acquired from the government of Jigawa State (the C of O for the land is presented in Appendix 3.3) while the 3.66km by 30 m transmission corridor RoW will be acquired by TCN. The process of land take will be carefully planned and implemented and affected persons and communities will be adequately consulted to determine appropriate compensation. Ultimately, a Resettlement and Livelihood Restoration Plan (RALRP) will be developed to international standards to compensate affected persons and communities.

- **Mobilisation of Personnel, Equipment and Materials**

Following land acquisition, heavy-duty and other pieces of equipment will be moved to the proposed project site at the beginning of construction activities for civil work activities and equipment installation. All PV, electrical and structural equipment are planned to be shipped through Lagos port and then trucked to site via road in steel "containers". It is envisaged that about 500 truckloads transporting 300-400 x 40-foot containers of equiment, as well as up to 5 digger loaders for land clearing; 5 to 10 trucks with cranes to assemble the facility would be required for construction phase.

During the site preparation period, the workforce required for site security, manual labour, civil works, transportation of goods and other similar services will largely be drawn from the local labour pool with international expertise providing oversight.

- **Site Preparation and Clearing**

Site preparation activities will entail clearing of vegetation in the entire 200 hectares project site and 3.66 km by 30 m RoW for the transmission line.

- **Installation of Structures**

Prior to the commencement of construction phase, there will be establishment of on-site facilities, such as temporary workers' accommodation, workshops, mobile toilets etc. It is anticipated that the preconstruction period will take approximately 2 months.

3.11.2 Construction Phase

Activities in the construction phase will include the following:

- **Construction/Improvement of Internal and External Access Roads**

To provide access to the site from the nearby highway, a short road will be prepared to a level that is acceptable for the transport of equipment, material and people to and from the site. Existing roads passing through or nearby villages will be rerouted away from affected villages to minimize impacts of dust and gaseous emission on human settlements.

- **Civil Works**

The civil works relating to the construction of a solar PV plant are relatively straightforward and will entail the following:

- Excavation, levelling and compaction of site;
- Installation of chain link site fencing with galvanized barb wire;

- Construction of buildings and foundations including on-site substation, connection building, control building, guard cabin, and warehouse;
- Installation of water supply infrastructures such as boreholes, pipe works and storage tanks.

- **Installation of Mounting Structures and PV Modules**

The foundation option selected for the ground-mounted PV system is the driven piles. The piles providing support for the PV panels will be driven into the ground to form the structural base of the PV arrays. Piles driven into the ground can substantially result in low-cost, large scale installations that can be quickly implemented. Baseline survey and preliminary geotechnical investigations revealed that ground conditions in the proposed project site are suitable for piling as bedrock is not close to surface. Once the PV components have arrived on site, technicians will supervise the assembly and installation of the panels to ensure the foundation is suitable for ground conditions and accurate orientation of modules. The height of the support structures will be 2.5 m (from ground to top of PV panel) and the panels will be installed on the structure at an angle of 10^0 due south. The useful life of fixed support structures, although largely dependent on adequate maintenance and corrosion protection, could be expected to be beyond 25 years. The piles will be galvanized steel structures to reduce corrosion. A phased approach will be adopted during the project construction.

- **Installation of Equipment**

During construction, the following pre-fabricated key components of the project will be installed:

- MV power units comprising of transformers, inverters and switchgears.
- Generation meters.
- CCTV.
- Supervisory Control and Data Acquisition (SCADA) System.

- **Installation of Grid Connection Facilities**

These works will entail erection of towers along the 3.66 km RoW and installation of overhead 132 kV HV transmission power lines.

- **Electrical Works**

These works will entail wiring of the PV panels and interconnection with the components of the MV power units. The works will consist of laying both underground and over-ground cables on the project site in line with manufacturer's recommendations. Underground cables shall be buried at a suitable depth 1m deep with warning tape or tiles placed above and marking posts at suitable intervals on the surface. Cables may either be buried directly or in ducts. If cables are buried directly, they will be enveloped in a layer of sand or sifted soil will be included to avoid damage by backfill material.

The general layout of the plant and the distance chosen between rows of mounting structures will be appropriately selected to minimize cable runs and associated electrical losses. However, sufficient space will be allowed between rows to allow movement for maintenance purposes.

- **Pre-Commissioning Testing of Facilities**

Following complete construction, the entire facilities including the transmission line will be tested to ensure all the components of the facilities are functioning effectively. Activities during testing will include power generation, calculations of energy yield, efficiency, performance monitoring, power rating, inverter efficiency monitoring, module temperature monitoring, system losses calculation etc.

In general, pre-commissioning testing should prove three main criteria:

- The power plant is structurally and electrically safe.
- The power plant is sufficiently robust (structurally and electrically) to operate for the specified project lifetime.
- The power plant is operating as designed and performs as expected.

Pre-Commissioning tests are normally split into three groups:

- ***Visual acceptance tests.*** These tests take place before any systems are energized and consist of a detailed visual inspection of all significant aspects of the plant.
- ***Pre-connection acceptance tests.*** These include an open circuit voltage test and short circuit current test. These tests must take place before grid connection.
- ***Post-connection acceptance test.*** Once the plant is connected to the grid, a DC current test will be carried out. Thereafter, the performance ratio of the plant can be measured and compared with the value stated in the contract.

An availability test, usually over a period of 5 days, shall also be carried out.

- **Demobilization (Site clean-up)**

Following successful testing of the facilities, personnel, materials and equipment will be demobilized from the site. All temporary structures used during construction such as mobile toilets, workers accommodations etc will be removed.

It is anticipated that the construction phase will be for a duration of 10-12 months.

3.11.3 Operation Phase

Once the facility is complete and operational, it is expected that it will have a lifespan of approximately 20 years to align with the Power Purchase Agreement (PPA). The plant; however, can last for much longer than the contract term. Compared to most other power generating technologies, PV plants have low maintenance and servicing requirements. However, suitable maintenance of a PV plant is essential to optimize energy yield and maximize the life of the system. Typically, routine maintenance of a solar plant consists of the following:

3.11.3.1 Scheduled or Preventative Maintenance

This is planned in advance and aimed to prevent faults from occurring, as well as to keep the plant operating at its optimum level. The frequency of the preventive maintenance will depend on a number of factors such as the technology selected, environmental conditions of the site, warranty terms and seasonal variances.

Scheduled maintenance typically includes:

- Module cleaning.
- Checking module connection integrity.
- Checking junction / string combiner boxes.
- Thermographic detection of faults.

- Inverter servicing.
- Inspecting mechanical integrity of mounting structures.
- Vegetation control.
- Routine balance of plant servicing / inspection.

3.11.3.2 Unscheduled Maintenance

This is carried out in response to failures. Common unscheduled maintenance requirements include:

- Tightening cable connections that have loosened.
- Replacing blown fuses.
- Repairing lightning damage.
- Repairing equipment damaged by intruders or during module cleaning.
- Rectifying SCADA faults.
- Repairing mounting structure faults.

During operation phase, measuring the performance of the PV power plant will be done remotely, through the use of telemetric monitoring.

3.11.4 Decommissioning phase

Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle from the project site. When NSPDL decides to decommission and shut down the power plant permanently, a comprehensive abandonment, decommissioning and closure plan shall be developed, taking into account the most cost-effective and practicable methods, legal requirements and industry practices at that time. This plan will be submitted to the FMEnv and other relevant regulatory agencies for approval, at least 2 years prior to scheduled abandonment and decommissioning.

Typically, the following steps would be followed during plant decommissioning:

- PV panels will be removed from the fixed aluminium frames.
- Fixed aluminium frame structures will be removed.
- PV panels will be transported to special recycling facilities (alternatively used at other operational sites).
- Electrical equipment (transformers) will either be re-used on other developments/projects or recycled.
- Underground cable runs (where applicable) will be removed and recycled.
- Gravel/chipstone on the access roads, on-site service roads, and guard house foundations will be removed and reused.
- Buildings, such as the guardhouse can be taken over by the landowner for operational purposes, alternatively all the reusable material will be removed, the structures demolished and the rubble transported to a municipal waste site.
- Disturbed land areas will be rehabilitated, and replanted with indigenous vegetation.

The PV power facility would be decommissioned at the end of its projected 20 year operational life time. Alternatively, with regular maintenance, the facility could be upgraded, with the useful lifespan of the project extending beyond the design lifespan.

NSPDL through the Operations and Maintenance (O&M) Contractor shall consider working with PV CYCLE, an association which organises the take-back and recycling of PV modules at the end of the project life span. PV CYCLE operates a comprehensive recycling process, which recovers most of the materials within the PV panel (including glass, semiconductor material, ferrous and non-ferrous metals, etc.) for reuse in new products. All panels and major electrical components will be recycled. The decommissioning phase is expected to be for a maximum of 6 months.

3.12 Employment, Workforce and Training

NSPDL will have ultimate oversight over labour and working conditions for all phases of the project.

During preconstruction phase, especially site preparation period, the workforce required for site security, manual labour, civil works, transportation of goods and other similar services will be drawn from the local labour pool. During this phase of the project and early stages of construction, a highly-skilled team of solar energy technicians will train potential local employees, preferably from Jigawa State, where possible.

During construction, the majority of workers will be hired and managed by the EPC Contractor and other subcontractors. It is envisaged that about 200-300 people will be employed for a duration of approximately 10-12 months. This would include around 20-30 experienced engineers, 10-15 experts and local skilled, semi-skilled and unskilled workers. Overall, the project aims to employ a minimum of 30% (can be up to 60%) of unskilled and skilled labour from the surrounding communities for construction.

A total of about 20-30 job opportunities will arise during the operation phase, including skilled and semi-skilled labour (such as electrical and mechanical technicians) and unskilled labour (such as module cleaners and security personnel) for a duration of approximately 20 years.

A Workforce Management Plan will be developed that will apply to direct workers, contract workers, and supply chain workers. The Plan will outline human resource policies and procedures, terms of employment and working conditions, project workforce requirements, recruitment strategies, management of employment contracts, housing and transportation of workers. The human resources policies and procedures will focus on non- discrimination and equal opportunity. The Workforce Management Plan will be designed to ensure that NSPDL manages its staff in accordance with the local labour rules, including allowing freedom of association, recognition of trade unions, respect for collective bargaining agreements and protecting worker's rights in terms of the national legislation.

3.13 Site Security

A project specific site security plan, procedures, and contract will be established and implemented. The Security Management Plan (SMP) will be developed to assess security threats and identify specific measures to be put in place to address such security threats. The plan will be developed in consultation and partnership with local police authority and local vigilante group(s), if any, who shall provide professional advice and update regarding local security challenges as well as security operational assistants as may be required.

NSPDL will award a contract to an appropriate security company, to provide 24 hour security at the site. The site security contractor will be required to comply with the above mentioned SMP, code of conduct, as well as good international practices, such as IFC Performance Standards on security personnel in terms of the principles of proportionality, hiring, rules of conduct, training, equipping and monitoring of such personnel. In addition, the security contractor will maintain an ongoing consultation with local police authority to update the plan based on emerging security concerns in the project region.

3.14 Project Health, Safety and Protective Measures

All works during project implementation and throughout the project life cycle shall conform to NSPDL HSE Policy presented in Chapter Seven of this Report. The EPC/O&M contractors shall develop a project specific HSE Plan which will guide activities in all phases of project implementation.

3.14.1 Fire Safety and Protection

With regards to fire protection, there is limited risk of fire at a solar PV project. Nevertheless NSPDL through its EPC/O&M contractors shall ensure that the solar plant is designed, constructed and operated in accordance with internationally accepted electrical standards as well as other life and fire safety standards. This will amongst others involve installation of fire extinguishers suitable for electrical fires within inverter cabins and other buildings on the site. Additional measures for fire protection are discussed in section 6.3.3.5 of the Report.

3.15 Water Use and Management

Water will be required during both the construction and operation phases of the project.

3.15.1 Water Requirements during Construction Phase

During the construction phase, water demand is driven by the following key requirements:

- To make concrete for piled concrete mounting structure foundations;
- Dust suppression; and
- For staff consumption and sanitation.

Driven piles will be used for the mounting system, therefore no water will be required for concrete piled mounting structure foundations. However, water will be required for foundation pad concrete mixing and pre-Performance Acceptance Certificate (PAC) washing of panels. Preliminary investigations suggest that a total of approximately 520,000 litres of water will be required (OST Energy, 2015).

In addition, water will be required for dust suppression especially on the site access road. It is estimated that up to 30,000 litres may be required daily for dust suppression if construction activities are taking place during the dry season. With activities likely to generate dust not expected to last beyond a few months during construction, water requirement for dust suppression is estimated at 1,800,000 based on a 5-day working week.

During construction, water will also be required for sanitary and drinking purposes by on-site workers. It has been assumed that 25 litres per worker per day will be required to cover this demand. A project of this size would create approximately 200 jobs over a 10-12 month construction period, with an average of 140 staff on site per day. This corresponds to a water requirement of 840,000 litres during construction phase for worker's consumption and sanitation based on a 5-day working week.

On the basis of the assumptions and calculations above, total water requirement during the construction phase is estimated at 3,160,000 litres.

3.15.2 Water Requirements during Operation Phase

Water use during operations for PV facilities is for washing of solar panels when necessary to prevent dust build-up, since dust can affect their performance. Water will also be required for miscellaneous industrial processes and sanitary uses to support the workforce.

Water Consumption per wash is estimated at 200,000 litres/MW/wash. Based on a proposed capacity of approximately 92 MW_{DC} and 3 washes a year, it has been estimated that the proposed project will consume approximately 55,200,000 litres per year for the cleaning of the solar panels. In addition, approximately 25 litres of water per day, per on-site staff member is estimated to be used with an average of 20-30 staff members on site each day. It is estimated that approximately 275,000 litres of water will be required per year by operations and maintenance staff. The total amount of water required during the operations phase is therefore estimated at 55,475,000 litres per year for cleaning and domestic purposes.

3.15.3 Water Supply System

All non-potable water required for use during the construction, operation and maintenance activities of the project will be sourced from borehole that will be constructed on the project site, while potable water will be tankered and stored on site.

3.15.4 Water Management

In order to conserve groundwater resource, there is need to consider water supply from other sources especially harvested rain water for panel washing. Other measures to conserve water are documented in Chapter Six of this Report.

3.16 Overview of Waste Streams and Management

Waste generation is inevitable in all phases of proposed project implementation and therefore will require great attention. It is the goal of NSPDL to design, construct and operate the proposed project in a sustainable and environment friendly manner. To this end, effective waste management practices shall be implemented through the entire life cycle of the project. Waste management principles and priorities shall be based on an integrated approach which will involve using a combination of techniques and programs to manage wastes. This approach shall be anchored on the 5Rs of waste management hierarchy of Reduce, Repair, Re-use, Recycle and Recover as the primary drivers while disposal shall be the last option.

All wastes generated from the project will be categorized as either non-hazardous or hazardous following an assessment of the hazard potentials of the materials.

Hazardous waste is waste that poses substantial or potential threats to public health and the environment due to its corrosive, ignitable, reactive or toxic nature. Anticipated hazardous wastes during proposed project implementation may include used oil and oil filter, chemical containers, batteries etc.

Non-Hazardous wastes are wastes that have little or no potential to cause harm but can become harmful if not properly handled. Anticipated non-hazardous waste from proposed project implementation may include general industrial type waste such as scrap metals, concrete, wooden pallets, vegetal waste etc.

A detailed approach for management of project related waste is discussed in Chapter Seven of this Report. The EPC and O&M contractors will be required to develop a project specific Waste Management Plan (WMP) for the construction and operation phases of the project.

An overview of the nature and types of waste streams expected to be generated during the different phases of the proposed project and their management are described below.

3.16.1 Preconstruction Phase

The only preconstruction activity that may likely generate waste is the site clearing. Anticipated waste streams from this activity are described below:

Non-Hazardous Waste: During preconstruction phase, a large volume of cleared vegetation is expected to be generated as waste from site clearing activities. These organic wastes will be largely degradable and therefore can be used for composting and will be made available to farmers to boost agricultural production and reduce reliance on agrochemicals. In addition, cleared woody vegetation will also be made available to inhabitants of nearby communities to be used for domestic purposes including as fire wood for cooking, though the clearing of trees will be very minimal.

Hazardous Waste: This class of waste is not expected during preconstruction phase

3.16.2 Construction Phase

Wastes associated with the construction of renewable energy facilities would be similar to wastes resulting from the construction of any large industrial facility. Anticipated wastes during construction phase are described below:

Non-Hazardous Waste: Construction waste will most likely consist of concrete and scrap metals, wooden pallets, paper, cardboard and other packaging materials. Other non-hazardous waste will be domestic-type solid waste from construction workers which may include residual packaging and food wastes, metal cans from food and drinks etc.

There are recycling opportunities for some of these materials, therefore they will be adequately segregated and stored on-site to be provided to local industries for reuse or recycling as appropriate. All waste that cannot be reused or recycled will be appropriately disposed of. All non-hazardous wastes not fit for reuse or recycling will be placed in appropriate on-site storage containers and evacuated at least once a week by third party waste contractor approved by JISEPA for disposal in a government approved facility. It is estimated that approximately 200 m^3 of construction debris will typically be produced per month during construction.

Hazardous Waste: Hazardous wastes are expected to be generated in limited quantities during construction and will be accumulated in appropriate containers with secondary containment or bunds provided to contain spillages and leakages. Hazardous solid waste may include used nickel-cadmium batteries, damaged panels, chemical containers, sanitary waste etc. The storage areas shall be properly demarcated and marked as hazardous. The storage of this category of waste will be brief before being evacuated by registered waste contractor with off-site permitted hazardous waste treatment, storage, or disposal facilities. Some recovery or recycling opportunities may also be identified for some hazardous industrial wastes. This will be handled by the waste contractor.

Mobile toilets will be used during construction and generated human/sanitary waste will be disposed appropriately daily by a JISEPA approved collector.

3.16.3 Operation Phase

In a manner similar to construction phase, both non-hazardous and hazardous wastes are expected during this phase in smaller quantity as described below:

***Non-Hazardous Waste*:** non-hazardous waste will be mainly from maintenance activities and domestic activities of the few on-site operational staff. As such, all non-hazardous waste classes highlighted during construction phase are expected in smaller quantities during operation. Non-hazardous waste will be segregated to enhance reuse and recycling opportunities while non-recyclables will be evacuated weekly by an approved waste contractor for onward disposal.

***Hazardous Waste*:** The amounts and variety of hazardous materials present on site during operation will largely depend on a number of factors, including the operational demands of the solar PV technology and frequency of scheduled and unscheduled maintenance. Hazardous waste especially those associated with PV technology and equipment installed on site may be more in quantity during operation phase. These may include, waste from damaged PV panels, electrical cables and other Waste Electrical and Electronic Equipment (WEEE), batteries, spent oils etc. The operation phase may also require the use of hazardous materials such as fuel and grease to fuel and maintain equipment and vehicles. These substances will be stored on-site in temporary storage tanks placed on the ground surface with secondary containment with capacity to hold at least 110% of the total capacity of each container. The storage areas shall be properly secured.

It is proposed that compost toilets will be used throughout the operation of the project for the few operational staff. Compost toilets treat human waste material by aerobic processes. They do not require water and produce a compost-like, odourless, dehydrated material that can either be disposed of via municipal waste services or be used for the production of compost.

The use, storage, transport, recycling and disposal of hazardous materials used for the project will be carried out in accordance with all applicable local and international regulations and supervised by JISEPA and FMEnv. Material Safety Data Sheets (MSDS) for all hazardous materials present on site will be readily available to on-site personnel. It is envisaged that approximately 0.2 m^3 of solid waste is estimated to be generated per month during the operational phase.

3.16.4 Decommissioning Phase

During decommissioning phase of the project, all materials, equipment and structures will be removed from the site.

Non-Hazardous Waste: Waste anticipated in this phase will be similar in nature to those of construction phase but in larger quantity. Hence, the management will be similar but on a larger scale.

Hazardous Waste: To a large extent, generation of hazardous waste will be minimized as majority of the solar plant equipment especially the PV panels, transformers, inverters and other major electrical equipment will be carefully removed to be reused in other solar PV plants or recycled through approved third party recycling plants which will be identified by NSPDL. Other hazardous materials such as spent oils, used batteries, oil and chemical containers shall be evacuated by an approved waste contractor.

A decommissioning plan will be developed to include a comprehensive waste management plan. The framework for the Decommissioning Plan is presented as Chapter Eight of this Report.

3.16.5 Waste Water and Drainage

During construction, small amounts of wastewater from equipment washing and concrete production are likely to be produced if an on-site concrete batching plant is used. Such wastewaters will typically be non-hazardous and therefore discharged to the ground surface.

During Operation, wastewater will primarily be as a result of the cleaning of the PV panels. Gentle and non- hazardous detergent will be used hence, the wastewater will be non-hazardous. Oil-impacted storm water is not envisaged to be generated from the site. Adequate drainage system will be constructed around the site according to the site conditions. Waste and storm water will be managed through a combination of open trenches, and ditches and will be led to drain away to the natural environment via gravity. Paved and concreted areas will be sloped to allow for proper drainage.

3.17 Project Schedule

Following project conceptualization, preliminary studies, ESIA studies and land acquisition activities are currently ongoing. However, preconstruction activities such as mobilization and site clearing are scheduled to commence by September 2016 to last for about 2 months while the construction phase of the project is scheduled to commence by January 2017. It is estimated that the project construction period will be up to 14 months following receipt of relevant permits and approvals from relevant regulatory authorities.

Performance testing is scheduled for December 2017 after which the solar plant will be handed over to a selected O&M contractor. The project lifetime is expected to be about 20 years after which the plant and associated infrastructures will be decommissioned. The project implementation schedule for preconstruction and construction phases is shown in Figure 3.10.

Construction Activity	Start Date	End Date	Duration (Working Days)
Issuance of Generation Ceritifcate	01/06/16	01/06/16	0
Financial Close	01/12/16	01/12/16	0
Notice to Proceed	08/12/16	08/12/16	0
Engineering and design phase	01/06/16	09/02/17	176
Procurement and delivery	07/10/16	26/08/17	221
Construction	01/01/17	01/01/18	241
Offices, facilities and utilities installation	01/01/17	16/01/17	12
Temporary fences staging area	01/01/17	16/01/17	12
Civil works	06/01/17	27/02/17	39
Mechanical and structural works	28/01/17	14/09/17	166
Electrical works	03/02/17	06/10/17	246
Security system installation	01/01/17	31/05/17	109
SCADA system installation & intergration	19/04/17	13/11/17	151
O&M Building	01/01/17	02/05/17	88
HV/MV Substation and OHL	01/06/16	23/10/17	294
Cold commissioning	16/03/17	24/10/17	161
Hot commissioning	23/10/17	01/12/17	30
Expected COD	01/12/17	01/12/17	0
Performance Testing	01/12/17	20/12/17	16
Handover to O&M Contractor	01/01/18	01/01/18	0

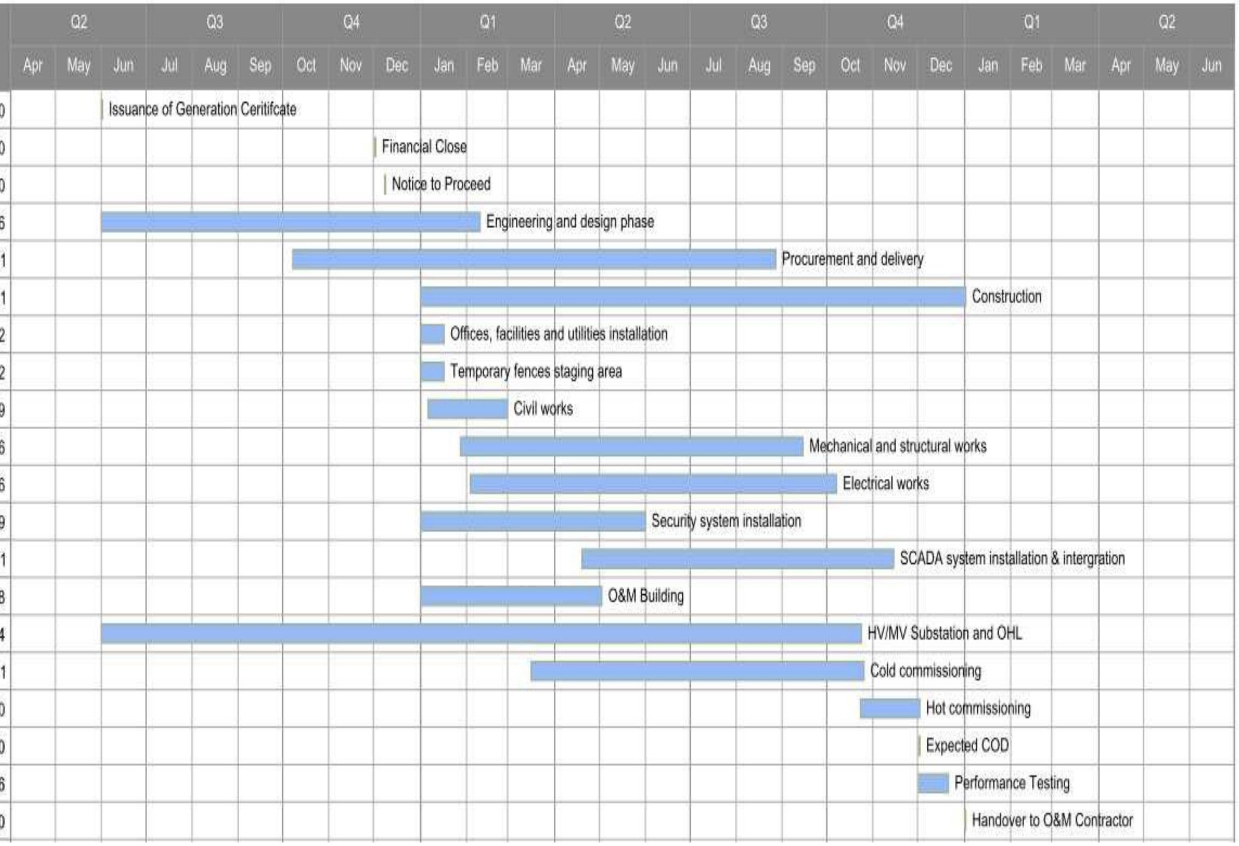

Figure 3.10: Project Implementation Schedule.

CHAPTER FOUR

DESCRIPTION OF ENVIRONMENT

4.1 Introduction

This Chapter documents the environmental and social characteristics of the project AoI as it exists (baseline) prior to the implementation of any activity of the project. The establishment of the baseline environmental and social conditions of the project AoI lays the foundation for the entire ESIA process. It provides the basis against which likely project impacts and risks can be identified, assessed and monitored in the future.

The baseline description is based on primary information obtained directly from a one season (wet season) field data gathering exercise carried out from 9th – 12th October, 2015 and secondary data obtained through desktop studies and review of literature including existing report of environmental assessments carried out in the project area (EIA of EMTS Base Stations in Jigawa State, 2012). The description essentially focuses on critical environmental and social receptors likely to influence the project or be impacted by the project. These include the following components:

- Physical Environment - climate & meteorology, ambient air, soils/land, geology/hydrogeology, hydrology & groundwater.

- Biological Environment - vegetation (flora) & wildlife (fauna), endemic and endangered/threatened species, etc.

- Socioeconomic Environment – demographics, religion/local culture & customs, education, employment, economic livelihood and income, amenities, infrastructure & social services, historical & cultural heritage/properties, community structure/administration, social organisations and institutions, land tenure & use, community health, etc.

4.2 Project Area of Influence

The project AoI is the area likely to be affected by the project, including all its ancillary aspects, such as power transmission corridors, access roads, borrow pits and disposal areas, construction camps, as well as unplanned developments induced by the project e.g. spontaneous settlement along access roads. This represents the geographical area where the project induced changes to the biophysical and social environment will occur.

For the ESIA study, the area within 5 km radius drawn from the centre of the project site was adopted as the project AoI in order to capture the full reach of possible effects of the proposed project. This is also considered as the study area. The AoI was determined using professional judgment taking the following into consideration:

- Area of direct impact i.e. the immediate surroundings localized to the project footprint;
- The 3.66 km transmission route and the location of Dutse substation;

- Prevailing winds, weather patterns, terrain, and the nature of likely pollutants from the project;
- Spatial distribution of the affected communities and socioeconomic conditions of the rural environments;
- Areas used for livelihood activities (hunting, grazing, gathering, agriculture, etc.);
- Available ecological and biodiversity resources;
- Area of indirect impacts which includes areas which may experience induced or cumulative changes in combination with activities not under the direct control of the project.

Figure 4.1 shows the proposed project site and AoI for the ESIA study.

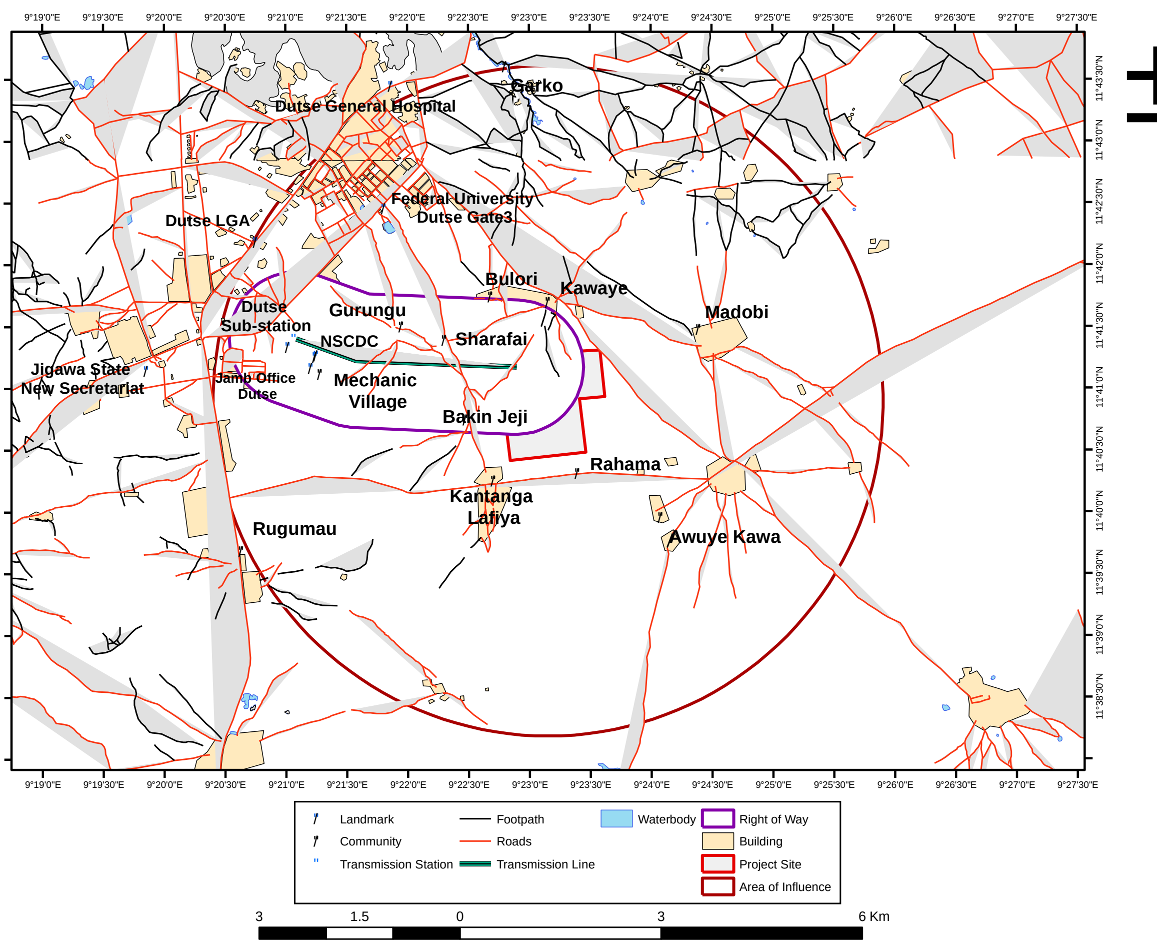

Figure 4.1: Map showing the Proposed Project Site and 5 km Radius Area of Influence for ESIA Study

4.3 Baseline Data Acquisition Method

A multidisciplinary approach was employed in the acquisition of baseline data from the project AoI. A Quality, Health, Safety & Environment (QHSE) management system approach was adopted which assured that the required data and samples were collected in accordance with agreed requirements (contractual, scientific and regulatory) using the best available equipment, materials and personnel. The approach also assured that the safety and health of personnel, public, environment and assets were not compromised at any time. The methods employed included reconnaissance survey, a mandatory first step of extensive literature search, field data gathering, laboratory analysis and stakeholder consultations. The following sections outline the methodology and procedures employed in the baseline data acquisition.

4.3.1 Reconnaissance Survey

A reconnaissance survey of the proposed project area was undertaken on 21st March, 2015 in order to acquaint the ESIA team with the nature of the environmental and social nomenclature of the area. Preliminary baseline information was obtained at this stage through physical observations and interviews with key informants.

4.3.2 Desktop Studies/Literature Review

The ESIA team conducted a thorough and comprehensive search and review of available literature and other information on the proposed project environment. These included reports of previously conducted environmental assessments in the project area of influence, meteorological data obtained over a long duration of time, academic research studies and technical publications. A comprehensive understanding of information already available was critical in designing the field data collection program.

4.3.3 Field Data Gathering

A one season (wet season) field data gathering exercise was carried out from 9th to 12th October, 2015 in accordance with FMEnv directives (see Appendix 4.1 for approval to conduct one season sampling). The dry season baseline information was obtained from the approved EIA Report of EMTS Base Stations in Jigawa State (2012) and was evaluated to ascertain seasonal variations. The exercise which was witnessed by representatives of Federal and State Ministries of Environment set out to establish the existing conditions of the environmental and social resources potentially subject to change by the project. Specifically, the baseline data were collected to:

- Provide an understanding of the environmental and social conditions of the project AoI;
- Verify and fill the gaps on preliminary information obtained from literature searches on the environmental and social characteristics of the area;
- Allow for complete, accurate and efficient predictions on how the project may change or impact key environmental and social components;
- Allow for predictions on how adverse effects can be avoided and beneficial effects enhanced; and
- Allow for use of data for future environmental purposes such as permit applications.

The field exercise entailed real-time observations, field sampling and in-situ measurements of fast degrading parameters of samples collected from a range of areas. Samples were preserved on the field and taken to the laboratory for analysis.

4.3.3.1 Sampling Design

Field data gathering was designed to cover the entire project site covering an area approximately 200 hectares and environment surroundings of the site up to approximately 5 km radius taken from the center of the project site (AoI). Sampling stations were established to ensure that critical environmental and social resources that characterize the area were adequately collected for analyses. The overarching considerations in the selection of sampling points included ecological features and the geographical location of communities/settlements in the project AoI. A total of 14 sampling stations were established prior to fieldwork implementation. Five (5) sampling stations were distributed within the boundaries of the proposed site and two (2) along the 3.66km transmission line RoW while five (5) sample stations were distributed outside the project site but within the project AoI. Two (2) control stations were located some distances away from the project AoI at two ends with one located toward the proposed project site and the other away from the transmission route. Each sampling station was georeferenced using an Extrex model Global Positioning System (GPS).

Table 4.1 shows the coordinates of the sampling stations and the environmental components sampled in the study area, while Figure 4.2 shows the spatial distribution of the sampling stations in the study area.

Table 4.1: GPS Coordinates of Sampling Points in the Study Area

Sampling Stations	Location	Sampling Coordinates		Elevation	Component Sampled
		Latitude	Longitude		
SS1	Project Site (Center)	11.68164	009.38588	444	Air & Noise level , Soil, Biodiversity
SS2	Project Site (NE)	11.68852	009.39299	435	Air & Noise level, Soil, Biodiversity
SS3	Project Site (SE)	11.67471	009.39104	444	Air & Noise level , Soil, Biodiversity
SS4	Project Site (SW)	11.67365	009.38072	440	Air & Noise level , Soil, Biodiversity
SS5	Project Site (NW)	11.68777	009.37897	446	Air & Noise level , Soil, Biodiversity
SS6	Transmission Route (AP_2) Near Gurungu Village	11.68797	009.36462	444	Air & Noise level, Soil, Ground Water (hand dug well), Biodiversity
SS7	Dutse Substation (AP_3)	11.68893	009.35059	444	Air & Noise level, Soil, Biodiversity
SS8	Federal University Dutse (Opposite Gate 1)	11.71353	009.36801	446	Air & Noise level, Soil, Biodiversity
SS9	Near Garko Village	11.72675	009.38037	457	Air & Noise level , Soil, Biodiversity
SS10	Madobi Community	11.69129	009.40680	438	Air & Noise level , Soil, Biodiversity
SS11	Awuye Kawa Village	11.66585	009.40528	437	Air & Noise level, Soil, Ground Water (hand dug well), Biodiversity
SS12	Rugumau Village	11.65917	009.34688	428	Air & Noise level , Soil, Biodiversity
C1	Control Point 1	11.63978	009.44030	437	Air & Noise level, Soil, Ground Water (borehole), Biodiversity
C2	Control Point 2 (Dutse Town)	11.69921	009.32872	436	Air & Noise level , Soil, Biodiversity

Source: GEHS Fieldwork 2015 **SS: Sampling Station** **C: Control**

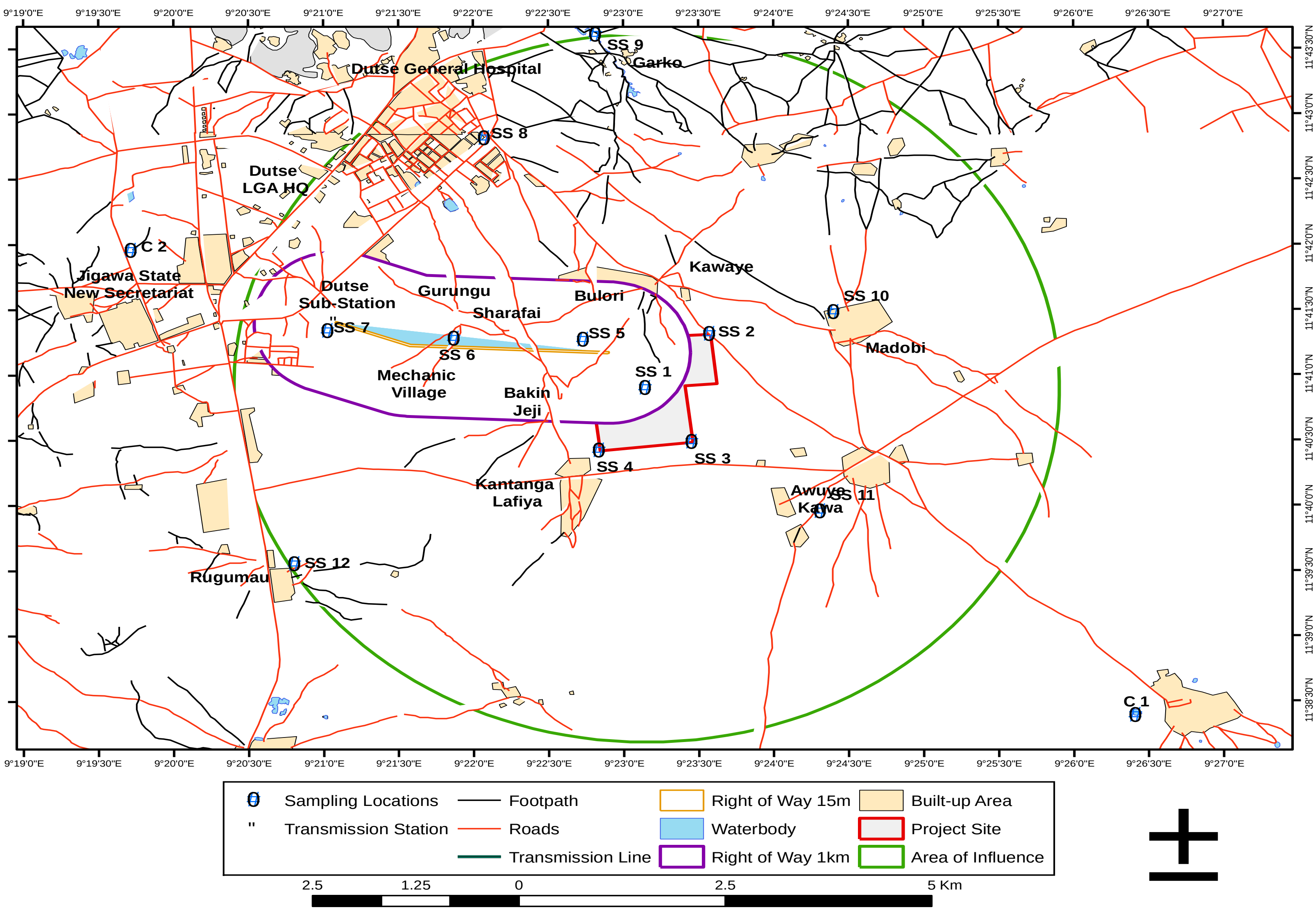

Figure 4.2: Map of Sampling Locations in the Study Area

4.3.3.2 Sampling Methodology

Field sampling was carried out using standard methods and protocols. The sampling methodologies used for each environmental/social component studied are discussed below:

❖ **Climate and Meteorology**

The meteorological data of the study area was obtained from the Nigerian Meteorological Agency (NIMET). The data obtained included weather parameters on rainfall, temperature, relative humidity, wind speed and sunshine hours spanning over a period of 34 years from 1981 – 2014.

❖ **Air Quality and Noise**

A time-averaged in-situ sampling technique was applied for air quality and noise measurements for this study. Measurements were taken on an hourly basis for a 12-hour period from 7am to 7pm for three days at 14 locations. Twelve of the selected locations were within the study area, while the two locations served as the control points for the study. Based on the objectives of the study, air quality and noise measurements were taken at the boundaries of the project site, along the transmission route, road intersections, and built-up areas. Details about the sampling locations are contained in Table 4.1 and the spatial distribution of the locations for air quality and noise measurements is shown in Figure 4.2.

The US EPA designated criteria air pollutants and specific GHGs were measured for this assessment. The pollutants are carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), total suspended particulates (TSP), non-methane volatile organic compounds (VOC), hydrogen sulphide (H_2S), and carbon dioxide (CO_2). Online monitors were used to obtain real-time measurements for the air quality and noise parameters.

Specifically, the following equipment were used for measurement of the pollutants:

- In-situ non-integrated single gas CO monitor (ToxiRAE Model PGM-1110);
- In-situ single gas NO_2 monitor (ToxiRAE Model PGM-1150);
- In-situ single gas SO_2 monitor (ToxiRAE Model PGM-1130);
- In-situ non-integrated single CO_2 monitor (ToxiRAE Model PGM-1191);
- In-situ MultiRAE gas monitor (Model PGM50-5P) for H_2S and VOC measurements; and
- Haz-Dust MODEL HD-1100 for particulate measurements.

A multifunctional sound level meter compatible with standards of IEC 651 Type 2 and ANSI 1.4 Type 2 was used to measure noise levels. The instrument has measurement ranges of 30 – 130 dB (A) and accuracy of $\pm$ 1dB. Measurements were taken at a height of approximately 2 m above ground level using the “A” weighting scale. Plate 4.1 shows the study team conducting air quality assessment at the proposed project site.

Plate 4.1 Study Team conducting Air Quality and Noise Assessment at the Proposed Project Site (SS2 & SS4)

❖ Soil Sampling

Soil sampling was carried out at 14 stations in the study area as shown in Table 4.1 and depicted in Figure 4.2. At each station, composite soil samples were collected from 0 – 15cm (top soil) and 15 – 30cm (sub soil) depths respectively using a stainless steel hand auger. Samples from each depth range were homogenized (with removal of non-matrix particles) and then sub-sampled into clean decontaminated containers and subsequently stored for transfer to the laboratory for physico-chemical and microbial analyses. Sub samples for microbial analysis were wrapped up using aluminum foil. All samples collected were preserved in ice chest and transported to the laboratory for analysis. Plate 4.2 shows the study team collecting soil samples at the proposed project site and the Dutse substation.

Plate 4.2 Study Team conducting Soil Sampling at the Proposed Project Site (SS1) and Dutse Substation (SS7)

❖ Groundwater Sampling

Groundwater sampling was carried out at 3 stations within the study area. The sampling design was based on availability of groundwater sources in communities near the proposed project site. Water samples were obtained from two existing hand dug wells and a borehole in three sampling locations in the study area shown in Table 4.1 and Figure 4.2. Water samples were collected at each location into appropriate containers according to the respective parameters i.e. plastic containers for physico-chemical parameters and heavy metals and glass bottles for samples for hydrocarbon determination. Water samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized amber bottles were used for samples collected for microbial analysis. In-situ analysis was immediately carried out to determine the following parameters with short holding time; pH, temperature, turbidity, electrical conductivity, total dissolved solids, salinity and dissolved oxygen using appropriate field equipment. All samples collected were preserved in ice chest and transported to the laboratory for further analysis. Plate 4.3 shows the study team collecting water samples and conducting in-situ analysis at Awuye Kawa village.

Plate 4.3: Study Team collecting Water Samples and conducting In-Situ Analysis at Awuye Kawa Village (SS11) in the Study Area

❖ Biodiversity (Flora and Fauna) Studies

The sampling technique adopted for the biodiversity study was a stratified random sampling technique. Stratified sampling was used to take into account different areas (strata) which were identified within 14 sampling locations indicated in Table 4.1 and depicted in Figure 4.2. For instance, cultivated fields were sampled separately from natural vegetation. In each of the locations a 100m×100m Biodiversity Monitoring Plots (BMPs) were marked out within which four Modified Whittaker Plots (MWPs) measuring 50×50m were marked out for rapid assessment. In areas with sparse vegetation for example, areas with natural vegetation within cultivated fields (weeds), a direct enumeration of all herbaceous species within the MWPs were taken. In dense vegetation, herbaceous species were enumerated using either a 1×1m quadrat or 2×2m quadrat. Crop species within the cultivated fields were also recorded. For woody species, direct enumeration of every individual specie ≥5cm within the BMPs was conducted. Non-chlorophyllous species (Fungi and Bryophytes) encountered were also recorded.

Species abundance within each MWP was calculated and converted to unit per ha. Species diversity and evenness for each plot and between plots was calculated using the Shannon-Weiner diversity and Evenness as follows:

H = -SUM [(pi) * ln(pi)]
$E=H/H_{max}$

Where, SUM = Summation
pi= Number of individuals of species i/total number of samples
S = Number of species or species richness
H_{max} = Maximum diversity possible
E= Evenness = H/H_{max}

Within the BMPs animals were detected by sight, carcasses, caste, footprints, niches, calls or vocalizations, and also from information gathered from the locals. Plate 4.4 shows the biodiversity team conducting studies along the transmission route at Gurungu village (SS6) and at the proposed project site (SS2) in the Study Area while Plate 4.5 shows a snake caste, bird nest and hole of a rat used to identify fauna species in the study area.

Plate 4.4: Biodiversity Team conducting Studies along the Transmission Route at Gurungu Village (SS6) and at the Proposed Project Site (SS2) in the Study Area

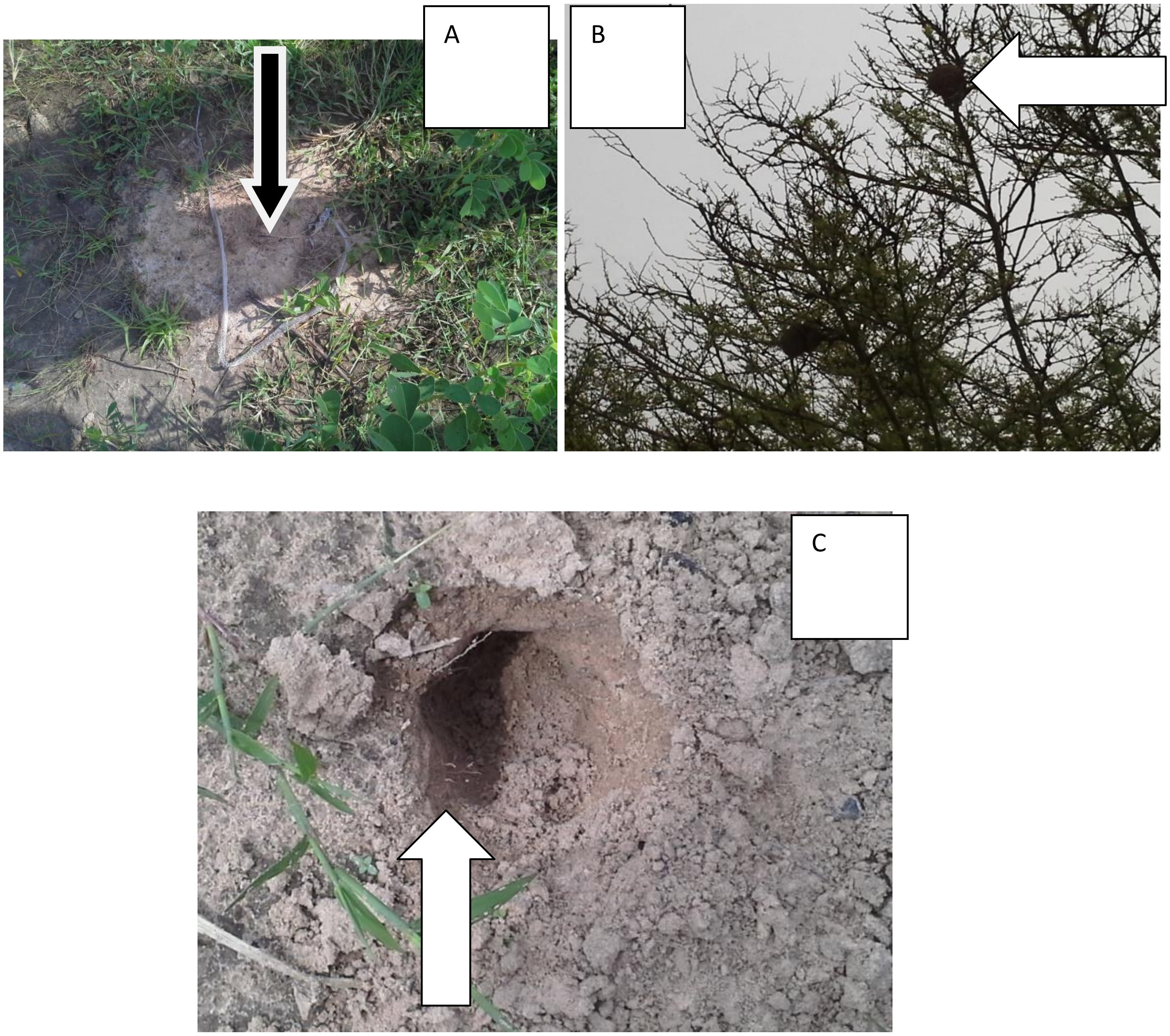

Plate 4.5: Evidence of Fauna Species in the Study Area: A (Snake caste), B (Bird nest) C (Hole of a Rat)

❖ Land Use

The existing land use characteristic of the study area was obtained using 5m-resolution multispectral SPOT 5 and 30m-resolution multispectral Landsat 8 (resolution enhanced to 15m using the panchromatic band) satellite images. The SPOT image was acquired in 2014 while the Landsat image used was acquired in 2015. The images were acquired during the edry season in order to ensure there was no obscurity due to cloud cover; and also to clearly differentiate the various land use classes (mostly agriculture, settlements and dry grasslands at this time of the year), with a greater degree of accuracy.

The methodology used incorporated satellite data pre-processing, processing, land use classification and digitization of facilities from the images. The overall objective of the image classification is to automatically categorize all pixels in an image into land cover classes or themes (Lillesand and Kiefer, 1994).

Supervised classification of the satellite images was carried out using the Maximum Likelihood classification algorithm in Erdas Imagine. The Landsat 8 imagery provided a wide-area overview covering the AoI, the proposed project site and areas farther away from the site at a medium resolution. The SPOT 5 imagery however provided a high resolution overview of the proposed project site and AoI. Using the classified SPOT 5 image and digitizing techniques, the major facilities in the AoI were extracted. Thematic layers of information on roads, footpaths, buildings/built-up areas were created using ArcGIS software.

- **Socioeconomic and Community Health Survey**

Primary data on the socioeconomic and health conditions in the study area was generated though a survey using strategic survey techniques which included administration of household questionnaires, in-depth interviews and focus group discussions (FGDs).

Sampling Method and Size

Random sampling technique was used for the household survey. The sampling size for the survey was established at 104. The 104 sample was established as sample population of responsive or adult population (1554 or 30%) from 5180 overall population of people in the project area using STAT 2 statistical analysis tools at 95% confidence level (CI). The 104 sample was evenly drawn from the villages and settlements in the project AoI namely Katangar Lafia, Bakin Jeji, Bulori, Kawaye, Rahama, Sharifai villages and Mechanic settlement. To ensure that all the seven villages and settlements were fairly represented, it was framed that questionnaire distribution should target between 10 and 20 respondents in each village. Table 4.2 shows the population sizes and coordinates of these villages and settlements as well as the number of questionnaires administered. Figure 4.2 also shows the spatial distribution of the 7 sampling locations in the study area.

Table 4.2: Location of Communities, Population Size and Number of Questionnaires Administered during the Socioeconomic Study

S/N	Village Name	Location Coordinate	Population	Number of Questionnaires
1	Katangar Lafia	N11.67085, E009.37873	1100	20
2	Bakin Jeji	N11.67910, E009.37493	960	15
3	Bulori	N11.69566, E009.37835	800	19
4	Kawaye	N11.69494, E009.3862	750	13
5	Rahama	N11.67189, E009.39024	720	12
6	Sharafai	N11. 68982, E009.37202	650	15
7	Mechanic Settlement	N11.68521, E009.35500	200	10
	Total		5,180	104

Source: GEHS Fieldwork 2015

In specific terms, the methodology employed in assessing the socioeconomic and health characteristics of the proposed project AoI entailed the following:

- ***Stakeholder Identification and Engagement***

Following the identification of stakeholders, two (2) community wide stakeholder consultations were held at the State Library Complex Dutse. This consisted of a scoping workshop which was held on the 8th of September 2015 and public consultation forum held on the 28th of October, 2015. Stakeholders identified and consulted included relevant MDAs, representatives of affected communities, the traditional ruler, community leaders, community based organizations (CBOs) as well as women and youth groups. The stakeholder engagement process and outcomes are comprehensively discussed in section 4.6.

- ***Administration of Survey Instruments***

Baseline data on the socioeconomic and health characteristics of communities in the study area were acquired essentially via the administration of the following survey instruments:

- Focus Group Discussions: FGD was used to interact and consult with smaller groups in the project AoI. Seven (7) FGDs were held from 9th – 16th September, 2015 with youths, hunters, farmers, mechanics and CBOs. As a guide for all the FGDs, the minimum number of participants was set at 6 while maximum number was 12. This threshold is consistent with best practices for conducting FGD and within the range as used by scholars such as Richard Krueger, (2009) and Kitzinger, (1994). The outcomes of the FGDs are presented in section 4.6.4.

- In-depth Interview: In-depth interviews were carried out at the community level to elicit in-depth information such as the history, culture, religious practices, dispute resolution mechanism, administrative hierarchy and cultural organization setups of the communities in the study area. Village Heads from the seven communities in the study area were interviewed as for this purposes as they are deemed to be the best custodians of their respective village profiles.

- Structured Household Questionnaires: Household questionnaires that included social, economic and health questions relevant to the proposed project were deployed to harness household data from affected communities in the AoI. A sample of the household questionnaire used for information gathering is attached as Appendix 4.2.

  Field guides and enumerators were recruited to administer the questionnaires. Criteria for selection and engagement included: higher education attainment, gender balancing and Hausa speaking skill. Field staff were trained in order to ensure validity and reliability of data obtained from the field. In order to assure quality, certain control variables were included in the questionnaire such as name, identification number and signature of enumerator, address as well as the phone number of the respondent. Compliance with data capture of these control variables were usually checked by the Field Supervisor at the end of each work day. Plates 4.6 show enumerators administering household questionnaires in some of the communities in the study area.


Plate 4.6: Field Enumerators administering Questionnaires at Katangar Lafiya and Bakin Jeji Communities

4.3.3.3 Laboratory Analysis

Soil and groundwater samples collected from the field were analyzed at LABCHEMNEC JANS Ltd a FMEnv accredited laboratory located in Wuse Zone 3, Abuja using standard analytical methods. The synoptic descriptions of the laboratory analytical methods and procedures employed for the various physical, chemical and biological parameters in soil and groundwater samples are presented in Table 4.3. The laboratory analysis was witnessed by FMEnv representatives namely, Mr Richard Nwaeze and Mrs Immaculata Effiong (see Plate 4.7).

Plate 4.7: FMEnv Officials witnessing Field Sample Analysis at Labchemnec Jans Laboratory

Table 4.3: Analytical Methods for Laboratory Sample Analysis

S/N	PARAMETER	METHOD
1.	Colour	Munsel (Soil), Visual (Ground water)
2.	pH	Electrometric
3.	Temperature	Thermoelectric (Soil), Electrometric (Ground water)
4.	E. Conductivity	Electrometric
5.	Turbidity	Electrometric (Soil), Nephenometric (Ground water)
6.	Total Dissolved Solid	Gravimetric (Ground water)
7.	Moisture Content	Gravimetric
8.	Vanadium	Colorimetric
9.	Total Hardness	Titrimetric (Soil), Colorimetric (Ground water)
10.	Total Suspended Solid	Colorimetric
11.	Total alkalinity	Titrimetric
12.	Salinity	Electrometric
13.	Chloride	Colorimetric (Soil), Titrimetric EDTA (Ground water)
14.	Sulphate	Colorimetric (Soil), Respirometric (Ground water)
15.	Nitrate(N)	Colorimetric
16.	Nitrite	Colorimetric
17.	$BOD_{20}{}^{5}$	Electrometric
18.	COD	Electrometric
19.	DO	Electrometric
20.	Phosphate	Colorimetric
21.	Barium	Colorimetric
22.	Iron	Colorimetric
23.	Zinc	Colorimetric
24.	Manganese	Colorimetric
25.	Magnesium	Colorimetric
26.	Lead	Colorimetric
27.	Carbonated	Colorimetric
28.	Calcium	Colorimetric
29.	Cu^{2+}	Colorimetric
30.	Selenium	Colorimetric
31.	Nickel	Colorimetric
32.	Arsenic	Colorimetric
33.	Cadmium	Colorimetric

Source: Labchemnec Jans Ltd (2015)

4.3.3.4 Quality Assurance & Quality Control (QA/QC)

Quality assurance and control is an essential part of any environmental study. It is a programme of activities that ensures that field sampling and measurements meet defined and appropriate standards of quality with a stated level of confidence. Quality assurance measures for this study covered the pre-measurement/sampling phase of the exercise and included determination of baseline data gathering objectives, sampling design, determination of sampling locations, equipment evaluation and operation training. Quality control measures were direct measurement-related activities such as fieldwork, calibration, data management and training. Guidelines covering all aspects of fieldwork were outlined to all team members before mobilization. These covered sample collection, preservation, storage and transportation. The team leader took charge of collating and documenting daily progress of work done. The documentation was done at the end of each day's work using structured daily progress report sheets. Specifically the following measures were employed during the field data gathering exercise:

Sample Collection

Samples were collected in line with standard practices for environmental samples collection. Collection was carried out in a manner that eliminated contamination of the samples and the environment. On collection, samples were properly tagged with labels showing the name/location of sampling site, date/time of sampling, sample name, number and time, sampling personnel and preservative added.

Sample Handling

Chain of custody forms were used for logging and tracking of samples from the point of collection in the field to the laboratory for analysis to be carried out. Samples were preserved in accordance with best industry practice.

4.4 Geographical Location

The proposed site for the project known as Dutse-2 is located at a distance of about 5km from the town of Dutse in Dutse LGA of Jigawa State, Nigeria. The area covering approximately 200 hectares of land falls within Latitude 11.6815N and Longitude 9.3858E. The project location also include the 3.66 km RoW for the transmission route through which electricity generated will be transmitted to the Dutse substation for onward connection to the national grid. The transmission route falls within Latitude 11.68728N to 11.69109N and Longitude 9.38058E to 9.35066E. Figure 4.3 shows the geographical location of the proposed project in Dutse LGA of Jigawa State.

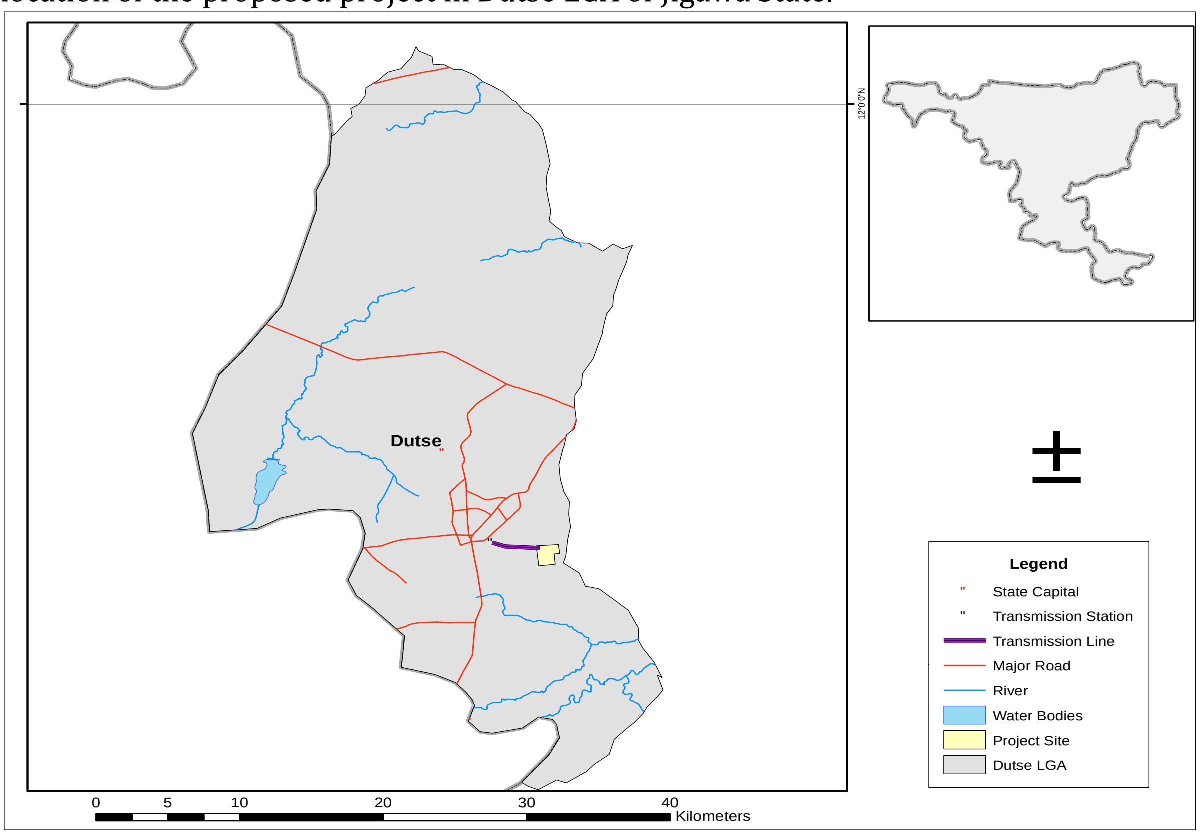

Figure 4.3: Map showing Geographical Location of Proposed Project in Dutse LGA of Jigawa State

The site is slope free and generally flat at an elevation of 436 m above sea level. It is largely devoid of natural vegetation as it is comprised of privately owned farmlands that are currently used to grow millets, ground nuts, sorghum and maize. There are no human settlements within the boundary of the site, however, the surrounding area is home to Bakinjeji, Katangar Lafiya, Rahama, Sharafai, Bulori, Kawaye, Gurungu and Mechanic Villages. These villages are all further than 200m away from their respective boundaries. Figure 4.4 shows the geographical location of the villages surrounding the project site and RoW. It is instructive to note that the proposed RoW for the transmission route does not pass through any human settlements. Located adjacent either side of the transmission route are Gurungu, Sharafai and Mechanic villages. The coordinates and specific distances of these communities to the proposed route are shown in Table 4.4.

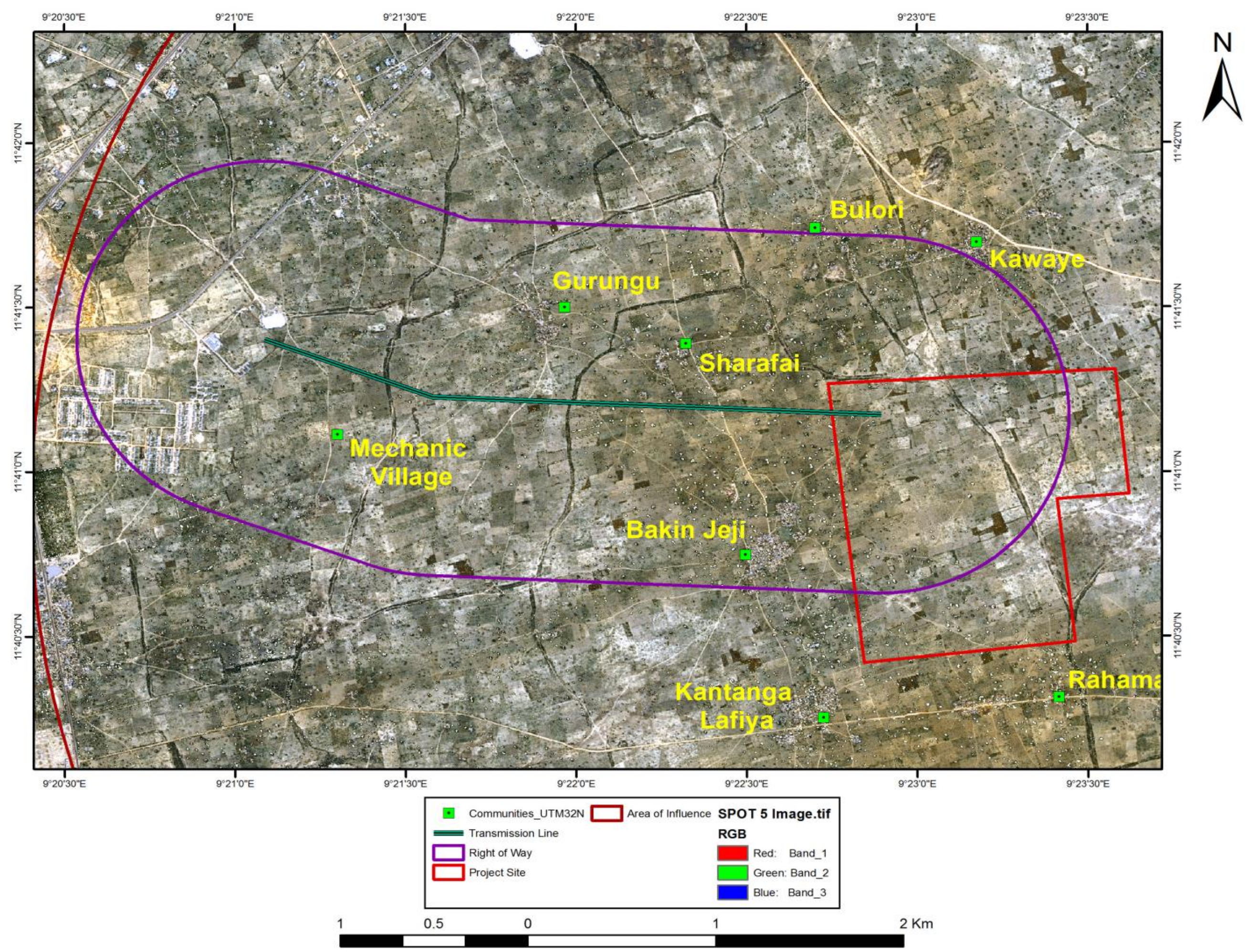

Figure 4.4: Geographical Location of Villages Surrounding the Proposed Project Site

Table 4.4: GPS Coordinates and Distances of Communities Adjacent the Transmission Route

S/N	Communities	Coordinates		Distance To Transmission Line
		Latitude	Longitude	
1	Mechanic Village	11.68521	009.35500	26.3m
2	Sharafai	11.68982	009.37202	35.5m
3	Gurungu	11.69166	009.36610	53 m

Source: GEHS Fieldwork 2015

4.5 Environmental and Social Setting of the Study Area

This section provides a clear and detailed description of the existing environment including the ecological and social characteristics of the project AoI.

4.5.1 Climate and Meteorology

The climate experienced in the study area is semi-arid characterized by two predominant climatic conditions annually. These include a very hot and long dry season and a warm, humid and short wet season influenced by two air masses: the tropical maritime or south-west trade winds and tropical continental or north-east trade winds. The former are the moisture laden, rain-bearing winds coming on- shore from the Atlantic Ocean and the latter are the dry, dusty and cold-bearing winds blowing from the Sahara desert associated with the dry season. Jigawa State experiences the same predominant climatic conditions as Kano State as both States share boundary. For a comprehensive discussion of the climatic conditions of the study area, the mean monthly climatological data of Kano region measured by NIMET for a thirty-four year (34) period from 1981–2014 is presented below for rainfall, temperature, relative humidity, wind speed and direction and sunshine hours.

4.5.1.1 Rainfall

The study area is characterized by short wet season with most of the rainfall occurring between May and September. During this period, rainfall are a daily occurrence even though they rarely last long and are a far cry from the regular torrential rain known in wet tropical regions of the south. The average annual rainfall ranges from 510mm – 1000mm in the study area. Historically, rainfall in the region usually peaks in August with little or no rain at all between October and April during which the climate is dominated by the harmattan wind blowing Sahara dust over the land. The dust dims the sunlight thereby lowering temperatures significantly and also leading to dust disturbance especially in rural regions with unpaved road surfaces. Figure 4.5 shows the average monthly rainfall between 1981 and 2014 for the study area.

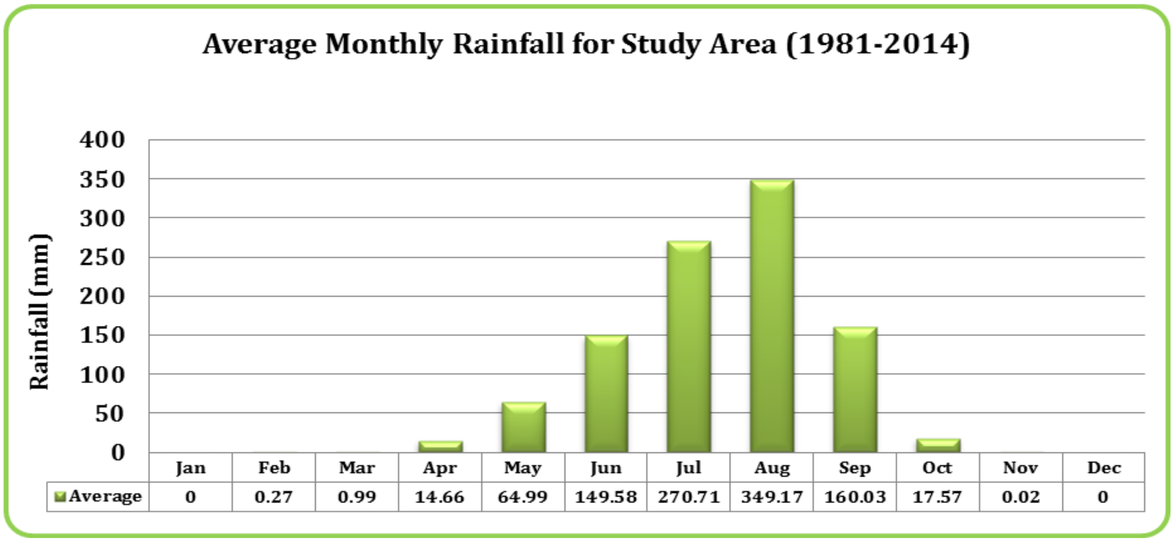

Figure 4.5: Average Monthly Rainfall for the Study Area (1981 - 2014)
Source: NIMET 2014

4.5.1.2 Temperature

The study area is characterized by two extreme temperatures relative to its tropical position, the hot and cold seasons. The maximum daytime temperatures for most of the year are generally under 40°C (104.0 °F). The highest monthly temperature of 36.6 - 39.2°C is experienced between March and May. There is usually the prevalence of harmattan, characterized by very cold temperatures and dust laden winds between November and February when average monthly temperature can be as low as 13.4°C. In general, the study area is very hot but the dryness however makes the heat bearable. Figure 4.6 show the average monthly maximum and minimum temperature distribution between 1981 and 2014.

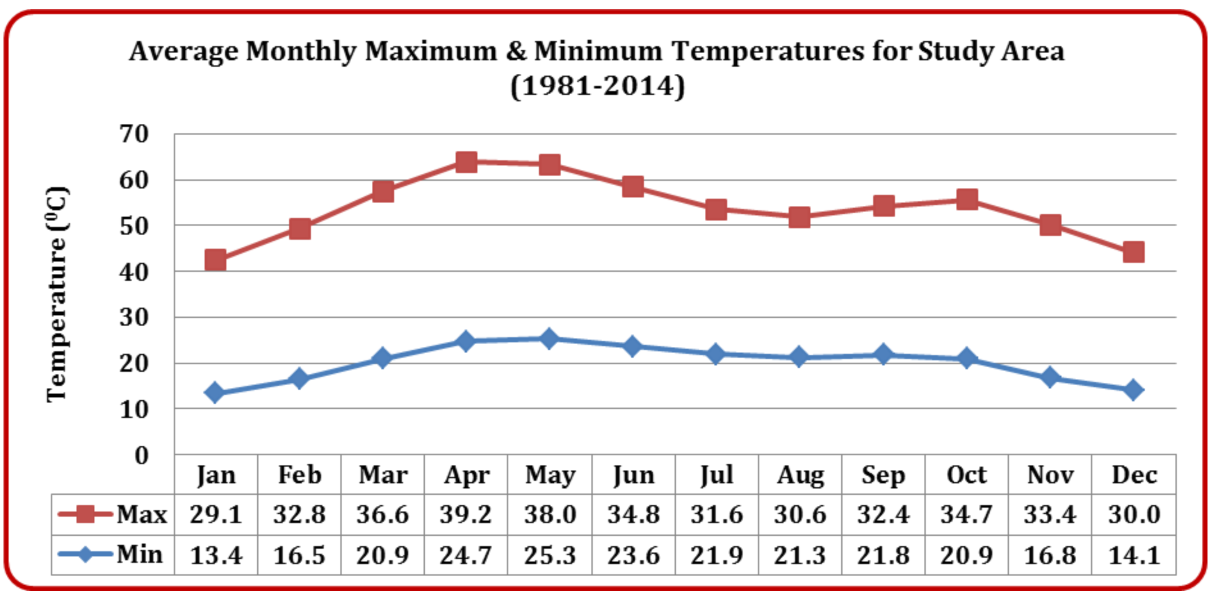

Figure 4.6: Average Monthly Maximum and Minimum Temperature for Study Area (1981 - 2014)
Source: NIMET 2014

4.5.1.3 Relative Humidity

The average monthly relative humidity for the region ranged from 52.8% to 78.6% during the rainy season (May to September), with its peak usually recorded in the month of August the same month of highest rainfall. Lower values were recorded during the dry season months. Figure 4.7 shows the average monthly relative humidity for the study area between1981 and 2014.

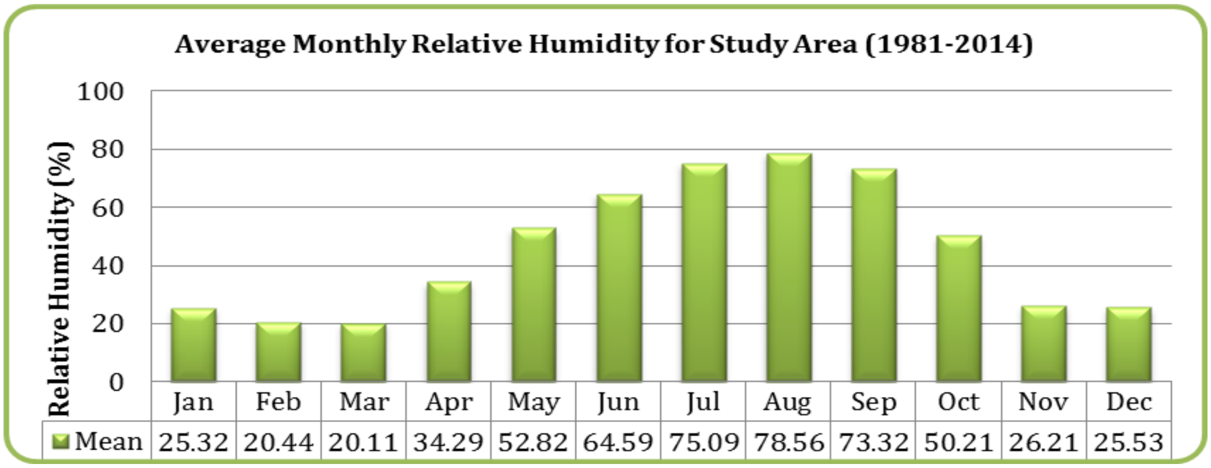

Figure 4.7: Average Monthly Relative Humidity for the Study Area (1981 - 2014)
Source: NIMET 2014

4.5.1.4 Wind Speed and Direction

The average monthly wind speed in the study area ranged from 6.63 to 10.09 Knots with the maximum figure recorded in June as depicted in Figure 4.8 There are some occasional calmness with insignificant wind speed mostly experienced between August and November. There are two major wind directions in the region, namely, the south-west and north-east directions. The northeast wind predominates during the dry season bringing a large amount of dust while the southwest winds are predominant during the wet season. It is expected that these winds will accelerate soiling of the PV panels. Regular operation and maintenance activities will be required to minimize the impacts of soiling on energy yield.

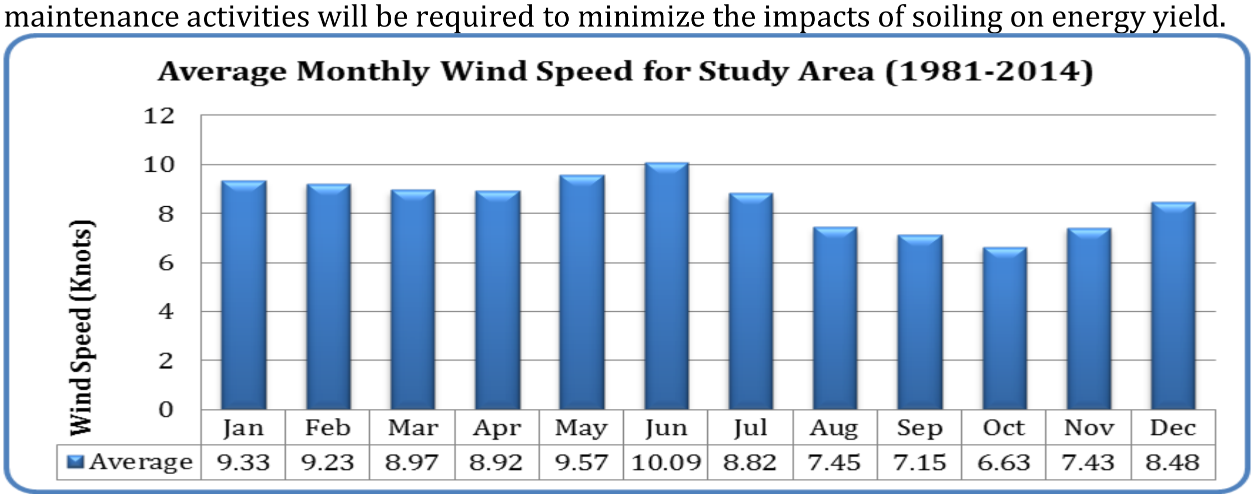

Figure 4.8: Average Monthly Wind Speed in the Study Area (1981 and 2014)
Source: NIMET 2014

4.5.1.5 Sunshine

In the study area, the average range of sunshine hours is between 6.88 hours per day in March to about 8.57 hours per day in November with an approximate average of 7.71 sunlight hours for each day. The average annual sunshine in the region is about 2,821 hours corresponding to an approximate average of 3000 hours obtainable in the northern part of Nigeria as against an average of 1,500 hours in the South. These figures suggest that the project region is most suitable for solar energy generation in Nigeria. Figure 4.9 shows the average sunshine hours for each month between 1981 and 2014.

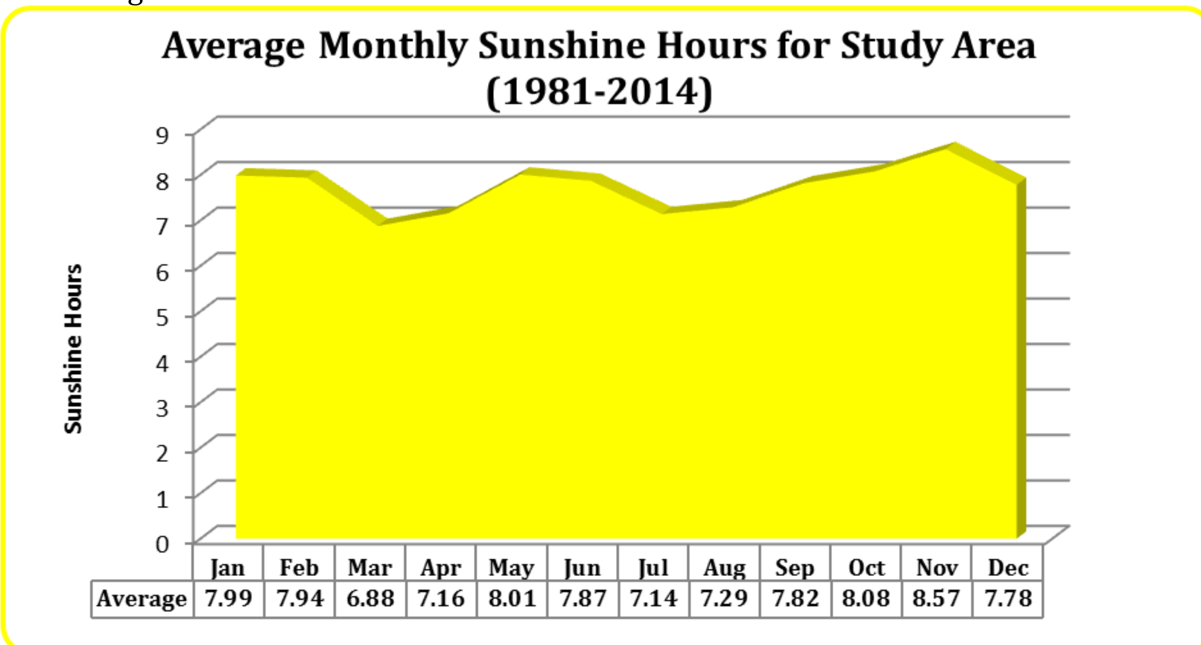

Figure 4.9: Average Monthly Sunshine Hours in the Study Area (1981- 2014)
Source: NIMET 2014

4.5.2 Ambient Air Quality & Noise Level (Wet Season)

The baseline status of the existing ambient air quality within the study area during the wet season has been assessed by comparing the results of the air quality parameters measured in 12 sampling stations (see 4.3.3.2) with the National Ambient Air Quality Standards (NAAQS) of Nigeria and the World Health Organization (WHO) Quality Guidelines presented in Table 4.5. Measured noise levels have also been compared with FMEnv noise exposure limits and the WHO guideline values recommended for community noise.

Results of the air quality measurements presented in Table 4.6 show a general trend of acceptable values. Five of the measured parameters CO, SPM, VOC, NO_2 and CO_2 were detected in most of the locations sampled while H_2S and SO_2 were virtually not detected in all the locations. All pollutants detected were however within the FMEnv permissible limits and guideline values recommended by WHO. The study area is virtually free of visible heavy industrial activities. The major sources of air pollutants in the area are mostly from light transportation and farming activities.

Table 4.5: Standards and Guidelines on Ambient Air Quality and Noise

Parameter	FMENV		WHO	
	Limit	Time of Average	Guideline Value	Averaging Period/Time Base
CO	10 ppm/ 11.4 μg/m³	1 - hour	25 ppm	1 - hour
NO_2	0.04 – 0.06 ppm/75.0 – 113 μg/m³	1 – hour	200μg/m³	1 - hour
SO_2	0.01 ppm/26 μg/m³	1 - hour	0.175 ppm/500 μg/m³	10mins
CO_2	-		-	
H_2S	0.008 mg/m³	30 mins	7 μg/m³	30 mins
TSP	250μg/m³	1 - hour	20 μg/m³	Annual
			50 μg/m³	24 - hour
Noise Industrial	90dB(A)	8 hour	70 dB(A)	24 hours
Outdoor Living Area	-		55 dB(A)	16

Source: Guidelines and Standards for Environmental Pollution Control in Nigeria FEPA (FMENV) 1991; WHO, Air Quality Guidelines, 2005

Table 4.6: Results of Air Quality and Noise Measurements in the Study Area (Wet Season)

Parameter	Sample Stations												Mean	Range	Sampling Stations	
	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12			C1	C2
TSP μg/m³	45.6	45.9	42.7	43.4	43.9	47.9	54.2	60.6	52.9	52.4	54.9	50.9	49.6	42.7 - 60.6	49.5	53.1
CO (ppm)	0.36	ND	0.3	0.3	0.5	0.5	1.4	3.3	2.2	1.2	1.3	1.5	1.07	0 - 3.3	0.1	0.9
CO_2 (ppm)	185.6	186.9	186.5	183.9	186.1	181.4	183.7	183.7	184.4	189.1	183.7	186	185.08	181.4 - 189.1	188.7	185
VOC (ppm)	0.02	ND	0.12	ND	0.2	0.16	0.6	0.12	ND	0.3	0.21	0.5	0.186	0 - 0.5	ND	0.4
NO_2 (ppm)	0.003	ND	ND	0.006	0.007	0.006	0.03	0.01	0.002	0.009	0.009	0.019	0.0084	0 - 0.03	0.01	0.016
SO_2 (ppm)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
H_2S (ppm)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NOISE dB(A)	47.8	47.2	46.6	46.7	48.9	45.9	54.4	66.1	48.3	53.8	55.3	59.3	51.69	45.9 - 66.1	45.6	53.4

Source: GEHS Fieldwork 2015

Going by the results of the air quality study, it can be deduced that the ambient air quality in the study area at the time of the assessment was good. Proposed project activities may however generate emissions of fugitive dust from site clearing, excavation and movement of earth materials as well as exposure of bare soil and soil piles to wind. Gaseous pollutants may also be generated from exhaust of diesel engines of heavy duty vehicles and earthmoving equipment. The air pollutants that are likely to be generated during the different phases of the project and their effects and applicability are discussed below:

Total Suspended Particulates

Particulates are finely divided air borne particles which can be of anthropogenic and/or natural origin. They are present in ambient air in the form of dust, fumes, smoke and other aerosols. Particulates may have short and long-term adverse effects on humans, animals and plants. Health effects of particulates on man depend on particle size and concentration. They include acute effects such as eye and throat irritation as well as chronic respiratory diseases such as cancer. Particles that are less than 10µm in aerodynamic diameter are of most concern because of their ability to get inhaled into the lungs to cause respiratory problems. Particulates on leaves reduces rate of photosynthesis and thereby reduces the growth of plants.

The TSP concentrations in the ambient air of the study area ranged from 42.7µg/m^3 to 60.0µg/m^3 with a mean of 49.6µg/m^3. The concentrations recorded in all the sampling locations including the control points were below FMEnv hourly average values of 250µg/m^3. The proposed project implementation would impact on the TSP levels of the area during the construction phase. However, this will be localized and short term.

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless and tasteless gas produced by the incomplete combustion of carbonaceous materials or fossil fuels such as gas, oil, coal and wood. Adverse health effect has been observed with carbon monoxide concentrations of 12 – 17ppm for 8 hours (Canter, 1977) while prolonged (45 minutes to 3 hours) exposure to concentrations of CO between 200ppm and 800ppm often results in severe headache, dizziness, nausea and convulsions which might also lead to death (CCDI, 2001).

The concentration of CO detected in the ambient air of the study area ranged from 0.0 ppm to 3.3 ppm with a mean value of 1.07 ppm. These concentrations were below the FMEnv permissible limit and WHO guideline value for 1 hour averaging time. The high concentrations of CO in SS7 – SS12 may not be unconnected with anthropogenic activities and vehicular movements in the built up areas. Exhaust emissions from heavy duty vehicles during construction may lead to increase in the baseline concentration of this pollutant gas in the proposed project area. However, this will not be significant as it will be short term and also localized.

Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless, pungent, irritating, water soluble and reactive gas produced from the combustion of sulphur-containing fuels, smelting, manufacture of sulphuric acid, and incineration of refuse. The gas is known to be a harsh irritant, and is capable of aggravating asthma, bronchitis and emphysema. It can also cause coughing and promote impaired functions in the human system (CCDI, 2001). Also, sulphuric acid aerosols (formed from dissolved sulphur dioxide) will readily attack building materials, especially those containing carbonates such as marble, limestone, and mortar. Excess exposure to sulphur dioxide accelerate corrosion rates for many metals such as iron, steel, zinc, and copper, especially at relative humidity over 70% (Peavy, et al, 1985).

Sulphur dioxide was not detected in the ambient air in any of the sampling locations. This is desirable for the proposed project and should be maintained during the life cycle of the project. This is because the PV solar panels may be prone to atmospheric SO_2 attack if concentrations increase in the ambient air. It is therefore advised that the level of SO_2 within the project AoI be monitored to ensure favorable conditions are maintained throughout the project's lifespan.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a member of the family of highly reactive gases called nitrogen oxides or oxides of nitrogen, which are formed during combustion processes. In air, oxides of nitrogen dissolve in rain water to form acid rain. NO_2 results when fuel is combusted at high temperatures and occurs mainly from motor exhaust and stationary sources such as electric utilities and industrial boilers (Canter, 1977, SIEP, 1995). It is the only oxide of nitrogen that has been shown to have significant human health effects, with exposure to concentrations higher than 0.5ppm (1mg/m^3) triggering changes in pulmonary function in healthy people (SIEP, 1995).

At the time of the study, the NO_2 levels in the ambient air of the study area were below the FMEnv prescribed maximum limit and WHO guideline value for 1 hour averaging time with concentrations ranging from 0 ppm to 0.03 ppm and a mean of 0.008 ppm. The ambient concentration of this gas in the study area may increase from use of combustion engines during project operations. It is also advisable to monitor the level of this gas within the project AoI due to possible impact on PV solar panels.

Hydrogen Sulphide

Hydrogen sulphide (H_2S) is a toxic, odorous and corrosive gas, which is rapidly oxidized to SO_2 in the atmospheres. It causes eye irritation in humans and odour annoyance. Exposure to concentrations in excess of 500 ppm can be fatal (SIEP, 1995). Its non-detection in the ambient air of the study area suggests that no activity leading to significant emission of the gas was going on in the vicinity of the study area at the time of the study. It is unlikely that the proposed project implementation may lead to an increase in the ambient level of this gas. However, the level of this gas within the project area should be monitored due to possible impact on PV solar panels.

Volatile Organic Carbons

Volatile organic compounds (VOCs) are chemical compounds that have high enough vapour pressure under normal conditions to significantly vaporize and enter the air. There are a wide range of carbon-based molecules (hence 'organic') that are considered VOCs such as aldehydes, ketones, and hydrocarbons. Most members of this group are significantly toxic and exposure to high concentrations in the atmosphere (about 1000 ppm or more) could result in interference with oxygen intake (Canter, 1977).

The concentration of VOC detected in the study area ranged from 0.0 ppm to 0.5 ppm with a mean of 0.19 ppm. This indicates that no activity leading to significant VOC emission was taking place in the vicinity of the study area at the time of this study. It is however unlikely that the proposed project will significantly increase the VOC level in the area.

Ambient Noise Level

Noise is a periodic fluctuation of air pressure and noise pollution is defined as "unwanted sound". The rate at which these fluctuations occur is the frequency, expressed in hertz (cycles per second). The range of sound pressures encountered is very large and to keep numbers in manageable proportions, noise levels are measured in decibels (dB), which have a logarithmic scale. In addition to causing a disturbance, excessive noise can damage health and have physiological effects. Environmental noise concerns focus on local communities and wildlife. Effects on local residents generally relate to the annoyance/ nuisance caused by both short-and long-term high sound levels. Also, disturbance of wildlife is of significance particularly during breeding seasons and/ or when rare species are present (SIEP, 1995).

The result of measurements of the ambient noise level in the study area shows that the recorded mean level is 51.69 dB (A), with levels ranging between 45.5 dB (A) and 66.1 dB (A). These levels were below FMEnv permissible noise level of 90 dB (A) for 8-hour working period and also within the WHO guideline value of 70 dB (A) for industrial areas. This therefore indicates the absence of significant noise sources within the vicinity of the proposed project AoI as at the time of the study. The construction phase of the project will however be accompanied with increased noise levels within the area, which might be due to the use of heavy-duty equipment during the construction phase. These increases will be short term and mostly localized.

4.5.2.1 Dry Season Air Quality & Noise Results

The ambient air quality of the study area during the dry season was assessed based on the result of the environmental study previously carried out for a telecommunication project sited in Madobi village at a distance of approximately 2.5 km away from the proposed project site (EIA of EMTS Base Stations in Jigawa State, 2012). The air pollutants measured during dry season were CO, CH_4, NH_3, SO_2, NO_2, CO_2, HCN, H_2S and SPM. The concentrations recorded for these pollutants are shown in Table 4.7. The concentration values for all gases measured were below the FMEnv permissible limits. High values of SPM recorded during the dry season were attributed to farming and domestic activities as well as vehicular movement on unpaved road surfaces. Although SPM values were high, however, the values recorded did not exceed the FMEnv threshold. Noise level was also within the permissible limit.

Table 4.7: Ambient Air Quality & Noise Level in Study Area (Dry Season)

Location	Parameter									
Madobi, Dutse, Jigawa	CO (ppm)	CH4 (%LEL)	NH_3 (ppm)	SO_2 (ppm)	NO_2 (ppm)	CO_2 (%)	HCN (ppm)	H_2S (ppm)	SPM (µg/m³)	Noise Level
	<0.1	<1	0.01	<0.01	<0.01	0.034	<0.01	<0.01	250	74.4

Source: EIA of EMTS Base Stations in Jigawa State, 2012

4.5.2.2 Seasonal Variation of Air Quality Parameters

The comparison of the results of the air quality parameters obtained during the wet and dry seasons showed that measured SPM was higher during the dry season. This is expected because of the predominant northeast wind in the region that brings about large amount of dusts during the dry season. Besides this all other parameters measured both in wet and dry seasons were all below the FMEnv permissible limits and WHO guideline values.

4.5.3 Soil Quality

Soil is an important component of the natural environment and is a primary medium for many human activities. An understanding of the existing conditions of the soils in the study area deserves considerable attention in order to provide a basis for identifying soil environmental impacts. The integrity of soils can be altered by a variety of physical disturbances including the removal/compaction of soils, changes in use of land or ground cover and disposal of wastes unto land. The characteristics of the soils in the study area is discussed in the following section while the soil sampling methodology is presented in section 4.3.3.2.

4.5.3.1 Soil Morphology

The soils of the study area are generally sandy at the top, compact at depth with often hard pans. Aeolian deposits from the Sahara desert form substantial part of the soils. The mixing of the sub soil in these deposits has given rise to clayey subsoil, which dominates the area. However, because of the sandy texture, the soil may be prone to erosion when vegetation cover is removed during construction works. The physical characteristics of the soils sampled in the area during the dry season are presented in Table 4.8 below.

Table 4.8: Physical Characteristics of Soils Sampled in the Study Area (Wet Season)

	Sample Stations													
Parameters	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**C1**	**C2**
Colour (Munsel)	10YR 6/3	10YR 5/2	10YR 3/4	10YR 6/2	7.5YR 3/6	10YR 6/4	10YR 6/4	10YR 4/4	5YR 5/4	7.5YR 5/4	7.5YR 3/6	10YR 6/3	10YR 6/3	10YR 6/4
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fin e	Fine	Fine	Fine	Fine	Fine
Type	Sandy	Silt	Silt	Sandy	Silty clay	Silt	Silt	Silty clay	Silt	Sandy	Silty clay	Sandy	Sandy	Sandy

Source: GEHS Fieldwork 2015

Particle Size Distribution

Soils are composed of particles of varying aggregates. The soil particles sizes comprises mainly of sand (the coarse), silt and clay (the smallest) fractions. The relative proportion of the soil separates in a particular soil determines its texture. The texture in turn determines the water intake rates (absorption), water storage, the ease of tilling, and the amount of aeration as well as influences on the soil fertility. The name and sizes of soil particle classes are provided in Table 4.9 below as defined by the United State Department of Agriculture (USDA) and International Society of Soil Science (ISSS).

Table 4.9: Classification of Soil Particle Sizes

Particle Fraction Name	USDA (mm)	ISSS (mm)
Gravel	>2	>2
Very Coarse Sand	1 – 2	-
Coarse Sand	0.5 – 1.0	0.2 – 2.0
Medium Sand	0.25 - 0.50	-
Fine Sand	0.10 - 0.25	0.02 - 0.20
Very Fine Sand	0.05 - 0.10	-
Silt	0.002 - 0.05	0.002 – 0.020
Clay	<0.002	<0.002

Source: Boyd *et al* 2002

The data obtained for Particle Size Distribution (PSD) of soils in the study area is presented in Table 4.10.

Table 4.10: Particle Size Distribution of Soils in the Study Area (Wet Season)

Particle Sizes	Sample Stations												Mean (%)	C1	C2
	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12			
	Weight in Gram of 100g														
Very Coarse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coarse	1.2	0.5	0.6	1	3.6	0.5	8.7	0.4	7.7	0.3	2.3	0.2	2.25	0.1	3.9
Medium	3.2	18.1	8.8	11.6	15.9	6.5	2.3	3.3	9.6	5.8	13.8	6.7	8.8	5.5	8.9
Fine Sand	29.7	32.1	55.8	45.5	44.2	55.7	55.3	55.3	45.4	56.9	56.2	61.8	49.49	64.5	58
Very Fine	30.2	15.2	3.6	7.6	9.1	4	7.2	12.9	7.7	6.8	3.4	9.6	9.78	2.8	5.9
Silt	27.1	28.2	25.4	26	21.9	28.8	25.2	25.9	25.3	27.2	17.8	19.3	24.84	23.8	18.9
Clay	8.6	5.9	5.8	7.9	5.3	4.5	1.3	2.2	4.3	2.9	6.5	3.4	4.88	3.3	5.2

Source: GEHS Fieldwork 2015

The PSD result confirms that the soils of the project area are predominantly fine sand with silt. The recorded mean percentage for sand, silt and clay were approximately 70%, 25% and 5%. These percentages represent a conservative ratio of 14:5:1 for sand, silt and clay respectively. Figure 4.10 below presents the PSD of the soils of the study area.

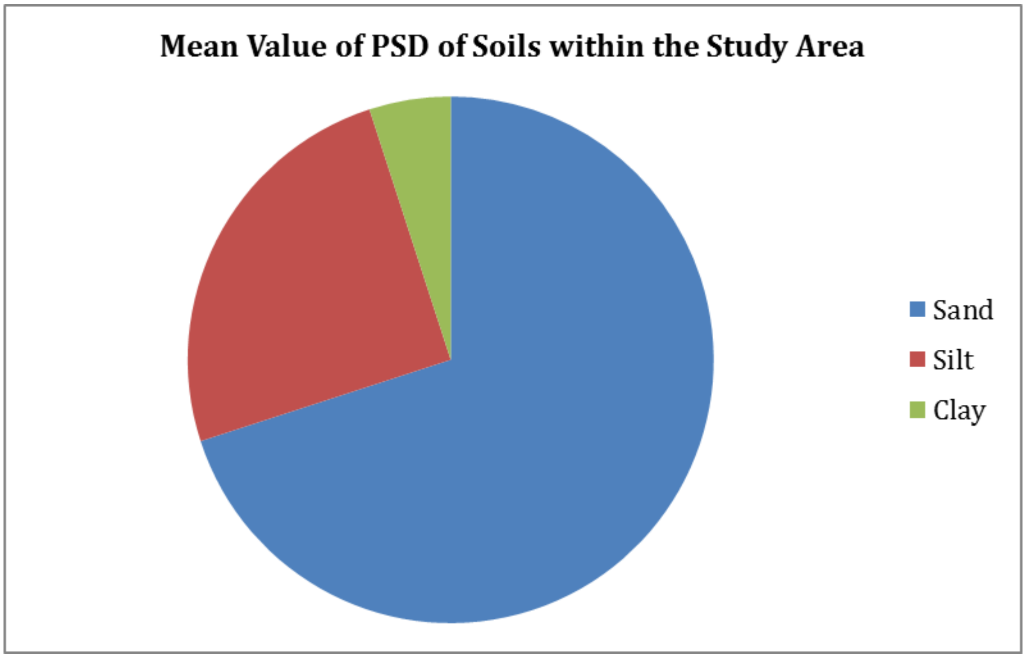

Figure 4.10: Representation of PSD of Soils in the Study Area

4.5.3.2 Soil Physico-chemical Characteristics

A summary of the physico-chemical properties of the soils sampled in the study area during the wet season is presented in Table 4.11.

Table 4.11: Physico-chemical Characteristics of Soils in the Study Area (Wet Season)

Parameters	Sampling Stations														FMEnv Limit
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	C1	C2	
pH@25°C	5.72	5.81	8.33	5.70	5.90	5.87	5.4	7.33	5.29	5.41	5.89	5.34	5.61	5.31	6 - 9
Temp.	27.0	27.1	26.9	27.1	27.5	27.4	27.2	27.2	26.9	26.9	27.6	26.8	26.9	27.2	<40
E.C. µS/cm	20.44	19.93	302	20.40	14.5	19.93	17.69	84.1	5.62	25.70	14.91	13.06	12.9	6.31	1000
MC %	9.2	3.0	7.0	7.5	9.2	8.0	8.9	8.76	8.5	8.0	9.5	8.3	9.0	8.5	NS
THC mg/kgDW	90	75	280	90	70	70	70	90	10	105	70	17.5	70	65	10
SO_4^{-2} mg/kgDW	47	47	45	46	45	40	47	42	47	50	43	45	45	46	500
NO_2^- mg/kgDW	0.12	0.21	0.02	0.02	0.22	0.001	0.21	1.00	0.02	0.30	0.22	0.02	0.12	0.19	NS
NO_3^- mg/kgDW	1.6	1.9	1.12	1.5	2.6	2.5	2.5	8.2	1.12	4.0	2.5	1.62	1.29	1.90	20
Cl^- mg/kgDW	17.7	27.5	17.9	35.7	27.5	28.0	27.6	25.7	17.7	17.7	25.7	27.7	20.5	21.2	NS
Mg^{2+} mg/kgDW	8.00	5.00	20.2	8.10	6.1	7.5	0.7	7.9	7.1	8.10	7.7	3.5	7.5	7.6	50
Mn^{2+} mg/kgDW	0.72	0.70	6.60	0.70	0.95	1.0	0.6	0.8	0.6	1.5	0.6	0.2	0.70	0.85	0.05
Ca^{2+} mg/kgDW	34.0	25.0	106	33.5	25.0	30.0	28.0	34.0	28.0	40.0	28.5	6.5	28.2	27.5	150
Ni mg/kgDW	0.11	0.12	0.09	Nil	Nil	0.15	0.12	0.15	Nil	Nil	0.09	0.17	0.16	0.27	0.05
Fe^{2+} mg/kgDW	2.00	1.00	1.01	2.30	4.5	1.30	0.50	0.91	2.15	1.19	1.29	0.61	1.93	0.90	1.5
Pb^{2+} mg/kgDW	Nil	Nil	Nil	Nil	0.001	Nil	Nil	0.10	Nil	Nil	0.96	0.91	0.96	0.51	0.05
Zn^{2+} mg/kgDW	0.003	0.003	0.001	0.002	0.02	0.03	Nil	0.11	0.019	0.11	0.51	0.11	0.005	0.002	5.0
Cu^{2+} mg/kgDW	0.010	0.020	0.110	0.100	0.030	0.020	0.105	0.020	0.020	0.010	0.100	0.11	0.10	0.50	0.1
As mg/kgDW	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2
Se mg/kgDW	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.01
V /kgDW	0.01	0.002	Nil	Nil	0.01	0.02	Nil	0.003	0.001	Nil	Nil	Nil	Nil	Nil	NS

Source: GEHS Fieldwork 2015 **ND: Not Detected** **NS: Not Stated** **DW: Dry Weight**

- ***pH***

Soil pH is an indication of the acidity or alkalinity of soil and is measured in pH units. The pH scale ranges 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 1, the soil is increasingly more acidic, and from pH 7 to 14, the soil is increasingly more alkaline or basic (McKenzie, 2003). Agronomists generally use soil pH as measured in a 2:1 water-to-soil mixture as an index of a soil's acidity or alkalinity. In a soil text report, pH is often reported with descriptive modifier as shown in Table 4.12 below.

Table 4.12: Soil pH Interpretation

Strongly Acidic	Medium Acidic	Slightly Acidic	Neutral	Mildly Alkaline	Moderately Alkaline	Strongly Alkaline
0 – 5.0	5.1 – 5.5	5.6 – 6.4	6.5 – 7.0	7.1 – 7.5	7.6 – 8.0	8.1 - 14

Source: Agedex 531-4. May 2003

The recorded values for soil pH in the study area ranged between 5.29 and 8.33 with a mean value of 5.99. The high values of 7.38 and 8.32 were only reported in two stations (SS3 and SS8). Going by the mean value, the soils in the study area are slightly acidic. Previous studies carried out in Nigeria in 2005 by the Food and Agriculture Organization (FAO) and the Federal Ministry of Agriculture and Rural development (FMARD), also showed that the pH of top soils of Jigawa State is predominantly slightly acidic with patches of moderately acidic areas

- ***Electrical Conductivity***

Electrical conductivity is a measure of the electric current transfer abilities of an aqueous solution. This is determined by the ionic content and ion exchange capacity of the substance (soil in this case) in aqueous solution. Thus, the lower the ionic content and ion exchange capacity of a substance (soil) in aqueous solution, the lower its electrical conductivity (KWW, 2001). Heavy clays, with high particle-to-particle contact and high moisture holding capacity are highly conductive, while coarse sands with limited particle contact and low moisture holding capacity are extremely poor conductors.

The conductivity of the soil samples in the area ranged between 5.62 µS/cm and 302 µS/cm with a mean of 46.5µS/cm. The recorded values for the control stations were 6.3 µS/cm and 12.9 µS/cm. The recorded soil conductivity of the project area is low. This is however consistent with the low moisture holding capacity and the fine sandy texture of the soils of the area.

- ***Moisture Content***

Moisture content is the water held in soil by strong cumulative forces. It has an effect on soil formation, erosion and structure stability but primarily concerned with plant growth. Water serves as a major constituent of plant protoplasm and is essential for photosynthesis and conversion of starches to sugars. It is also the solvent in which nutrients move into and through plant parts and provides plant turgidity, which maintains the proper form and position of plant parts to capture sunlight (Donahue et al., 1990).

The moisture content of the soils sampled in the study area ranged from 3.0% – 9.5%, with a mean value of 7.98%.

- ***Total Hydrocarbon Content***

The total hydrocarbon content (THC) of soil is an indicator of the extent or otherwise of hydrocarbon contamination of the soil environment. Sources of hydrocarbon accumulation include accidental spillages during transportation, storage and dispensing of petroleum products as well as municipal/industrial wastes.

THC levels in the soils of the study area ranged from 10 to 280 mg/kg with a mean of 86.5mg/kg. It is expected that the proposed project will not significantly affect the soil THC. However, this baseline result will be useful in monitoring future impact of development projects within the project AoI.

- ***Soil Nutrients***

Nitrate, phosphate and sulphate ions (NO_3^-, PO_4^{3-}, and SO_4^{2-}) are the ionic and utilisable forms of nitrogen, phosphorous and sulphur, which are essential plant nutrients present in the soil. Nitrogen is most often the limiting element in plant growth and is a constituent of chlorophyll, plant proteins, and nucleic acids. Sulphur occurs in proteins and is required for plant vitamin synthesis. In acidic soils, sulphur comes from mineralisation of organic matter, particularly weathered soil (Donahue et al, 1990).

The nitrates levels in soils of the study area ranged from 1.12 – 8.2mg/kg with a mean of 2.59mg/kg, the sulphates level ranged from 42 - 50mg/kg with a mean of 45.3mg/kg. The proposed project implementation may affect the nutrients level of the study area, through clearing of vegetated areas.

- ***Exchangeable Cations***

The exchangeable cations in the soil are easily dissolved into solution making them readily available for uptake by the roots of plants. Their presence in soils is therefore directly related to the nutrient levels and hence, fertility of the soil. Cation nutrients such as, Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Potassium (K^+) etc, also help in cleansing the soil by providing adsorption/exchange sites for potential soil and groundwater pollutants e.g. Lead (Pb^{2+}), Cadmium (Cd^{2+}), etc. First, the pollutants are immobilised and finally form insoluble hydroxides, carbonates, etc, thus, becoming unavailable for plants use (Donahue, et al, 1990).

Magnesium and Calcium were the soil cations analysed for this study. Calcium in the soil samples has a concentration range of 6.5 – 106mg/kg with a mean of 34.9mg/kg while the Magnesium concentration ranged between 0.7 and 8.1mg/kg with an average of 7.5mg/kg. Figure 4.11 shows the exchangeable cations in soil sampled in the study area.

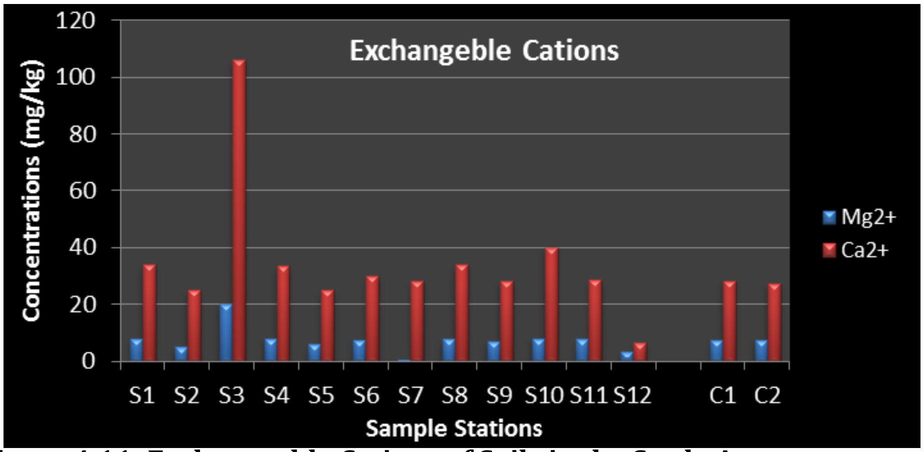

Figure 4.11: Exchangeable Cations of Soils in the Study Area

Generally, only SS3 showed elevated levels of the cations, values recorded in all the other sampling stations were consistent. These values were however all below FMEnv limits. No major significant change is expected in the levels of the cations within the project area due to the implementation of the proposed project.

- ***Heavy Metals***

Heavy metals such as Cu, Mn, Zn, Ni, Fe, Pb, and As constitute a large class of organic and inorganic compounds that are both essential and toxic (in large doses) to human and the environment. In agriculture, they are referred to as micronutrients, stressing their low requirement in the soil and their importance for plant growth. These metals often form soluble compounds in soil and contribute in various measures to the fertility of soil and growth of plants. The fate and transport of a heavy metal in soil depends significantly on the chemical form and speciation of the metal. They are also known to accumulate in plants and animal tissues where they cause various physiological problems. The phenomenon by which they accumulate in tissues is known as bio-accumulation. The mean concentration of heavy metals in the soils of the study area compared with FMEnv acceptable limits is shown in Table 4.13. The slightly elevated levels of Mn, Ni and Pb in the soil of the study area may not be unrelated to the mechanic activities and use of agricultural chemicals in the area.

Table 4.13: Summary of Mean Concentrations of Heavy Metals in Soils of the Study Area (Wet Season)

Heavy Metals	Range Values (mg/kg)	Mean Field Values (mg/kg)	FMEnv Limits (mg/kg)
Copper	0.01 – 0.11	0.055	0.10
Manganese	0.2 – 6.60	1.25	0.05
Zinc	0.0 – 0.51	0.08	5.0
Nickel	0.0 – 0.17	0.13	0.05
Iron	0.50 – 4.5	1.56	1.5
Lead	0.0 – 0.96	0.16	0.05
Arsenic	ND	ND	0.2
Selenium	ND	ND	0.01
Vanadium	0.0 – 0.02	0.008	NS

Source: GEHS Fieldwork 2015 **ND: Not Detected** **NS: Not Stated**

- **Copper**

Copper is a very common substance that occurs naturally in the environment. Copper enters the air, mainly through release during the combustion of fossil fuels. Copper concentration in soil sampled ranged from 0.01 mg/kg – 0.11 mg/kg with a mean value of 0.055 mg/kg. This concentration values are not above the FMEnv acceptable limit of 0.1 mg/kg.

- **Manganese**

Manganese is one of the most abundant metals in soils, where it occurs as oxides and hydroxides, and it cycles through its various oxidation states. Manganese is an essential element for all species. The uptake of manganese by humans mainly takes place through food, such as spinach, tea and herbs. Concentration of manganese in soil samples taken from the study area ranged between 0.2 mg/kg - 6.60 mg/kg with a mean value of 1.25 mg/kg which is above the FMEnv allowable limit of not more than 0.05 mg/kg.

- **Zinc**

Zinc is one of the eight trace elements which are essential for the normal healthy growth and reproduction of crop plants. All soils contain measurable concentrations of essential trace elements. The total zinc content of a soil is largely dependent upon the geochemical composition of the weathering rock parent material on which the soil has developed. However, in some cases, environmental pollution or the agricultural application of zinc-rich materials can mask the parent material's contribution. Zinc concentration in soil samples taken from the study area was in the range of 0 – 0.51 mg/kg with a mean value of 0.08 mg/kg which is below the FMEnv allowable limit 0f 0.5 mg/kg.

- **Nickel**

Nickel is a compound that occurs in the environment only at very low levels. Organic matter has a strong ability to absorb the metal which is why coal and oil contain considerable amounts. Nickel concentration in the study area was in the range of 0 mg/kg - 0.17 mg/kg with a mean value of 0.13 mg/kg which is above FMEnv limits of 0.05 mg/kg.

- ***Iron***

Iron can exist in two valency states F_2+ and Fe_3+. The reversible oxidation/reduction of iron plays an important role in its translocation and transformation in soils. Even at low concentrations iron oxides within soils have a high pigmenting power and determine the colour of soils. The concentration of iron in soil samples taken from the study area ranged between 0.5 – 4.5 mg/kg with a mean value of 1.56 mg/kg.

- ***Lead***

Lead is usually found in ore with zinc, silver and copper and it is extracted together with these metals and occurs naturally in the environment. Lead can end up in soils through corrosion of leaded pipelines in a water transporting system and through corrosion of leaded paints. Lead concentration in soil samples taken from the study area was in the range of 0.9 – 44.2 mg/kg.

Arsenic and Selenium were not detected in all the soils sampled in the study area. The Implementation of the proposed project will not in any foreseeable way impact significantly on the baseline concentrations of heavy metals in the soils of the project AoI.

4.5.3.3 Soil Microbiology

Soil micro-organisms are key regulators of the biogeochemical cycles and processes in the soil. They are therefore an important factor in determining availability of nutrients and to a large extent soil fertility. The summary of microbial characteristics of the soil in the study area is presented in Table 4.14.

Table 4.14: Microbial Characteristics of Soil Sampled in the Study Area (Wet Season)

Sampling Stations	Parameters		
	THB cfu/g	Yeast & Mold cfu/g	TCC Cfu/100ml Plate Count
SS1	3.2×10^5	1.0×10^1	2.1×10^1
SS2	2.3×10^4	1.1×10^2	3.0×10^2
SS3	2.0×10^3	1.0×10^1	5.4×10^5
SS4	2.5×10^3	5.0×10^0	2.3×10^3
SS5	2.5×10^4	3.0×10^0	3.0×10^2
SS6	2.1×10^3	1.1×10^1	1.3×10^1
SS7	2.1×10^4	1.3×10^1	1.3×10^2
SS8	3.1×10^3	5.0×10^0	4.6×10^1
SS9	3.1×10^3	1.3×10^1	2.2×10^3
SS10	3.0×10^5	1.0×10^2	3.1×10^2
SS11	2.3×10^3	9.0×10^0	1.5×10^0
SS12	3.0×10^5	7.0×10^0	3.7×10^2
C1	3.1×10^4	1.1×10^1	3.0×10^3
C2	3.0×10^3	1.0×10^1	2.8×10^0

Source: GEHS Fieldwork 2015

The result of soil samples collected from the study area indicated that the total heterotrophic bacteria (THB) count ranged between 2.0×10^3cfu/g and 3.2×10^5cfu/g. The predominant fungal species in the soils of the area were yeast and mold with counts that ranged between 3.0×10^0cfu/g and 1.10×10^2cfu/g. The total coliform count (TCC) recorded for the soil samples ranged between 1.5×10^0cfu/g and 5.4×10^5cfu/g. The high value is expected probably due to possible human defecation on farmlands and bushes around the area.

4.5.3.4 Soil Productivity

The ability of soils to support growth and development of vegetation under the prevailing climatic, edaphic and natural conditions is a measure of its productivity. Soil productivity is commonly evaluated through the assessment of physical, chemical and microbial properties of soils, crop yield and other factors. The soil productivity potential is important for food supply and the economy of the area. The soils have been grouped as:

- Soils of poor or good productivity, which are to be put to drainage and irrigation. The content organic materials are to be increased by manicuring, growing of fodder crops, mulching and crop rotation.

- Soils of medium productivity, which need to be put to irrigation and whose properties should be improved through organic and inorganic fertilizers as above.

4.5.3.5 Dry Season Soil Quality Results

The results of the physico-chemical analysis of soils in the study area as obtained from the EIA of EMTS Base Station (2012) are presented in Table 4.15. The result shows that the soils are predominantly sandy with pH values ranging from 5.5-5.6 suggesting slight acidity. The average EC is 0.031 dsm^{-1} while the average concentrations of calcium, magnesium, potassium and sodium are 3.0, 1.19, 0.14 and 0.15 Cmol $(H)kg^{-1}$ respectively. The sulphate levels ranged from 2.72 – 4.23 mg/kg with an average value of 3.48 mg/kg while the average phosphate level in soils during the dry season was 1.94 mg/kg.

Table 4.15: Physico-chemical Characteristics of Soils in the Study Area (Dry Season)

Horizon	Depth	Sand	Silt	Clay	USDA Textural Classification	pH	EC	Ca	Mg	K	Na	CEC	Cl	SO4	PO4
	(cm)	%					dsm^{-1}			Cmol $(H)kg^{-1}$				Mg kg^{-1}	
A	0-17	86	2	12	LS	5.5	0.045	3.0	1.20	0.13	0.11	8.0	4.5	4.23	1.94
AB	17 -67	82	6	12	LS	5.6	0.017	3.0	1.18	0.15	0.18	7.6	1.5	2.72	1.94
Range	0 – 67	82-86	2-6	12	LS	5.5-5.6	0.017-0.045	3.0	1.18-1.20	0.13-0.15	0.11-0.18	7.6-8.0	1.5-4.5	4.23-2.72	1.94
Average		84	4	12	LS	5.55	0.031	3.0	1.19	0.14	0.15	7.8	3.0	3.48	1.94

Source: EIA of EMTS Base Station (2012)

4.5.3.6 Seasonal Variation in Soil Quality Results

The soils in the study area showed similar trend in the distribution of measured soil quality parameters. The comparative analysis shows that for both wet and dry seasons, the soils of the study area are predominantly sandy and slightly acidic with mean pH values of 5.99 and 5.55 respectively. The EC of soils was low for both seasons as well the concentrations of exchangeable cations including calcium and magnesium. The concentration of soil nutrients especially sulphate for both seasons were generally low with average value of 45.3mg/kg in wet season and 3.48mg/kg in dry season suggesting that soils in the area are generally of low to moderate fertility. However, slightly higher sulphate values during wet season may be attributed to availability of increased moisture contents and dissolved minerals in the soil during the wet season.

4.5.4 Geology and Hydrogeology

Dutse is located in the northwestern part of Nigeria and it falls within the Chad formation that consist predominantly of recent Aeolian deposits. The rocks underlying this area are made up of 95% ancient crystalline basement complex formations. The basement complex rocks consists mainly of gneiss migmatites schists quartzites and marble but locally granite or syenite and intrusion of amphiobolites and olive rich dykes are found. Sandy beds are formed over impervious clay of the chad formation. Within the proposed project site, the Chad sediments are concealed by sand dunes with no surface outcrops. The soils are generally sandy at the top and compact at depth with often hard pans. The sandy soils are aeolian deposits from the Sahara Desert which form substantial part. The soils in the study area consist of very fine to fine grained silty sand graduating to ferretic hard pan laterite with occasional gravels. The Aeolian sand is characterized by a loose to medium dense soil but as soon as it is excavated it forms loose non-cohesive sand. The report of the geotechnical investigations carried out in the proposed project site is attached as Appendix 4.3.

The depth of aquifers (fed by precipitation and river infiltration) is 25-30 meters for the upper ones and 90-100 meters for the lower ones. Groundwater is obtained from the river valleys and from the upper and lower sub-artesian aquifers. Due to the nature of the Chad formation, with high infiltration rate and the openness of the semi-arid vegetation zone, most of the limited run-off from the rainfall is captured in local depressions and fadama and lost to evapo-transpiration. The water table is usually independent of the fluctuation in the annual rainfall, but related to extensive deforestation/cultivation of vast areas, which increases surface run-off.

4.5.5 Hydrology and Groundwater

4.5.5.1 Hydrology

Jigawa State is blessed with both surface and subsurface water resources, with its greatest potential based on underground. The drainage basin of the region is determined by the Hadejia river system which flows from the high plateau of northern Nigeria. The Hadejia river meanders for 828 km (about 300 km within Kano and Jigawa states) across the old lake bed with many ox-bow lakes and numerous channels spread over a wide area. The river thus contributes immensely to a very vast underground aquifer in Jigawa State. There are however no surface water bodies in the study area. There are however 2 main rivers within the Dutse LGA, the Duddurin Gaya and Warwade rivers that are seasonal and more than 10 km away from the proposed project site.

4.5.5.2 Groundwater Quantity

The amount of groundwater available in the study area is determined by the amount of rainfall each year. Regimes of water available are therefore related to the climate. Information from reports of past environmental studies in the proposed project area revealed that the maximum yield from borehole range from 3 – 5 litres/sec. The water table depth varies from 3 – 10m in basement areas whilst the flow direction is largely determined by the elevation of the location. A total of 447.8 m^3 of surface water and 3555 Mm^3 of groundwater are available for utilization. Considering the present surface and sub-surface demand of 599 Mm^3 for both domestic and agricultural usage, the groundwater potential of the area can be said to be promising.

4.5.5.3 Groundwater Quality

The effects of industrial development on groundwater quality can be especially pronounced in regions where groundwater is the major source of water supply. Both waste water and solid wastes if improperly disposed of can percolate or produce leachates that could contaminate and affect the quality of ground water.

In order to establish the baseline status of the quality of groundwater in the study area, samples of groundwater were collected from three sampling stations (see 4.3.3.2) and analyzed to determine their physico-chemical and microbiological characteristics.

The results have been compared with the FMEnv permissible limit standard for drinking water and the WHO Guidelines for Drinking Water Quality as applicable.

4.5.5.3.1 Physico-Chemical Characteristics of Groundwater

The physico-chemical characteristic of groundwater in the study area is presented in Table 4.16.

Table 4.16: Physico-chemical Characteristics of Groundwater in the Study Area (Wet Season)

PARAMETERS	SAMPLING STATIONS			FMEnv Limit	WHO
	SS6	SS11	C1		
Colour	Colourless	Colourless	Slightly Turbid	Colourless	NS
Odour	Odourless	Odourless	Odourless	Odourless	Unobj.
pH	7.75	7.78	7.79	6.5 – 8.5	6.5 – 8.0
Temperature ^{0}C	26.6	26.4	26.7	NS	NS
E. Conductivity(µS/cm)	598	167.3	231.6	NS	NS
Tubidity NTU	2.00	6.00	0.57	1.0	NS
Total Dissolved Solid mg/l	476	100.9	157.7	500	1200
Total Hardness (mg/l) $CaCO_3$	280	70	140	200	200
Total Suspended Solid mg/l)	8.70	19.9	2.7	<10	NS
Total Alkalinity (mg/l)	262.50	70	86	NS	NS
Salinity (%)	0.00	0.00	0.00	0	NS
Chloride (mg/l)	37.50	23.50	17.70	250	250
Sulphate (mg/l)	67.5	47.7	58.9	500	500
Nitrate mg/l	35.00	5.40	25.00	10.0	50
Nitrite (mg/l)	0.77	0.27	0.47	1.0	NS
BOD_5 (mg/l)	8.0	12.0	3.35	0	NS
COD (mg/l)	18.50	25.0	7.50	NS	NS
DO (mg/l)	6.7	7.5	6.8	7.5	NS
Phosphate (mg/l)	0.50	0.65	1.02	>5	NS
Barium(mg/l)	ND	ND	ND	1.0	NS
Iron (mg/l)	1.02	0.15	0.25	1.0	NS
Zinc (mg/l)	0.51	0.051	0.05	5.0	3.0
Manganese (mg/l)	2.86	0.67	1.5	0.05	NS
Magnesium (mg/l)	28.60	7.15	14.3	NS	NS
Lead (mg/l)	Nil	Nil	Nil	0.05	0.01
Calcium(mg/l)	110.55	28.0	55.50	NS	NS
Copper (mg/l)	0.03	Nil	0.025	0.1	2.0
Selenium (mg/l)	Nil	Nil	Nil	0.01	NS
Nickel (mg/l)	ND	ND	ND	0.05	0.02
Arsenic (mg/l)	ND	ND	ND	0.2	0.01
Cadmium(mg/l)	Nil	Nil	Nil	0.01	0.003

Source: GEHS Fieldwork 2015 **SS: Sampling Station** **NS: Not Stated**

The results of the analysis of the groundwater show that most of the parameters measured were within the regulatory permissible limits except for turbidity, total hardness, TSS, BOD, DO, iron, manganese and calcium which values were above the limits in some of the sampling stations.

The pH values ranged between 7.75 – 7.78 while temperature ranged between 26.4 ^{o}C and 26.6^{o}C. The recorded conductivity which is an index of the total dissolved solids in water ranged from 167.3 to 598µS/cm. The TDS concentrations were 100.9mg/l and 476mg/l respectively. The concentrations of chloride, nitrate and sulphate ranged from 23.50 to 37.50mg/l, 5.4 - 35.0mg/l and 47.7 – 67.5mg/l respectively. The concentrations of magnesium, copper and zinc levels ranged from 7.15 - 28.60mg/, 0.0 to 0.03mg/l and 0.005 to 0.05mg/l respectively. All these values were within permissible/recommended limits prescribed by FMEnv and WHO. Barium, cadmium and lead were not detected in all the groundwater samples collected. Parameters which values were above permissible limits and implications are discussed below.

❖ ***Turbidity***

Turbidity is a unit of measurement quantifying the degree to which light travelling through a water column is scattered by suspended organic (including algae) and inorganic particles. It can be termed as a measure of "cloudiness" in water (Howard *et al*, 1985). It is of general concern in water due to aesthetic considerations, filterability and disinfection. As turbidity level increases, the aesthetic value decreases, and the filtration of water is rendered more difficult and costly, reducing the effectiveness of disinfection procedure. The turbidity level of the groundwater samples ranged from 2.0 to 6.0NTU which is above the acceptable level of 1.0NTU set by FMEnv. No significant health implication has however been attributed to turbidity in drinking water.

❖ ***Total Hardness***

Hardness in water is caused by dissolved calcium and, to a lesser extent, magnesium. Depending on pH and alkalinity, hardness above 200mg/l can result in scale deposition, particularly on heating. The degree of hardness in water may affect its acceptability to the consumer in terms of taste and scale deposition. The values recorded for total hardness in groundwater ranged from 70mg/l - 280mg/l, the maximum value of which is above FMEnv permissible limit and WHO guideline value. The high value obtained from the groundwater sampled from one of the hand dug wells (SS6) may be attributed to contamination from runoffs and debris. Total hardness in water is however not associated with any significant health effect.

❖ ***Total Suspended Solids***

Suspended solids consist of inorganic fractions of silt, clay, calcium, potassium, bicarbonates, chlorides etc. or organic fractions such as algae, zooplankton, bacteria and detritus or immiscible liquids such as oil and grease that impart turbidity characteristics to water within the water column (GEMS, 1992). These usually occur as objectionable by-products in water. The total suspended solid of the groundwater ranged from 8.70mg/l - 19.9mg/l. The maximum value observed in water collected from hand dug well in SS11 is above the permissible limit standard prescribed by FMEnv which makes it unsuitable for drinking and use in industrial applications. The high concentration of TSS is consistent with the high turbidity value recorded for the groundwater from the same sampling station. The high value observed may be attributed to shallow depth of the well, poor maintenance and over-usage as it was observed to be the only functioning well in the village.

- ***Phosphate***

Phosphate is a nutrient component in water. Major source of phosphate is from weathering activities of rocks. High amounts could lead to eutrophication and cause algae bloom in water bodies rendering them unhygienic for domestic purposes. Phosphate concentrations were 0.50mg/l and 0.65mg/l. These values are below FMEnv permissible value of >5mg/l.

- ***Biochemical Oxygen Demand***

Biochemical Oxygen Demand (BOD) is an indirect measure of the amount of biologically degradable organic materials in water, and is an indicator of the amount of dissolved oxygen that will be depleted from the groundwater during natural biological assimilation of organic pollutants. Excess BOD in the water therefore could adversely affect humans and aquatic organisms (Keily, 1998). BOD concentrations ranged from 8.0 to 12.0mg/l. These values are above FMEnv permissible limit of 0.0mg/l.

- ***Chemical Oxygen Demand***

Oxygen is made available to water bodies in the course of mass transfer across the air/water interface with the amount transferred depending on its' solubility in the water. The amount of oxygen required to chemically oxidise organic matter contained in waters under aerobic conditions is termed Chemical Oxygen Demand (COD). These organic matter are such that are not easily biodegraded and therefore toxic to microorganisms (Keily, 1998). COD levels of the groundwater ranged from 18.50mg/l - 25.0mg/l.

- ***Dissolved Oxygen***

Dissolved Oxygen (DO) level is the measure of the amount of gaseous oxygen dissolved in water. It is one of the most important parameters (indicator) in aquatic systems as it is required for the metabolism of aerobic organisms and also influences inorganic chemical reactions (UNEP, 1984). The DO values recorded were 6.7mg/l and 7.5mg/l respectively. These values are consistent with the high BOD values recorded and are slightly below the FMEnv minimum limit of 6.8mg/l.

- ***Calcium***

As a result of the natural occurrence and abundance of calcium in nature, calcium occurs naturally in water. It is often a product of dissolution of minerals and rocks such as calcite, dolomite, gypsum, limestone, marble, etc. It is a major determinant of water hardness. Calcium is also an essential mineral required by plants and animals, and is found in bones, plant fibres, blood, muscles, etc. It is a vital element useful in the development of cell membrane, and responsible for muscle contraction and blood clotting. Recorded calcium concentrations were 28.0mg/l and 110.55mg/l respectively. The value in groundwater collected from SS6 (110.55mg/l) was above the FMEnv permissible limit though consistent with the high total hardness value recorded in water from the same source.

- ***Iron***

Iron is one of the most abundant metals and it is found in natural fresh waters at levels ranging from 0.5 to 50 mg/litre. Iron may also be present in drinking-water as a result of the use of iron coagulants or the corrosion of steel and cast iron pipes during water distribution. Concentrations of iron greater than 1.0 mg/l would markedly impair the potability of the water. The iron concentrations in the groundwater were 0.15mg/l and 1.02mg/l respectively. The iron level in the groundwater collected from SS6 (1.02mg/l) was also above FMEnv permissible limit.

- ***Manganese***

Manganese is an essential element for humans and other animals and occurs naturally in many food sources. The most important oxidative states for the environment and biology are Mn^{2+}, Mn^{4+} and Mn^{7+}. Manganese is naturally occurring in many surface water and groundwater sources, particularly in anaerobic or low oxidation conditions, and this is the most important source for drinking-water. Manganese levels in the groundwater sources ranged from 0.67 to 2.86mg/l. The recorded levels were above the FMEnv permissible limits. The high levels of manganese in all the groundwater samples may be attributed to the parental soil material since the soils of the area were also found to have high levels of manganese.

4.5.5.3.2 Microbiological Characteristics of Groundwater

Microbes are minute organisms, which are in constant competition for organically combined carbon and other nutrients essential for their growth and development. Their ability to get these growth materials depends on temperature, pH, suitable energy source and competition by other organisms. The coliform group of organisms is the primary bacterial indicator used in determining the potability or otherwise of a particular water system. Ideally, drinking water should not contain any microorganisms known to be pathogenic and should also be free from bacteria indicative of pollution with excreta (feacal pollution). The detection of feacal (thermo tolerant) coliform organisms, in particular *Escherichia coli*, provides definite evidence of faecal pollution. The total coliform comprises of all the coliform group of organisms. The presence of the sub-group, faecal coliform bacteria, in aquatic environments indicates that the water is contaminated with faecal material of man or other animals (KWW, 1994). Table 4.17 presents the microbiological characteristics of groundwater sampled during the wet season in the study area.

Table 4.17: Microbiological Characteristics of Groundwater in the Study Area (Wet Season)

Parameters	Sampling Stations			FMEnv Limit
	SS6	SS11	C1	
TBC Cfu/100ml	$3x10^2$	$2x10^2$	$1x10^1$	Absent
Total Coliform Count Cfu/100ml	$1.0x10^1$	5.0	Nil	Absent
FAECAL COLI FORM MPN/100ml	<2.8	<2.8	<2.8	Absent

Source: GEHS Fieldwork 2015

The results show that the levels of Total Bacterial Count (TBC) and Total Coliform Count (TCC) in the collected groundwater samples ranged from 200 to 300 Cfu/100/ml and 5.0 to

10 Cfu/100/ml respectively. Faecal coliform was detected in all the groundwater samples. These values coupled with the detection of E.coli indicate faecal contamination which could pose harmful health effects.

4.5.5.3.3 Groundwater Quality Results (Dry Season)

The physico chemical and microbiological characteristics of groundwater reported for samples analysed during the dry season (EIA of EMTS Base Stations, 2012) is presented in Table 4.18. Although the water was clear and odourless, high values were recorded for TSS, nickel, DO, BOD and COD. No trace of cyanide, mercury, lead or oil and grease was found in the water.

Table 4.18: Physico-chemical and Microbiological Characteristics of Groundwater in the Study Area (Dry Season)

PHYSICO-CHEMICAL PARAMETERS		FMEnv Limit	WHO Guideline Value
Colour (Visual)	Clear	15.0 (Colourless)	NS
Conductivity	13.782	NS	NS
Odour	Odourless	3.5 (Odourless)	NS
pH (value)	8.4	6.5-8.5	6.5 - 9.5
Temperature	24	NS	NS
Total Dissolved Solids	26.0	500	1200
Total Suspended Solids	12.0	<10	NS
Cadmium	0.0001	0.01	0.003
Chromium	<0.0001	0.05	0.05
Copper	0.0486	0.1	2.0
Iron	0.6512	1.0	NS
Lead	<0.0001	0.05	0.01
Magnesium	14.3051	NS	NS
Nickel	0.1848	0.05	0.02
Zinc	0.2398	5.0	3.0
Sodium	8.66	200	200
Chloride	21.67	250	250
Cyanide	<0.0001	0.1	0.07
Phosphate	14.200	>5	NS
Sulphate	26.34	500	500
Dissolved Oxygen	7.8	7.5	NS
BOD	2.2	0	NS
COD	11.7	NS	NS
Oil and grease	0	0.05	NS
MICROBIOLOGICAL PARAMETERS			
BACTERIAL COUNT (cfu/ml)	9.80E+01	0	
MPN (coliforms/100ml)	<2	0	0
BACTERIAL IDENTIFICATION	*Bacillus, Pseudomonas*		

Source: EIA of EMTS Base Station (2012)

4.5.5.3.4 Seasonal Variation of Groundwater Parameters

The comparative analysis of wet and dry season's groundwater samples showed little variability as most of the parameters analysed for both seasons were consistent and largely within acceptable FMEnv and WHO limits for drinking water. The concentration of water nutrients were moderate and within acceptable limits for both seasons except for phosphate with concentration levels ranging between 0.50 – 1.02 mg/l well below recommended FMEnv level which should be greater than 5 mg/l in all water samples during the wet season. There is however high level of suspended solids recorded for water samples in both seasons in the area. High levels of BOD and COD were also recorded in groundwater in both seasons.

There was no evidence of heavy metal contamination for water samples in both seasons. Heavy metals were either not detected or have very low concentration well below the recommended thresholds except for nickel which was not detected in wet season but has concentration levels of 0.18 mg/l slightly above FMEnv limit of 0.05 mg/l during the dry season. For both seasons, there was evidence of bacteria isolates including the coliforms indicating bacterial contamination in drinking water in the study area.

4.5.6 Ecology and Biodiversity

According to the convention on Biological Diversity, Biodiversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic systems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems". Biodiversity considerations are very important in environmental management. Many developmental activities are likely to play a major role in the overall reduction of biodiversity; hence there is need for proper understanding of the existing environmental setting in terms of habitat types, selected flora and fauna species, endangered or threatened species. This will help in developing mitigation measures for protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing the living natural resources. This section presents a description of the terrestrial flora and fauna and other natural resources and habitats constituting the biological environmental setting.

4.5.6.1 Vegetation (Terrestrial Flora)

There is no doubt that the world's terrestrial flora is under pressure largely from rapid urbanization. The proposed project is an example of anthropogenic activity that can add pressure on the relatively sparse vegetation in the study area. Baseline information of, at least, the plant species composition of the project area will help in developing mitigation measures or conservation plans for any impact of the proposed project.

4.5.6.1.1 Regional Vegetation.

The study area falls within the Sudan Savannah vegetation belt of Nigeria. This region is characterized by relatively long dry season lasting 5-7months resulting in less woody species compared to the Forest belt or even the Guinea Savannah. Thus the regional vegetation is a mixture of grasses and low growing shrubs and trees. The region is currently experiencing desert encroachment which is greatly exacerbated by human activities such as over cultivation, overgrazing, etc.

The Sudan Savannah vegetation belt is found in the north-west, stretching from the Sokoto plains in the west, through the northern sections of the central highland. It spans almost the entire northern states bordering the Niger Republic and covers over one quarter of Nigeria's total area (Figure 4.12).

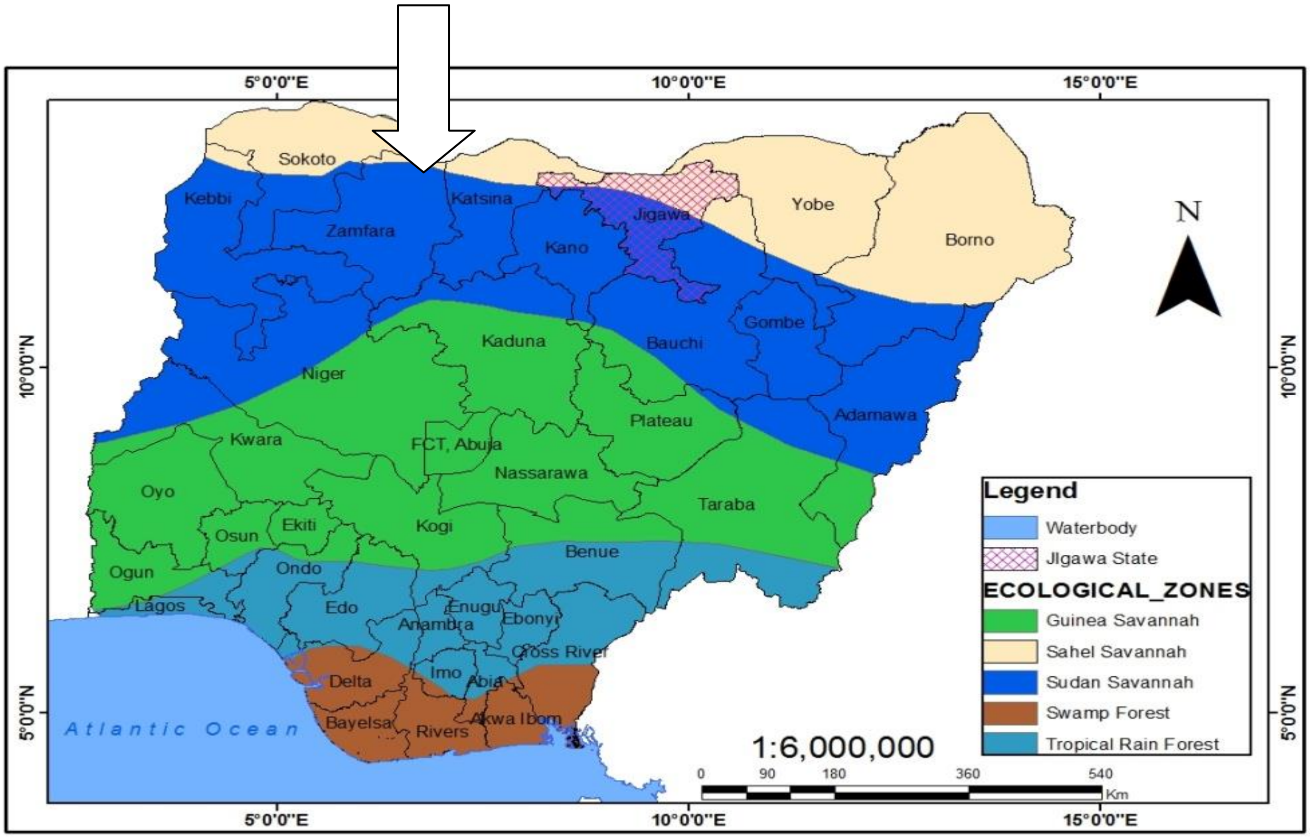

Figure 4.12: Map showing Different Vegetation Belt of Nigeria (White arrow points to Jigawa State where the study area is located)

4.5.6.1.2 Vegetation in the Study Area.

The terrestrial plant life in the study area is typically a mixture of herbaceous flora especially of members of the grass family- the Poaceae and low growing woody species, with the herbaceous species being more abundant. Common grasses are *Setara pallid-fusca*, *Chloris gayana, Digitaria exilis and Eragrostis atrovirens.* Common woody species are *Azadirachta indica, Acacia Senegal, Vitellaria paradoxa*-all trees of economic importance. Plate 4.8 shows the vegetation in the study area.

Plate 4.8A: Typical Herbaceous Plant Community in the Study Area: (1) *Senna obtusifloia* (Fabaceae) (2) *Digitaria exilis* (Poaceae) and (3) *Andropogon gayanus* (Poaceae)

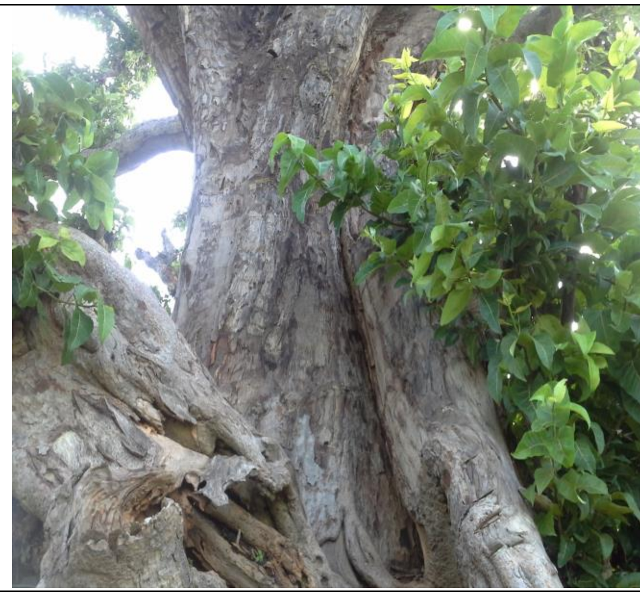

Plate 4.8B: *Ficus ingens* (Moraceae) a Common Woody Species in the Study Area (Plot 5)

Plate 4.8C: Maize and Groundnut Farm along the Proposed Transmission RoW (Plot 6)

Plate 4.8D: Maize Farm on the Proposed Project Site (Plot 5)

- **Classification, Distribution and conservation Status of Plant Species**

A total of 122 species of plants cutting across 37 plant families and 107 genera were recorded from all the sampling points in the study area. The most dominant families with more than ten species are Fabaceae (27 species), Poaceae (22 species) and Asteraceae (14 species). Other dominant families were Malvaceae (9 species), Rubiaceae (6 species) and Euphorbiaceae (5 species). The families Commelinaceae and Cyperaceae were represented by three species each while other families were represented by either one or two species. The proportion of plant families in the study area is shown in Figure 4.13.

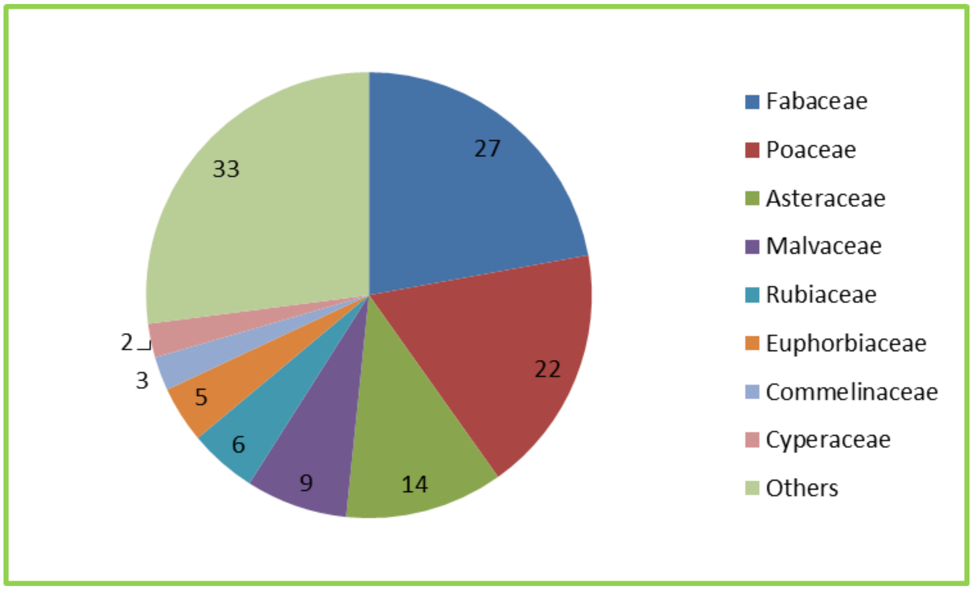

Figure 4.13: Chart Showing the Proportion of Plant Families in the Study Area

The conservation status of the plant species were evaluated using the International Union for Conservation of Nature (IUCN) Red List Categories and Criteria. The IUCN Red List of Threatened Species is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of animal, fungi and plant species and their links to livelihoods. The IUCN Red List is set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies. The aim is to convey the urgency of conservation issues to the public and policy makers, as well as help the international community to try to reduce species extinction. Species are classified by the IUCN Red List into nine groups as follows:

- Extinct (EX) – No known individuals remaining.
- Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.
- Critically endangered (CR) – Extremely high risk of extinction in the wild.
- Endangered (EN) – High risk of extinction in the wild.
- Vulnerable (VU) – High risk of endangerment in the wild.
- Near threatened (NT) – Likely to become endangered in the near future.
- Least concern (LC) – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.
- Data deficient (DD) – Not enough data to make an assessment of its risk of extinction.
- Not evaluated (NE) – Has not yet been evaluated against the criteria.

When discussing the IUCN Red List, the official term "threatened" is a grouping of three categories: Critically Endangered, Endangered, and Vulnerable.

More details regarding plant species classification, conservation status and distribution in all plots in the study area is presented in Table 4.19.

Table 4.19: Classification and Distribution of Plant Species in the Study Area

S/N	FAMILY	SPECIES (Scientific Name)	COMMON NAME	HABIT	OCCURRENCE/HA PLOTS														IUCN STATUS
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	Asteraceae	*Centaurea senegalensis*	Centaurea (Kodebabi)	Herb	7	-	-	-	-	6	53	-	-	-	-	6	48	-	NE
2	Rubiaceae	*Borreria stachydea*	Borreria	Herb	-	4	-	-	-	23	-	-	-	-	-	23	-	-	NE
3	Poaceae	*Digitaria exilis*	White fonio/fonio millet	Grass	276	402		106	552	666		402		210	130	500		1402	NE
4	Liliaceae	*Chlorophytum laxum*	Variegated spider plant	Herb	-	2	-	-	-	-	-	-	-	-	-	-	-	2	NE
5	Fabaceae	*Alysicarpus glumaceus*	Alyce clover	Herb	18	-	4	-	-	-	-	-	4	-	-	-	-	-	NE
6	Poaceae	*Setaria pallide-fusca*	Cattail grass	Grass	1162	-	-	-	-	-	30	-	-	-	-	217	200	-	NE
7	Fabaceae	*Zornia glochidiata*	Zornia	Herb	42	-	-	-	-	-	-	-	-	-	-	-	-	-	NE
8	Poaceae	*Chloris gayana*	Rhodes grass	Grass	110	316	-	-	-	222	-	316	-	-	-	160	-	1213	NE
9	Fabaceae	*Acacia albida*	Acacia (Gao in hausa)	Tree	4	-	-	-	-	-	-	-	-	-	-	-	-	-	NE
10	Poacea	*Cynodon dactylon*	Bermuda grass	Grass	315	-	103	293	-	-	-	-	103	-	55	-	-	-	NE
11	Rubiaceae	*Borreria verticillata*	Borreria verticillata	Shrub	9	-	-	-	-	-	-	-	-	-	-	-	-	-	NE
12	Asteraceae	*Vernonia bluemoides*	Vernonia	Herb	7	-	-	-	-	-	-	-	-	-	-	-	-	-	NE
13	Poaceae	*Digitaria debilis*	Digitaria	Herb	4	-	-	-	-	-	-	-	-	-	-	-	-	-	NE
14	Rubiaceae	*Mitracarpus scaber*	Mitracarpus	Herb	334	-	-	-	3	-	-	-	-	1	-	-	-	-	NE
15	Poaceae	*Dactyloctenium aegyptium*	Egyptian crowfoot grass	Grass	4	-	-	-	1	882	-	-	-	1	-	882	-	-	NE
16	Malvaceae	*Adansonia digitata*	Boabab	Tree	19	-	-	-	-	3	-	-	-	-	-	3	-	-	NE
17	Burseraceae	*Commiphora pedunculata*	Commiphora	Tree	27	-	-	-	-	3	-	-	-	-	-	-	-	-	NE
18	Commelinaceae	*Aerva lanata*	Mountain knotgrass	Herb	6	-	-	-	16	-	-	-	-	16	-	-	-	-	NE
19	Lythraceae	*Lawsonia inermis*	Henna or Henna tree	Tree	1	-	-	-	-	41	-	-	-	-	-	41	-	-	NE
20	Fabaceae	*Acacia sieberiana*	Gum Arabic	Tree	3	5	-	-	-	-	-	5	1	-	-	-	-	5	NE
21	Euphorbiaceae	*Croton lobatus*	Gaasayaa (Hausa)	Herb	8	-	-	-	-	-	-	-	-	-	-	-	-	-	NE
22	Malvaceae	*Sida cordifolia*	Country mallow	Shrub	9	-	-	-	-	-	-	-	-	-	-	-	-	-	NE
23	Malvaceae	*Sida linifolia*	Fanpetals or sida	Shrub	-	-	-	32	-	-	-	-	-	-	12	-	-	-	NE
24	Poaceae	*Urelytrum giganteum*	Quinine grass	Grass	14	-	-	-	-	-	161	-	-	-	-	-	120	-	NE
25	Balanitaceae	*Balanites aegyptiaca*	Desert date	Tree	-	2	-	-	-	-	3	2	-	-	-	-	3	2	NE
26	Ebenaceae	*Diospyrus mespiliformis*	African Ebony	Tree	-	1	-	-	37	-	3	1	-	37	-	-	3	1	NE
27	Araceae	*Stylochiton hypogeaus*	Stylochiton	Herb	-	16	-	-	-	3	-	16	-	-	-	12	-	16	NE
28	Rubiaceae	*Feretia apodanthera*	Kuru-kuru (Hausa)	Shrub	-	2	-	-	-	2	2	2	-	-	-	2	2	2	NE
29	Cyperaceae	*Kylinga pumila*	Low spikesedge	Herb	-	202	-	-	23	-	-	202	-	23	-	-	-	202	NE
30	Cucurbitaceae	*Ptenolepis madrasa*	-	Herb	-	5	-	-	-	-	-	5	-	-	-	-	-	-	NE
31	Poaceae	*Setaria barbata*	Indian bristlegrass	Grass	-	996	-	-	16	199	-	996	-	16	-	123	-	996	NE
32	Cyperaceae	*Cyperus diformis*	Small flower umbrella	Sedge	-	19	-	-	26	-	-	-	-	3	-	-	-	19	NE
33	Poaceae	*Eragrostis atrovirens*	Thalia lovegrass	Grass	-	751	-	-	-	-	-	-	-	-	-	-	-	135	NE
34	Poaceae	*Erogarastis gangetica*	Slimflower lovegrass	Grass	-	1051	-	-	-	-	-	-	-	-	-	-	-	231	NE

35	Poaceae	*Aristida mutabilis*	Aristida	Grass	-	61	-	-	-	-	-	-	-	-	-	-	-	61	NE
36	Poaceae	*Tripogon minimus*	Tripogon	Grass	-	11	-	-	-	-	-	-	-	-	-	-	-	11	NE
37	Asteraceae	*Biden bipinnatum*	Blackjack	Herb	-	72	-	-	4	-	-	-	-	4	-	-	-	72	NE
38	Fabaceae	*Senna obtusifolia*	Chinese senna, American siclepod	Shrub	-	79	-	-	221	-	-	-	-	42	-	-	-	79	NE
39	Asparagaceae	*Asparagus africanus*	Climbing asparagus fern	Shrub	-	2	-	-	-	-	-	-	-	-	-	-	-	2	NE
40	Poaceae	*Andropogo gayanus*	Rhodesian blue grass	Grass	-	-	13	-	-	19	-	-	13	-	-	19	-	-	NE
41	Poaceae	*Imperata cylinderica*	Cogon grass	Grass	-	-	19	-	-		-	-	19	-	-	-	-	-	NE
42	Acanthaceae	*Hypoestes cancellata*	Senegal basari	Herb	-	-	12	-	-	-	-	-	6	-	-	-	-	-	NE
43	Asclepiadaceae	*Leptadenia hastate*	Senegal balanta	Shrub	-	-	3	-	-	-	12	-	1	-	-	-	6	-	NE
44	Convolvulaceae	*Ipomoea asarifolia*	Morning glory	Herb	-	-	3	-	-	-	-	-	3	-	-	-	-	-	NE
45	Fabaceae	*Senna sieberana*	Senna	Tree	-	-	8	-	-	-	-	-	8	-	-	-	-	-	NE
46	Euphorbiaceae	*Phyllanthus amarus*	Stone breaker	Herb	-	-	7	-	-	-	-	-	7	-	-	-	-	-	NE
47	Solanaceae	*Physalis peruviana*	Golden berry	Herb	-	-	5	19	-	-	-	-	5	-	15	-	-	-	NE
48	Moraceae	*Ficus ingens*	Fig tree	Tree	-	-	2	-	4	-	-	-	2	1	-	-	-	-	NE
49	Fabaceae	*Senna sinqueana*	Sticky pod	Tree	-	-	3	-	26	-	-	-	3	26	-	-	-	-	NE
50	Poaceae	*Eleusine indica*	Wiregrass	Grass	-	-	12	-	-	-	-	-	12	-	-	-	-	-	LC
51	Poaceae	*Sporobolus pyramidalis*	Giant rat's tailgrass	Grass	-	-	9	-	-	-	-	-	9	-	-	-	-	-	NE
52	Fabaceae	*Desmodium tortosum*	Beggarweed	Herb	-	-	1	-	-	-	-	-	1	-	-	-	-	-	NE
53	Fabaceae	*Eriosema psoraloides*	Canary pea	Herb	-	-	2	-	-	-	-	-	2	-	-	-	-	-	NE
54	Fabaceae	*Indigofera nummalarifolia*	Indigofera	Herb	-	-	2	-	-	-	11	-	2	-	-	-	-	-	NE
55	Euphorbiaceae	*Phyllanthus niruri*	Stonebreaker	Herb	-	-	1	-	-	-	-	-	1	-	-	-	-	-	NE
56	Malvaceae	*Waltheria indica*	Sleepy morning	Herb	-	-	3	-	-	-	3	-	-	-	-	-	3	-	NE
57	Fabaceae	*Aeschynomene uniflora*	Budda pea	Herb	-	-	20	-	-	-	-	-	20	-	-	-	-	-	NE
58	Euphorbiaceae	*Chrozophora senegalensis*	Baurenkiyeshi(Hausa)	Herb	-	-	5	-	-	-	26	-	5	-	-	-	26	-	NE
59	Fabaceae	*Indigofera arrecta*	Bengal indigo	Shrub	-	-	2	-	-	-	-	-	-	-	-	-	-	-	NE
60	Fabaceae	*Crotolaria retusa*	Brown Hemp	Shrub	-	-	-	41	-	3	-	-	-	-	41	3	-	-	NE
61	Fabaceae:P	*Sesbania sesban*	Egyptian pea	Shrub	-	-	-	71	-	-	7	-	-	-	71	-	7	-	NE
62	Asteraceae	*Sclerocarpus africanus*	African Bonebract	Herb	-	-	-	13	-	-	-	-	-	-	13	-	-	-	NE
63	Asteraceae	*Blumea aurita*	Awka (Ibo)	Herb	-	-	-	4	-	-	-	-	-	-	4	-	-	-	NE
64	Asteraceae	*Conyza aegyptiaca*	Horseweed	Herb	-	-	-	41	-	-	-	-	-	-	41	-	-	-	NE
65	Asteraceae	*Ageratum conyzoides*	Chickweed	Herb	-	-	-	66	-	-	-	-	-	-	66	-	-	-	NE
66	Portulacaceae	*Portulaca oleraceae*	Pigweed or Red root	Herb	-	-	-	21	-	-	-	-	-	-	32	-	-	-	NE
67	Asteraceae	*Emilia pratermissa*	Mende (Seirraleone)	Herb	-	-	-	16	-	-	-	-	-	-	16	-	-	-	NE
68	Asteraceae	*Bidens pilosa*	Blackjack	Herb	-	-	-	21	-	-	-	-	-	-	19	-	-	-	NE
69	Asteraceae	*Cosmos sulphureus*	Yellow cosmos	Shrub	-	-	-	161	-	-	-	-	-	-	-	-	-	-	NE
70	Solanaceae	*Scoparia dulcis*	Goatweed	Herb	-	-	-	5	-	-	-	-	-	10	10	-	-	-	NE
71	Commmeliceae	*Commelina africana*	Spiderwort	Herb	-	-	-	9	18	-	-	-	-	4	9	-	-	-	LC

72	Companulaceae	*Cephalostigma thonnigii*	-	Herb	-	-	-	1	-	-	-	-	-	-	1	-	-	-	NE
73	Fabaceae:P	*Stylosanthes arecta*	Penicil flower	Herb	-	-	-	2	-	-	-	-	-	-	2	-	-	-	NE
74	Malvaceae	*Urena lobota*	Congo Jute	Shrub	-	-	-	13	-	-	-	-	-	-	13	-	-	-	NE
75	Euphorbiaceae	*Bridellia ferruginea*	Burburumhi (Fulani)	Shrub	-	-	-	4	-	-	-	-	-	-	4	-	-	-	NE
76	Asteraceae	*Porpyrostema angostifolius*	-	Shrub	-	-	-	5	-	-	-	-	-	-	5	-	-	-	NE
77	Fabaceae	*Crotolaria lachnosema*	Rattle pod	Herb	-	-	-	3	-	-	-	-	-	-	-	-	-	-	NE
78	Poaceae	*Sacciolepis africana*	Cupscale grass	Grass	-	-	-	6	-	-	-	-	-	-	-	-	-	-	NE
79	Convulvolaceae	*Ipomoea aquatica*	Water spinach	Herb	-	-	-	-	7	-	4	-	-	5	-	-	4	-	LC
80	Fabaceae	*Piliostigma thonningii*	Monkey bread	Shrub	-	-	-	-	3	-	-	-	-	2	-	-	-	-	NE
81	Malvaceae	*Hibiscus asper*	Hibiscus	Herb	-	-	-	-	4	-	-	-	-	4	-	-	-	-	NE
82	Cyperaceae	*Mariscus alternifolius*	-	Sedge	-	-	-	-	31	-	-	-	-	20	-	-	-	-	NE
83	Asteraceae	*Vernonia ambigua*	Ironweed	Herb	-	-	-	-	111	-	-	-	-	62	-	-	-	-	NE
84	Xyridaceae	*Xyris straminea*	Yellow eyed grass	Herb	-	-	-	-	29	-	-	-	-	23	-	-	-	-	NE
85	Asteraceae	*Acanthospermum hispidum*	Goat's head	Herb	-	-	-	-	11	-	-	-	-	16	-	-	-	-	NE
86	Lamiaceae	*Leucas martinicensis*	Wild tea bush	Shrub	-	-	-	-	2	-	-	-	-	7	-	-	-	-	NE
87	Malvaceae	*Hibiscus suratensis*	Hibiscus	Herb	-	-	-	-	15	-	-	-	-	15	-	-	-	-	NE
88	Verbenaceae	*Clerodendron capitatum*	Diola (Senegal)	Shrub	-	-	-	-	11	-	-	-	-	11	-	-	-	-	NE
89	Amaranthaceae	*Achyranthes aspera*	Devil's horsewhip	Herb	-	-	-	-	18	-	-	-	-	18	-	-	-	-	NE
90	Malvaceae	*Melochia corchorifolia*	Chocolate weed	Shrub	-	-	-	-	2	-	-	-	-	2	-	-	-	-	NE
91	Fabaceae	*Senna mimesoides*	Senna	Herb	-	-	-	-	3	-	-	-	-	3	-	-	-	-	NE
92	Fabaceae	*Tamarindus indica*	Tamarind	Tree	-	-	-	-	218	-	-	-	-	218	-	-	-	-	NE
93	Fabaceae	*Indigofera secundiflora*	Indigofera	Herb	-	-	-	-	19	-	-	-	-	-	-	-	-	-	NE
94	Arecaceae	*Phoenix dactylifera*	Date palm	Tree	-	-	-	-	-	-	-	-	-	1	1	-	-	-	NE
95	Apocynaceae	*Plumeria rubra*	Temple tree	Tree	-	-	-	-	-	-	-	-	-	1	-	-	-	-	NE
96	Asteraceae	*Eclipta alba*	False daisy	Herb	-	-	-	-	-	3	-	-	-	-	-	-	-	-	DD
97	Capparaceae	*Caparis tomentosa*	Woolly Caper bush	Shrub	-	-	-	-	-	1	-	-	-	-	-	1	-	-	NE
98	Rubiaceae	*Oldenlandia herbacea*	Chay root	Herb	-	-	-	-	-	16	-	-	-	-	-	16	-	-	LC
99	Colchiceae	*Gloriosa superba*	Flame lily	Herb	-	-	-	-	-	1	-	-	-	-	-	1	-	-	LC
100	Combretaceae	*Guiera senegalensis*	Moshi medicine	Shrub	-	-	-	-	-	38	24	-	-	-	-	38	24	-	NE
101	Fabaceae	*Crotalaria falcata*	Smooth rattlebox	Shrub	-	-	-	-	-	2	2	-	-	-	-	2	2	-	NE
102	Fabaceae	*Indigofera linearifolia*	Indigofera	Shrub	-	-	-	-	-	20	-	-	-	-	10	20	-	-	NE
103	Anacardaceae	*Sclerocara birrea*	Marula	Tree	-	-	-	-	-	7	-	-	-	-	-	7	-	-	NE
104	Orobanchaceae	*Striga asiatica*	Witchweed	Herb	-	-	-	-	-	150	28	-	-	-	-	12	28	-	NE
105	Poaceae	*Axonophus smithii*	Wheat grass	Grass	-	-	-	-	-	3	19	-	-	-	-	60	19	-	
106	Rubiaceae	*Borreria octodon*	Borreria	Herb	-	-	-	-	-	4	-	-	-	-	-	4	-	-	NE

107	Fabaceae	*Tephrosia linearifolia*	Felatsifotra	Herb	-	-	-	-	-	402	-	-	-	-	-	402	-	-	NE
108	Poaceae	*Eragrostic tenella*	Lovegrass	Grass	-	-	-	-	-	778	-	-	-	-	-	778	-	-	NE
109	Meliaceae	*Azadirachta indica*	Neem	Tree	-	-	-	-	-	62	-	-	-	-	-	62	-	-	NE
110	Commmeliaceae	*Commelina difusa*	Climbing day flower or spreading day flower	Herb	-	-	-	-	-	82	-	-	-	-	-	82	-	-	NE
111	Poaceae	*Cenchrus biflorus*	Indian sandbur	Grass	-	-	-	-	-	4	-	-	-	-	-	-	-	-	NE
112	Fabaceae	*Crotalaria senegalensis*	-	Herb	-	-	-	-	-	5	-	-	-	-	-	-	-	-	NE
113	Sterculiaceae	*Sterculia setigera*	Karaya gum tree	Tree	-	-	-	-	-	-	1	-	-	-	-	-	1	-	NE
114	Fabaceae	*Zornia latifolia*	Maconha brava	Herb	-	-	-	-	-	-	702	-	-	-	-	-	200	-	NE
115	Amaranthaceae	*Gomphrena celosiodes*	Gomphrena weed	Herb	-	-	-	-	-	-	218	-	-	-	-	-	15	-	NE
116	Fabaceae	*Senna hirsuta*	Woolly senna	Herb	-	-	-	-	-	-	10	-	-	-	-	-	10	-	NE
117	Apocynaceae	*Calotropis procera*	Sodom's apple	Shrub	-	-	-	-	-	-	218	-	-	-	-	-	12	-	NE
118	Poaceae	*Pennisetum pedicellata*	Desho or desho grass	Grass	-	-	-	-	-	-	12	-	-	-	-	-	12	-	NE
119	Capparidaceae	*Capparis polymorpha*	Kauk-kweza (Myanmar)	Shrub	-	-	-	-	-	-	22	-	-	-	-	-	22	-	NE
120	Malvacea	*Hibiscus linearifolia*	Hibiscus	Herb	-	-	-	-	-	-	14	-	-	-	-	-	14		NE
121	Fabaceae	*Parkia biglobosa*	Locust bean tree	Tree	-	-	-	-	-	-	4	-	-	-	-	4	4	-	NE
122	Poaceae	*Rottoboellia exaltata*	Itchgrass	Grass	-	-	-	-	-	-	18	-	-	-	-	18	18	-	NE

Source: GEHS Fieldwork 2015 **KEY: NE – Not Evaluated; LC – Least Concern; DD – Data Deficient**

- **Variability of Plant Species in the Study Area**

Plots 5 had the highest number of species of 33 spread across 16 families and 17 genera followed by Plot 11 with 31 species spread across 14 families and 15 genera. Plot 8 had the lowest number of species. Figure 4.14 shows the distribution of plant taxonomic groups across the plots in the study area. In terms of species diversity, all the sampled locations had a Shannon-Weiner diversity index of above 1 indicating high species diversity in each plot (see Figure 4.15). Plot 5 has the highest diversity with a Shannon-Weiner index (H) of 2.39 followed by Plot 4 with a Shannon-Weiner index (H) of 2.33. Other locations with diversity index above 2 are Plots 3, 6 and 13. Similarly, the distribution of species within all plots was fairly even (see Figure 4.16).

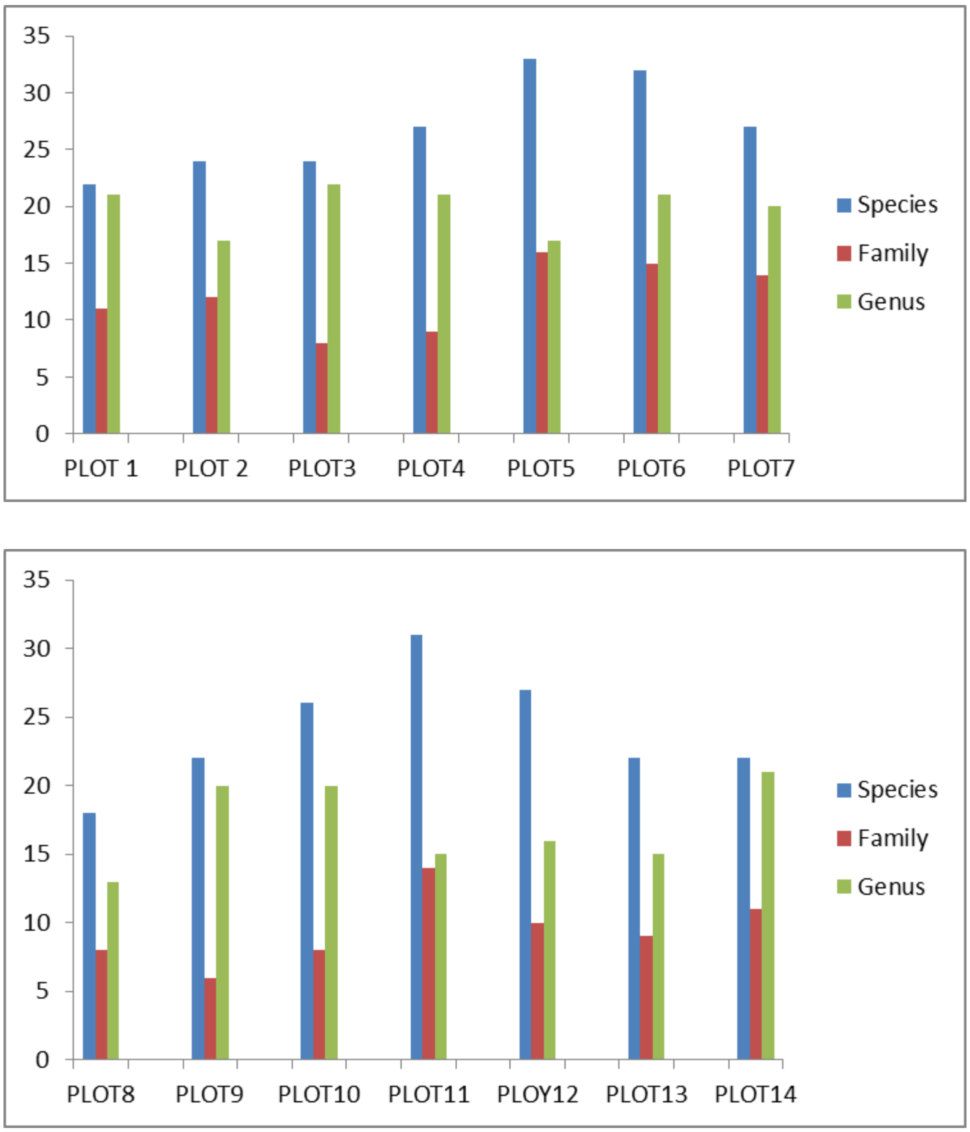

Figure 4.14: Chart showing Distribution of Plant Taxonomic Groups across Plots in the Study Area.

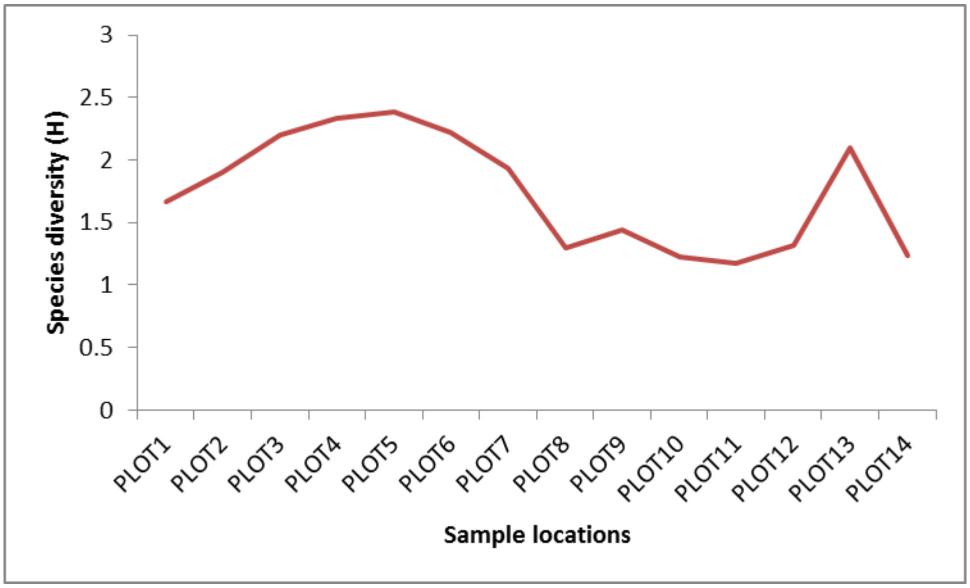

Figure 4.15: Chart showing Species Diversity within Sampled Locations in the Study Area

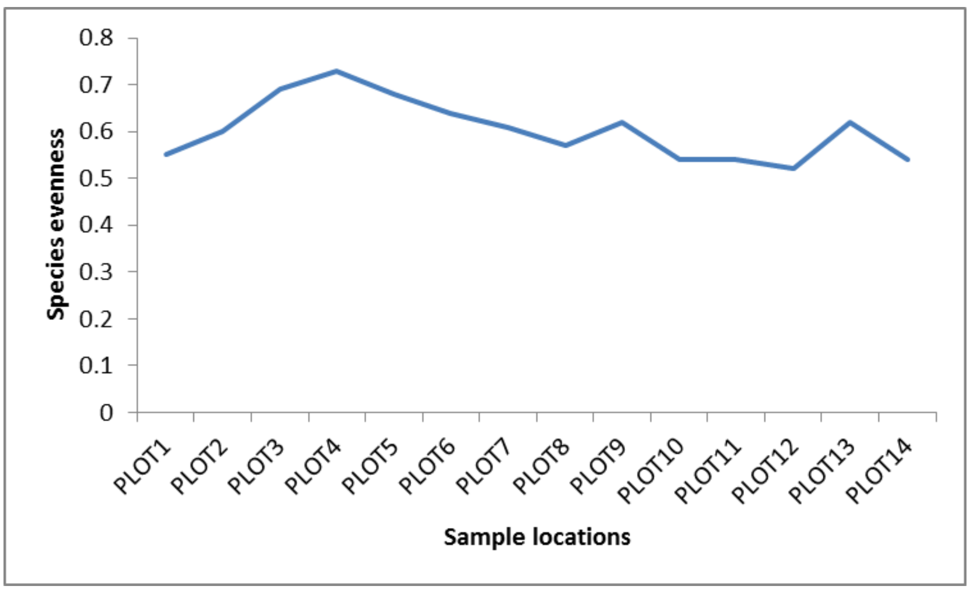

Figure 4.16: Chart showing Species Evenness within Sampled Locations in the Study Area

- **Habitat Characterization**

Habitat is defined as a physical environment that supports assemblages of living organisms and their interactions with the non-living environment. The distribution and abundance of plant and animal species has a direct relationship with the physical environment (Habitat) in which they live. For the purpose of this study, habitats are divided into modified, natural, and critical. Critical habitats are a subset of modified or natural habitats.

Natural Habitat - These are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

Modified Habitat - These are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity such as farming has substantially modified an area's primary ecological functions and species composition.

Critical Habitat - These are areas with high biodiversity value, including (i) habitat of significant importance to critically endangered and/or endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

Based on the above classification, the predominant habitat within the project site and the entire study area is the modified habitat. The indigenous natural vegetation has over the years been largely converted by agricultural related practices such as farming and grazing. Although, there are fallow fields with shrubs and scattered woody vegetation particularly outside the boundaries of the project site, there are however no critical habitat on the project site and the entire study area. The summary of habitat description for the various sampled plots in the entire study area is presented in Table 4.20.

Table 4.20: Habitat Type and Plant Species Composition in the Study Area

Sampling Location (Plots)	Habitat Type/ Description	Plant Species Composition
1	Modified habitat (Cultivated farmland and fallow field)	22 species mixture of herbaceous and woody species. Herbaceous species dominant
2	Modified habitat (Cultivated farmland and fallow field)	24 species mixture of herbaceous and woody species. Herbaceous species dominant
3	Modified habitat (Cultivated farmland)	24 species mixture of herbaceous and woody species. Herbaceous species dominant
4	Modified habitat (Cultivated farmland)	27 species mixture of herbaceous and woody species. Herbaceous species dominant
5	Modified habitat (Cultivated farmland)	33 species mixture of herbaceous and woody species. Herbaceous species dominant
6	Modified habitat (Cultivated farmland)	32 species mixture of herbaceous and woody species. Herbaceous species dominant
7	Modified and Natural habitat (with some natural shrubs)	27 species mixture of herbaceous and woody species. Herbaceous species dominant
8	Modified habitat (Cultivated farmland)	10 species mixture of herbaceous and woody species. Herbaceous species dominant
9	Modified habitat (Cultivated farmland)	23 species mixture of herbaceous and woody species. Herbaceous species dominant
10	Modified habitat (Cultivated farmland)	30species mixture of herbaceous and woody species. Herbaceous species dominant
11	Modified habitat (Cultivated farmland)	21species mixture of herbaceous and woody species. Herbaceous species dominant
12	Modified and Natural habitat (with some natural shrubs)	29species mixture of herbaceous and woody species. Herbaceous species dominant
13	Modified habitat (Cultivated Farmland)	27species mixture of herbaceous and woody species. Herbaceous species dominant
14	Modified and Natural habitat (with some natural shrubs)	23species mixture of herbaceous and woody species. Herbaceous species dominant

Source: GEHS Fieldwork 2015

4.5.6.1.3 Wildlife (Terrestrial Fauna)

A total of 72 species of animals comprising of 26 invertebrates and 46 vertebrates were recorded. Dominant families of the invertebrates with more than one species across all sampled plots were Pyrgomorphidae, Lygaeidae, Nymphalidae and Pieridae which were represented by two species each. For the vertebrates, the dominant families were Columbidae represented by four species, Laniidae and Ploceidae represented by three species each as well as Elapidae, Varanidae, Agamidae, Scincidae, Testudinidae, Phasianidae and Accipitridae represented by two species each respectively. Table 4.21 presents the classification of fauna species in the study area whilst Plate 4.9 shows fauna species encountered during the study.

Table 4.21 (a): Classification of Fauna Species in the Study Area (Invertebrate)

S/N	Phylum	Class	FAMILY	SCIENTIFIC NAME	COMMON NAME	IUCN STATUS
1	Arthropoda	Insecta	Drosophilidae	*Drosophila* sp.	Fruit flies	NE
2	Arthropoda	Insecta	Aerididae	*Ornithocris magnifica*	Cricket	NE
3	Arthropoda	Insecta	Gryllidae	*Gryllopsis nerabillis*	Ground cricket	NE
4	Arthropoda	Insecta	Pyrgomorphidae	*Gastromagus Africana*	Brown grasshopper	NE
5	Arthropoda	Insecta	Pyrgomorphidae	*Zonocerus variegatus*	Variegated grasshopper	NE
6	Arthropoda	Insecta	Kalotermitidae	*Cryptotermes* sp.	Drywood termite	NE
7	Arthropoda	Insecta	Libellulidae	*Grachythemis leuconeura*	Groundlings dragon fly	NE
8	Arthropoda	Insecta	Lygaeidae	*Leptocoris graseiveripis*	Soapberry bug	NE
9	Arthropoda	Insecta	Lygaeidae	*Oncopeltus famelucus*	Milkweed bug	NE
10	Arthropoda	Insecta	Coreidae	*Cletus notatus*	Plainfin midshipman	NE
11	Arthropoda	Insecta	Dermestidae	*Dermestes* sp.	Hide beetle	NE
12	Arthropoda	Insecta	Scarabaeidae	*Anachalcos* sp.	Dung beetle	NE
13	Arthropoda	Insecta	Erebidae	*Diacrisia maculosa*	Moths	NE
14	Arthropoda	Insecta	Noctuidae	*Agrotis spinifera*	African moth	NE
15	Arthropoda	Insecta	Charaxidae	*Charaxes leadice*	Charaxes butterflies	NE
16	Arthropoda	Insecta	Nymphalidae	*Charaxes varanes*	Brushfoots, butterflies etc	NE
17	Arthropoda	Insecta	Nymphalidae	*Amauris niavius*	Common friar	NE
18	Arthropoda	Insecta	Pieridae	*Acraea eponina*	Orange acraea butterfly	NE
19	Arthropoda	Insecta	Pieridae	*Catopsilia florella*	White butterfly	NE
20	Mollusca	Gastropoda	Achatinidae	*Limicolaria flammea*	Garden snail	NE
21	Arthropoda	Insecta	Culicidae	*Aedes* sp.	Aedes mosquito	NE
22	Arthropoda	Arachnida	Trombidiidae	*Trombidium* sp.	Red velvet soil mite	NE
23	Arthropoda	Arachnida	Scorpionidae	*Pandinus* sp.	Black scorpion	NE
24	Arthropoda	Arachnida	Buthidae	*Tityus* sp.	Reddish-brown scorpion	NE
25	Arthropoda	Insecta	Gerridae	*Aquarius paludum*	Pond skater, waterbugs etc	NE
26	Arthropoda	Insecta	Nepidae	*Nepa cinerea*	Water scorpion	NE

Source: GEHS Fieldwork 2015 **KEY: NE – Not Evaluated**

Table 4.21 (b): Classification of Fauna Species in the Study Area (Vertebrate)

S/N	PHYLUM	CLASS	FAMILY	Scientific name	COMMON NAME	IUCN STATUS
				AMPHIBIANS		
1	Chordata	Amphibian	Hyperoliidae	*Hyperolius* sp.	Reed Frog	NE
2	Chordata	Amphibian	Hyperoliidae	*Afrixalus* sp.	Morere's banana frog	NE
3	Chordata	Amphibian	Bufonidae	*Bufo regularis*	Toad	LC
4	Chordata	Amphibian	Ranidae	*Dicroglossus occipitalis*	African Bullfrog	NE
5	Chordata	Amphibian	Pipidae	*Xenopus* sp.	Clawed frog	NE
				REPTILES		
6	Chordata	Reptila	Colubridae	*Natrix* sp.	Brown water snake	NE
7	Chordata	Reptila	Elapidae	*Naja melanoleuca*	Black cobra	NE
8	Chordata	Reptila	Elapidae	*Dendraspis* sp.	Green mamba	NE
9	Chordata	Reptila	Viperidae	*Bitis arientans*	Puff adder	NE
10	Chordata	Reptila	Varanidae	*Varanus niloticus*	Nile monitor lizard	NE
11	Chordata	Reptila	Varanidae	*V. exanthamaticus*	Bosc's monitor lizard	NE
12	Chordata	Reptila	Agamidae	*Agama sakaranica*	Senegal agama	NE
13	Chordata	Reptila	Agamidae	*Agama agama*	Rainbow lizard	NE
14	Chordata	Reptila	Scincidae	*Mabuya* sp.	Mabuya skink	NE
15	Chordata	Reptila	Scincidae	*Scincopus fasciatus*	Banded skink	DD
16	Chordata	Reptila	Chamaeleonidae	*Chamaeleo basiliscus*	Chameleon	NE
17	Chordata	Reptila	Trionychidae	*Trionyx* sp.	Soft-shelled turtle	NE
18	Chordata	Reptila	Testudinidae	*Centrochelys* sp.	African spur toitoise	NE
				BIRDS (AVES)		
19	Chordata	Aves	Musophagidae	*Crinifer piscator*	Grey Plantain eater	LC
20	Chordata	Aves	Ardeidae	*Ardea* sp.	Heron	NE
21	Chordata	Aves	Laniidae	*Corvinella* sp.	Shrikes	NE
22	Chordata	Aves	Laniidae(shrikes)	*Eurocephalus* sp.		NE
23	Chordata	Aves	Laniidae(shrikes)	*Lanius* sp.		NE
24	Chordata	Aves	Phasianidae	*Francolinus bicalcaratus*	Bush fowl	LC
25	Chordata	Aves	Phasianidae	*Ptilopachus petrosus*	Stone partridge	LC
26	Chordata	Aves	Falconidae	*Milvus migrans*	Black Kite	LC
27	Chordata	Aves	Accipitridae	*Kaupifalco monogrammicus*	Lizard buzzard	LC
28	Chordata	Aves	Accipitridae	*Elanus caerulus*	Black-Winged Kite	NE
29	Chordata	Aves	Ardeidae	Cattle Egret (*Bulbulcus ibis*)	Cow crane, cow bird	LC
30	Chordata	Aves	Columbidae	*Columba guinea*	Speckled Pigeon	LC
31	Chordata	Aves	Columbidae	*Streptopelia semitorquata*	Red-eyed Dove	LC
32	Chordata	Aves	Columbidae	*Streptopelia decipiens*	Mourning Dove	LC
33	Chordata	Aves	Columbidae	*Streptopelia senegalensis*	Laughing Dove	LC
34	Chordata	Aves	Coraciidae	*Coracias abyssinicus*	Abyssinian Roller	LC
35	Chordata	Aves	Apodidae	*Apus apus*	Common Swift	LC
36	Chordata	Aves	Ploceidae	*Ploceus nigricollis*	Black-necked Weaver	LC
37	Chordata	Aves	Ploceidae	*Ploceus cuculatus*	Village Weaver	NE
38	Chordata	Aves	Ploceidae	*Euplectes* sp.	Northern Red Bishop	NE
39	Chordata	Aves	Strigidae	*Ptilopsis leucotis*	White-faced owl	LC
40	Chordata	Aves	Cuculidae	*Centropus senegalensis*	Senegal Coucal	LC
41	Chordata	Aves	Psittacidae	*Poicephalus senegalus*	Senegal parrot	LC
				MAMMALS		
42	Chordata	Mammalia	Sciuridae	*Xerus erythropus*	Striped *ground squirrel*	LC
43	Chordata	Mammalia	Muridae	*Mus* sp.	Rats	LC
44	Chordata	Mammalia	Nesomyidae	*Cricetomys gambianus*	Gambian pouched rat	LC
45	Chordata	Mammalia	Erinaceidae	*Atelerix* sp.	Hedgehog	LC
46	Chordata	Mammalia	Bovidae	*Modoqua* sp.	Dik-dik	NE

Source: GEHS Fieldwork 2015 KEY: NE – Not Evaluated; LC – Least Concern; DD – Data Deficient

- **Conservation Status and Threats to Wildlife in the Study Area**

Most of the animal species recorded in the study area have not been evaluated or are of least concern according to the IUCN Red List of threatened species (Table 4.21). However, 3 animal species listed as threatened by the Endangered Species (Control of International Trade & Traffic) Act No. 11 of 1985, were identified. These included Heros (*Ardea sp*), Family Ardeidae; Bosc's monitor lizard (*Varamus eamthematicus*), Family Varanidae; and Black kite (*Milvus migrans*), Family Falconidae. It was also observed that every other fauna species in the study area are threatened by habitat destruction and poaching.

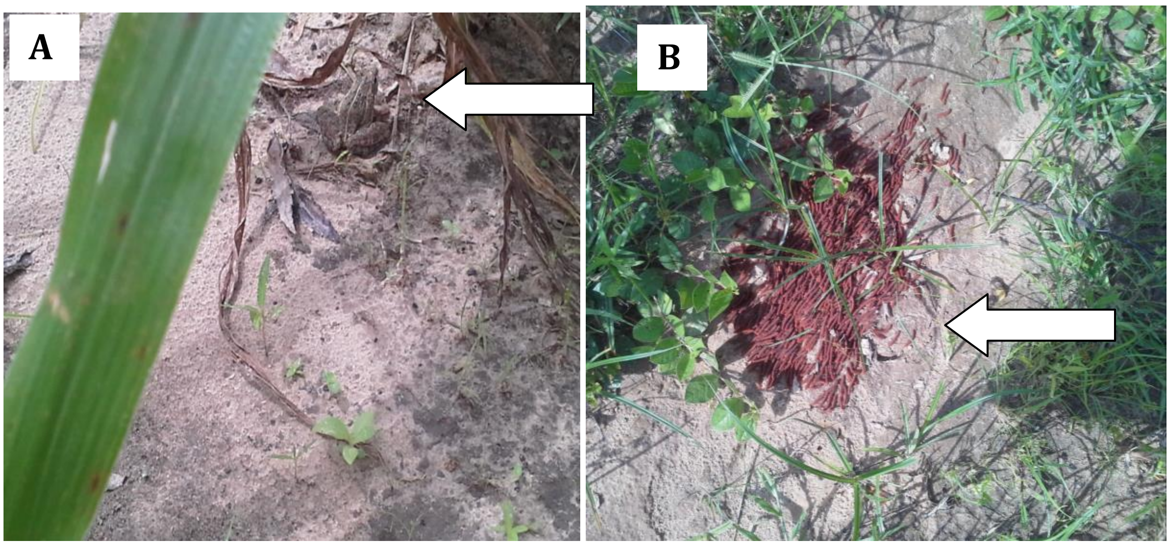

Plate 4.9: Fauna Species (A: Frog, B: Millipede) observed in the Study Area

4.5.6.1.4 Ecosystem Services

Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems; e.g food, freshwater, timber, fibers, medicinal plants. (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; e.g carbon storage and sequestration, climate regulation, protection from natural hazards. (iii) cultural services which are the nonmaterial benefits people obtain from ecosystems; e.g sacred sites and areas of importance for recreation and aesthetic enjoyment. (iv) supporting services, which are the natural processes that maintain the other services; e.g soil formation, nutrient cycling, primary production. The natural vegetation in the study area provides many benefits to the host communities. These are discussed in the following section.

- **Plant Species of Economic Importance (Provisioning Services)**

The study area host plant species that provide provisioning services and are of economic importance. For instance the woody species in the area provides wood which is a versatile raw material, which has a variety of uses in many labor-intensive industries such as sawmills, ply mills, industrial/residential construction, and furniture manufacture. More importantly, for the host community, wood forms the principal cooking fuel. The availability of fuel wood is a key factor in the life of the people. Plant species of *Acacia albida* and *Piliostigma reticulatum* form good fodder, fuel wood *and* industrial raw material.

In addition to wood, there are other non-wood components of the natural vegetation that are critical for survival in the study area. Members of the host communities rely on the leaves and barks of trees such as *Azadirachta indica* (Neem tree) for the treatment of malaria. Herbaceous species found in the area for instance *Senna obtusifolia* have also been found to provide good remedy for the treatment of ailments like typhoid. The seed of *Parkia biglobosa* is used to prepare a local seasoning (*dawadawa*) which is still a veritable delicacy for most rural communities. Similarly, Shea butter a major ingredient in most creams and soap is derived from the Shea butter tree (*Vitellaria paradoxa*). The bark of Acacia *senegal* produces gum arabic which is used in the manufacture of writing ink, hair glazing cream, mucilages for pharmaceuticals, and glues in plywood industries. Due to the multiplicity of the industrial products that can be obtained from it, the Federal Government of Nigeria (FGN) in 1993, through the Accelerated Industrial Crops Production Programme showed a renewed interest in promoting the production of *Acacia senegal* (Mokwunya and Aghughu, 2010). Through this programme, government agencies were funded to produce over 2million seedlings of *Acacia senegal* as planting materials between 1995 and 2009. Table 4.22 gives a summary of plant species of economic importance in the study area, while Plate 4.10 shows one of the plant species of importance in the study area.

Table 4.22: Plant Species of Economic Importance in the Study Area

S/N	Family	Species	Habit	Common Name	Local Name	Economic Importance/ Local Use
1.	Fabacea	Acacia senegal	Tree	Gum Arabic	Bagaruwa	Produces gum for manufacture of ink, hair glazing cream, mucilages for pharmaceuticals and glue
2.	Fabaceae	Acacia albida	Tree	Paperback tree	Gao	Tanin which is a raw material for many industries
3.	Sapotaceae	Vitellariaparadoxa	Tree	Shea butter	Kadanya	Formulations in many creams and soap
4.	Meliaceae	Azadirachta indica	Tree	Neem	Bedi	Used for the treatment of malaria
5.	Fabaceae	Senna obtusifolia	Forb/herb	Chinese senna, American siclepod	Tafasa	Provides good remedy for treatment of ailments like typhoid
6.	Fabaceae	Parkia biglobosa	Tree	Locust bean tree	Dorowa	Used to prepare local seasoning

Source: GEHS Fieldwork 2015

Plate 4.10: *Azadirachta indica* Plant Specie with antimalaria properties in the Study Area

- **Plant Species of Traditional & Cultural Significance**

Apart from the recreational benefits provided by natural vegetation in general, members of the host communities have spiritual/religious attachments to some species in the study area. For instance, the fruit of the Date palm, Phoenix dactylifera. This plant, belonging to the family Arecaceae has a lot of traditional and cultural significance. It has been in cultivation since 6000BC. It was mentioned more than 50 times in the Bible and more than 20 times in the Quran. In Islamic culture, the date fruit is the first food consumed after sunset during Ramadan. Plate 4.11 shows the Date palm plant species in the study area.

Plate 4.11: The Date Palm Plant Species in the Study Area

- **Animal Species of Economic Importance**

Natural vegetation provides habitat for a great variety of animals which are of economic and aesthetic value. Many members of the host community depend on wild animals as their main source of animal protein. Apart from their aesthetic value and source of protein, the skin of some of the species are raw materials for the hide and skin Industries. These are:
Black cobra, *Naja melanoleuca*; Green mamba, *Dendraspis* sp; and Puff adder, *Bitis arientans.*

4.5.6.1.5 Invasive Species

There are so many definitions of the term invasive species. Classically the term refers to new/introduced alien species that become the dominant species in the new environment.
The term invasive also includes plant species that have been accorded "noxious weed" statues. In this category are:

- *Commelina difusa:* Is a spreading colonizing weed of orchards belonging to the family Commmeliaceae. It causes extensive yield loss and is very difficult to manage Significant presence of this species was observed in plots 6 and 12.
- *Commelina africana*: Is a colonizing weed of most cultivated fields. It is a very fast growing weed and difficult to control. Significant presence was observed in plots 4,5,10 and 11.

- *Striga asiatica* observed growing on farmlands is an obligate parasite of crops such as sorghum, cowpea, maize, etc. This plant parasite belonging to the family Scruphulariaceae is one of the major causes of yield loss in these crops (Hautier et al. 2010).

4.5.6.1.6 Major Conservation Areas

The study area is not situated in a main conservation or protected area. Vegetation of ecological and conservation importance were typically rare as vegetation were predominantly composed of scattered trees, cultivated farmlands and grasses.

4.5.7 Land Use/Land Cover

This section discusses the existing land use/land cover in the study area as obtained using 5 m-resolution multispectral SPOT 5 and 30 m-resolution multispectral Landsat 8 satellite images (see 4.3.3.2). The SPOT 5 satellite image of the project AoI (study area) and proposed project site is shown in Figure 4.17 while Figures 4.18 and 4.19 show the land use distribution within the AoI and the proposed project site.

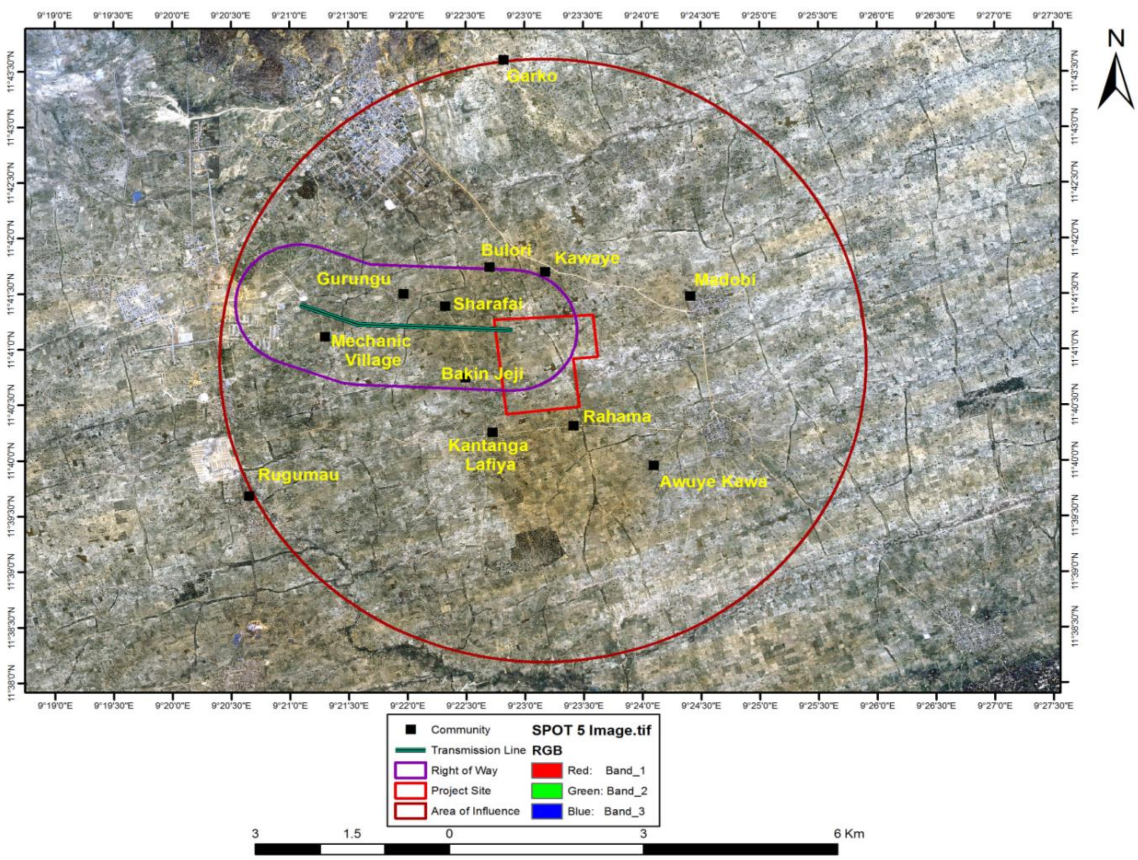

Figure 4.17: SPOT 5 Image showing the Project Area of Influence (Study Area) and Proposed Project Site

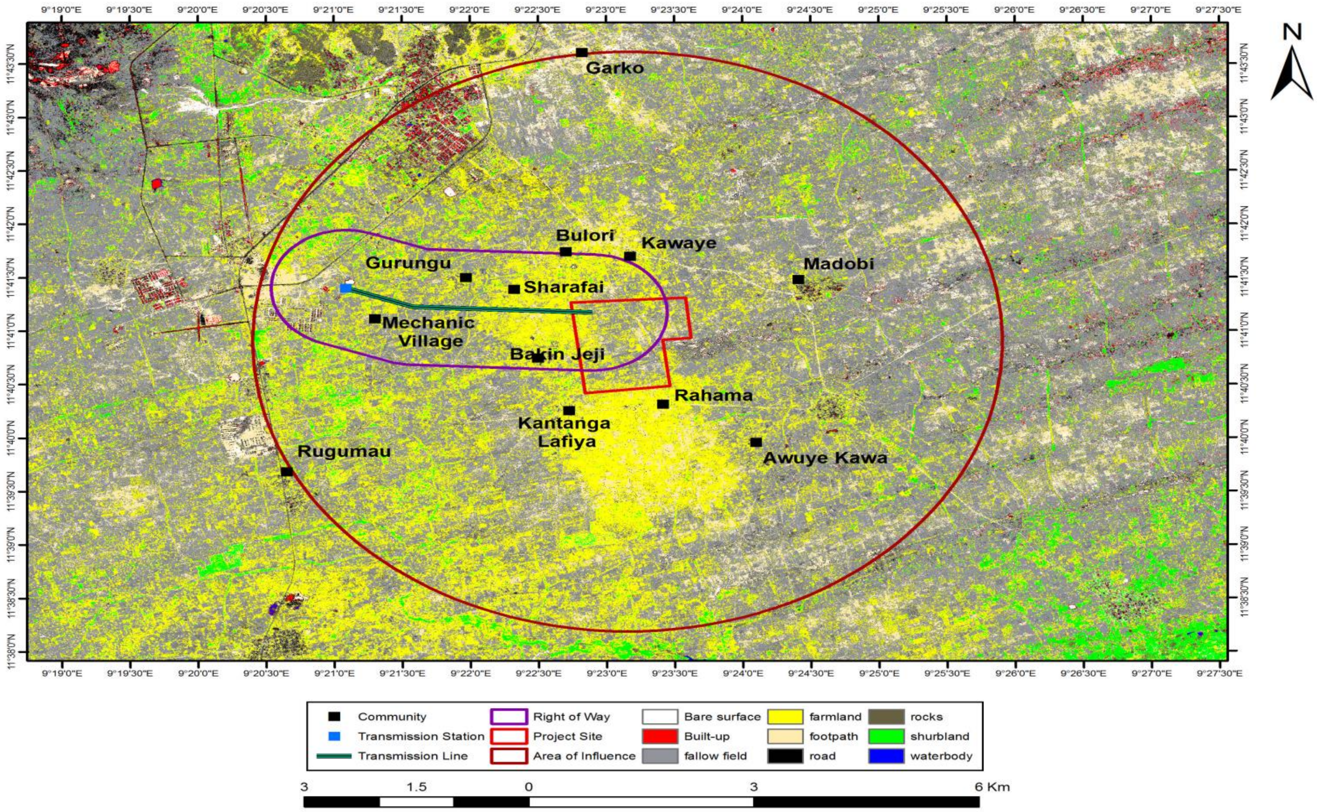

Figure 4.18: Land Use Distribution within the Project Area of Influence (Study Area)

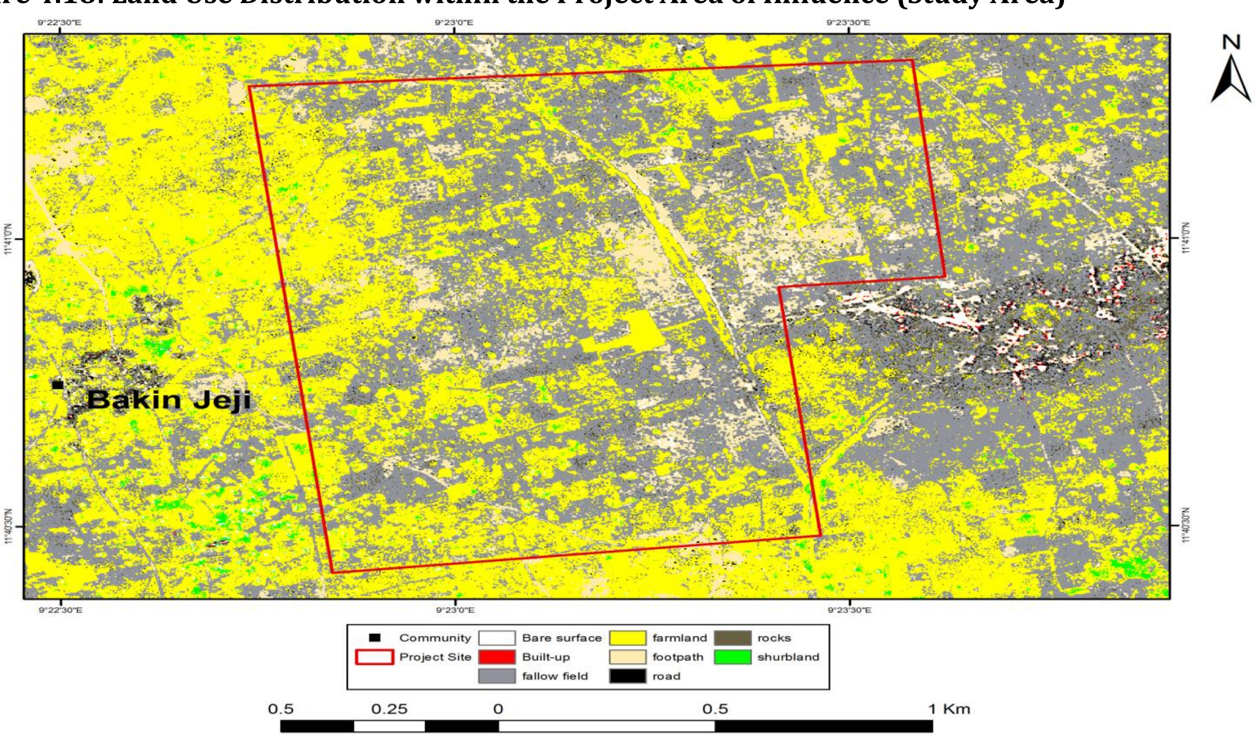

Figure 4.19: Land Use Distribution within the Proposed Project Site

The SPOT 5 classified image shows that the total land cover area for the study area is estimated at 7820.2 ha. It also identified nine land use/land cover classes in the study area and eight classes in the proposed project site. The statistical details of the area covered by each land use class within the study area and proposed project site are presented in Table 4.23.

Table 4.23: Area covered by land use classes within the Study Area (AoI) and Proposed Project Site

Land Use class	Study Area (AoI)		Proposed Project Site	
	Area(ha)	% Cover	Area(ha)	% Cover
Fallow Field	3596.25	45.986	83.0388	40.937
Bare Surface	119.781	1.531	2.30063	1.134
Built-up	42.6206	0.545	0.018125	0.0089
Farmland	2685.82	34.344	86.4913	42.639
Footpath	734.588	9.393	24.2106	11.935
Road	103.188	1.319	0.908125	0.447
Rocks	333.345	4.262	5.0125	2.471
Shrub Land	203.042	2.596	0.86375	0.425
Water Body	1.5325	0.019	-	-
Total	**7820.1671**		**202.84383**	

Within the proposed project site, the predominant land use classes are farmland and fallow field. Farmland covers an estimated 86.49 ha, representing 43% of the total area covered by the proposed project site. Fallow field covers an estimated area of 83.039 ha, representing 41% of the total proposed project site area. Built-up area constitutes the least land use area covered within the project site at 0.01% of the proposed project site area. Water body class is not represented within the site. The footpath class represents the major route network within the project site with roads contributing to less than 1ha.

The predominant land cover within the study area is fallow field, which covers about 46% of the total area. This is followed by farmland, representing approximately 35% of the total area. The least land cover type observed in the area is water body, which covers an estimated 0.02% of the study area. The land use distribution and percentage cover in the study area is depicted in Figure 4.20.

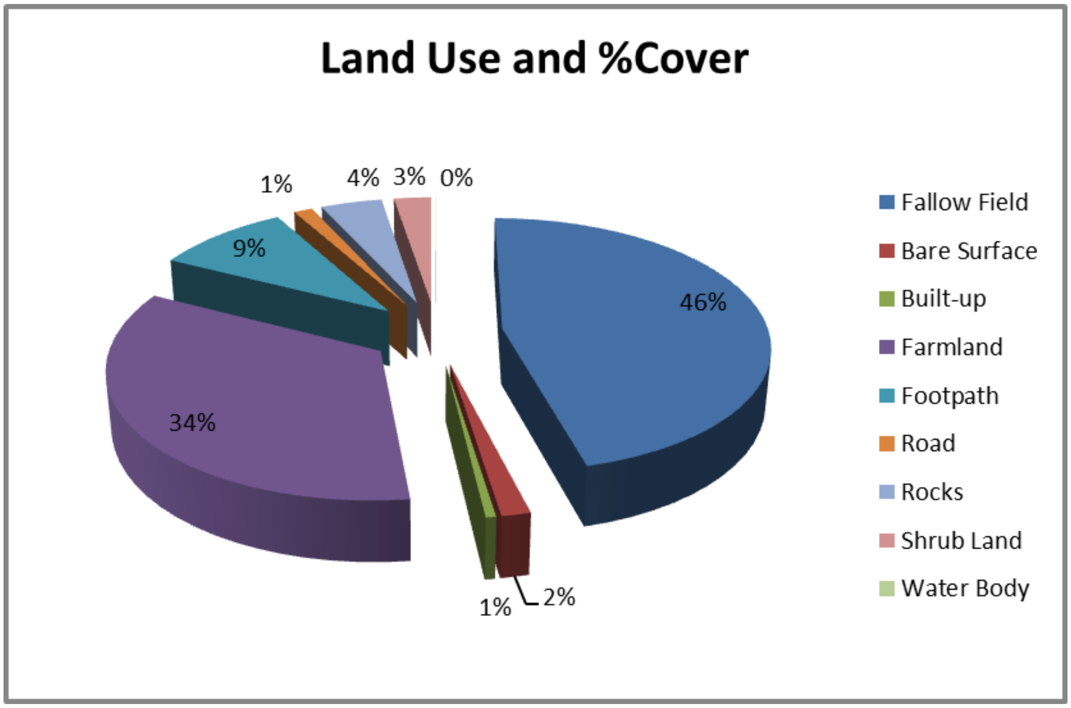

Figure 4.20: Land Use Distribution and Percentage Cover in the Study Area

The land use pattern in the study area is described and discussed below:

Fallow field

A fallow field is a farm area that a farmer does not cultivate to allow for recovery or has not been attended to for cultivation. Land use analysis revealed that fallow land is the predominant land cover in the study area covering approximately 3,595 ha constituting about 45% of total area under consideration. This area comprises mainly grasses and low shrubs with scattered woody vegetation.

Bare Surface

This is an area comprising of soil surface that are not covered by vegetation, gravel, artificial turf or similar covering. Bare surface constitute about 119 ha of land corresponding to less than 2% of land mass in the study area. Bare surface in the area include open spaces, bald soil patches, borrow areas and some footpath.

Built-up Area

Built-up areas comprise settlements, town concentrations, rural and urban residential sites. There are about 14 human settlements within the study area and they include Awuye Kawa, Rahama, Katangar Lafiya, Bakin Jeji, Sharifai, Madobi, Kawaye, Bulori, Gurungu, Garko, Rugumau and the Mechanic Village. In addition, there are other visible developments within the area including the new Federal Univerisity Dutse, Dutse substation and the offices of the Joint Admission and Matriculation Board (JAMB) and the Nigeria Security and Civil Defense Corps (NSCDC). The location of all human settlements and facilities in the study area are presented in Figure 4.21. Land use analysis however revealed that built-up area covers approximately 43 ha constituting less than 1% of the land mass that falls within the study area. This suggests that the area is largely rural and underdeveloped with scattered human dwellings between large farmlands and fallow lands. The nearest settlement to the project site is about 200m away.

Farmland

A farmland is a piece of land used for agricultural purposes. The land use analysis revealed that farmland within the project area of influence covers approximately 2,685 ha constituting about 34% of the total land use in the area. This figure suggests that farmland is the second most predominant land cover in the area. This is consistent with baseline survey which revealed that farming is the major occupation of inhabitants of the area and the area is characterized predominantly by cultivated farmlands. The predominant crops cultivated in these farmlands are legumes including millets, ground nuts, sorghum and maize which are grown primarily for their food grain seed.

Footpath

Footpath covers an approximately 735 ha of land constituting about 9% of total land cover in the study area. The area is largely rural with numerous footpaths traversing human settlements and farmlands in the area. These footpaths are used to a large extent for transportation with the aid of motorcycle and cow-carts which serve as the major means of transportation in the area.

Road

Access road to the project site and human settlements within the study area are sandy and narrow, specifically less than 4 meter wide. These roads are largely unsuitable for vehicles thus constraining transportation to the use of motorcycle and cow-carts as stated above. This is consistent with the land use analysis which revealed that roads in the area covers approximately 103 ha constituting about 1% of the 7,820 total land surveyed as the study area.

Rocks

Rocks are described as solid aggregate of one or more minerals or mineraloids. The result of land use analysis of the project AoI revealed that rock outcrops are scattered across the area covering a total land mass of 333 ha constituting about 4% of the total land mass surveyed. This is consistent with the topography of Dutse town which is close to the boundaries of the study area which derived its name from the numerous hilly rocks which covering an area of about 5 square miles in the Dutse Emirate. Dutse is a Hausa word denoting “Rock”. It is instructive to note however, that there are no visible rock outcrops within the project site.

Shrub Land

The area occupied by shrub according to the land use analysis is approximately 203 ha constituting about 3% of the 7,820ha surveyed as study area. Some of the dominant vegetation observed in the area during baseline survey includes *Setaria pallid fusca, Chloris gayana, Digitaria exiles, Eragrostis atrovirens, Cynodon dactylon, Urelytrum gigantium.*

Water Body

The analysis of land use in the area revealed that there is zero percent water body in the entire area under survey. This is consistent with ground truthing findings and baseline field survey which equally revealed that there is no surface water body in the study area.

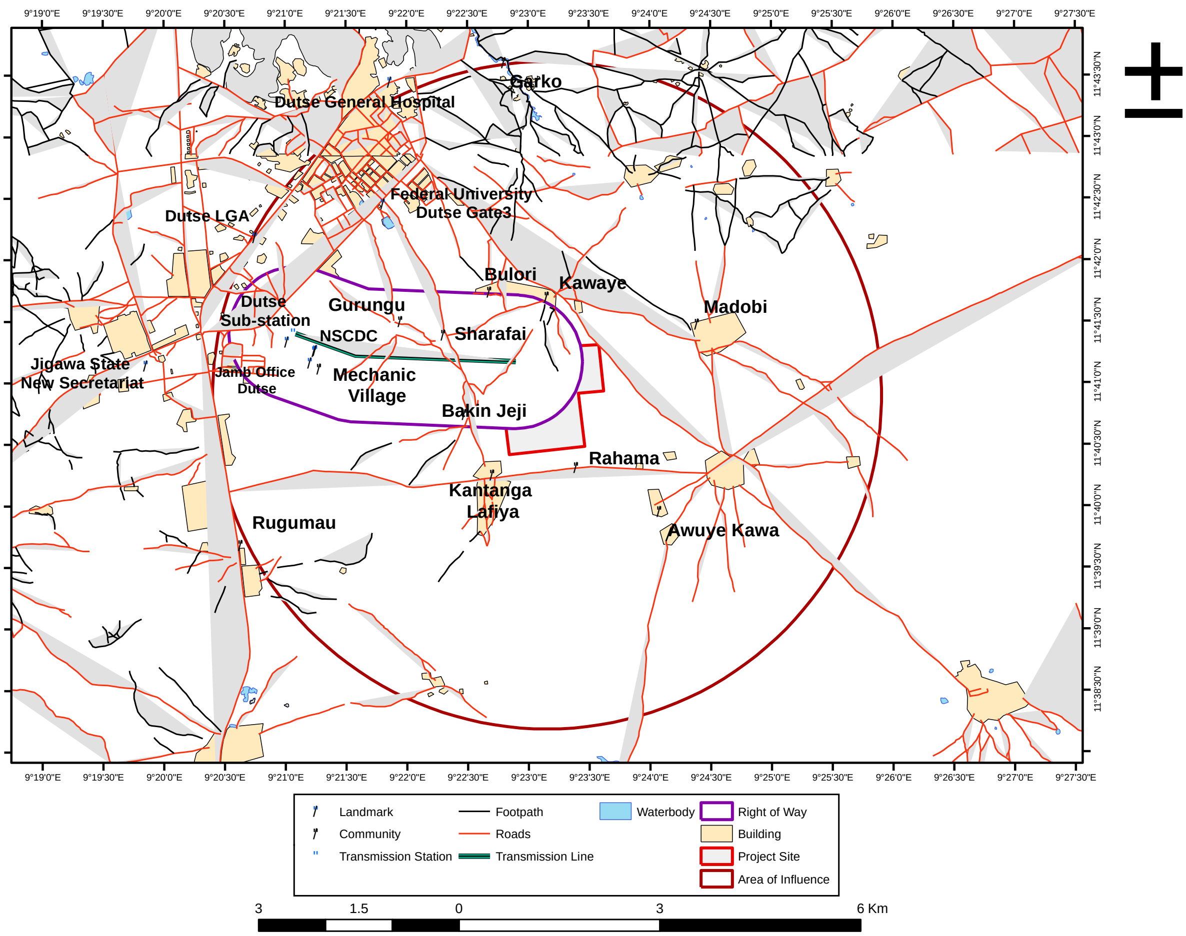

Figure 4.21: Map showing Location of all Human Settlements and Facilities in the Study Area

4.5.7.1 Engineering Constraints in the Study Area

Constraint mapping of the study area is the process of identifying the various landforms and existing infrastructure that may constitute constraints to the development of the proposed project. The landforms and infrastructure that may constitute constraints to the implementation of the project include the following:

a. Flood zones/Drainage Area
b. Protected trees/vegetation
c. Archeological sites
d. Heritage sites

e. Buildings/structures
f. Rock outcrop
g. Path/roads
h. Railway
i. Any buffer zones or setbacks

The derivation of the constraint map considered the information generated through the land use mapping of the entire study area i.e. 5 km AoI. In addition, the results obtained from the field survey of the proposed project site provided additional information in verifying the land use information obtained from remote sensing and the information that could not be ascertained from remote sensing.

The study area comprises the project site and a 15m buffer round the proposed transmission line (the transmission route). The study area is predominantly characterized by fallow land and farmlands interspersed with bare surfaces, shrubs and footpaths. There are no landform obstructions such as rock outcrops, water bodies or rivers, protected forests and built-up areas. However, there is scanty distribution of rocky ground amongst the fallow areas. In addition, there are no heritage and cultural sites located within the project site or in proximity to the transmission route as observed during the site visit.

An assessment of the land use, landform and the existing infrastructure within the project site and 15 meter buffer of the proposed transmission route indicate that the only set of constraints to the implementation of the project are roads and footpaths that cross the transmission route and the proposed project site. Figure 4.22 shows the constraint map of proposed project site and RoW.

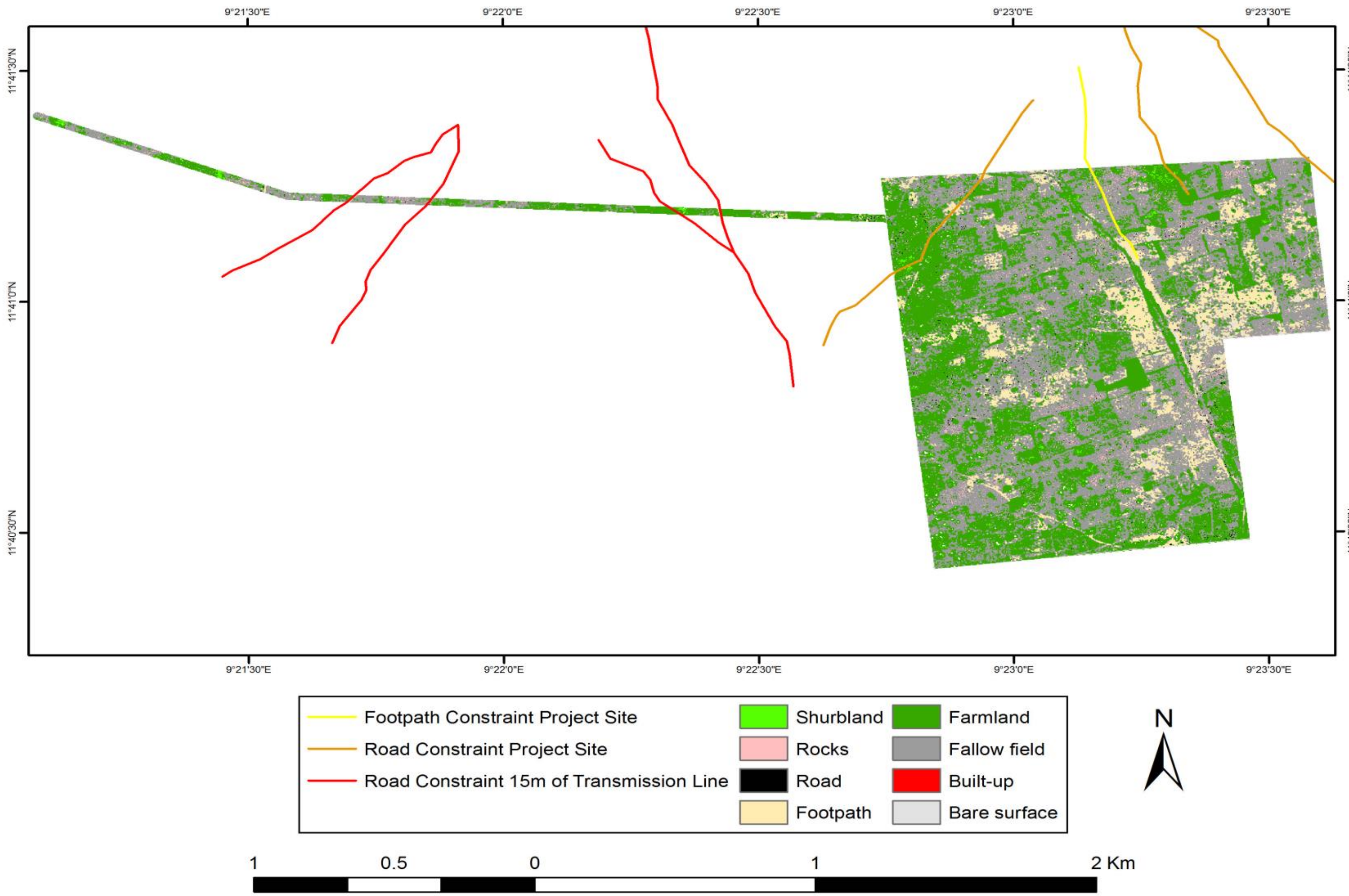

Figure 4.22: Constraint Map of Proposed Project site and RoW

4.5.8 Socioeconomics

4.5.8.1 Historical Overview of Project Location

The proposed project area is located near Dutse town in Dutse LGA of Jigawa state which is also within the Dutse emirate. Dutse is an Hausa word denoting "Rock". It therefore, derived its name from the hilly rocks, which encircled the town of Garu {the headquarters of the Emirate} and its environs covering an area of about 5 square miles. Dutse also happens to be the capital city of Jigawa State Nigeria since August 1991 when the State was created.

4.5.8.2 Community Structure/Administration

There is a homogenous traditional administrative system in the villages that make up the study area. The Emir is Head/Chairman of the Dutse emirate council and is supported by Councilors, District Heads, Village Heads and Ward Heads as depicted in Figure 4.23.

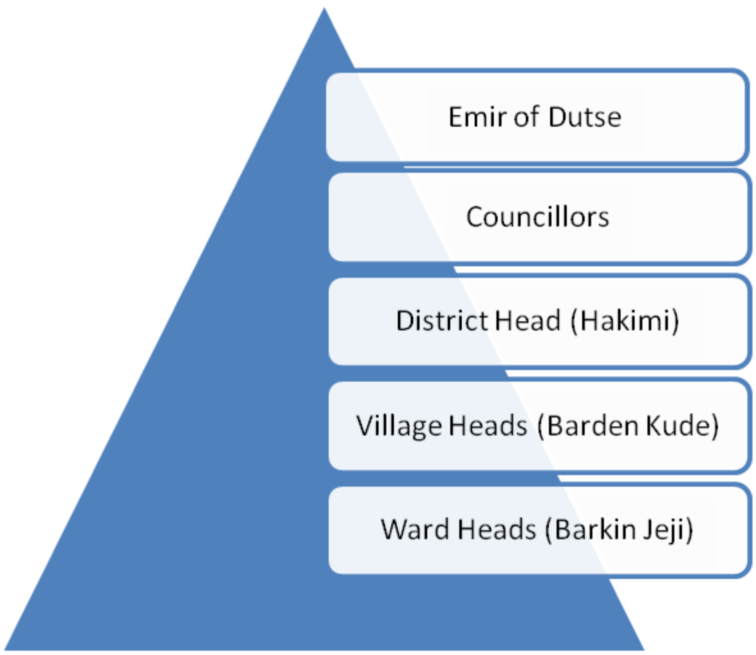

Figure 4.23: Organogram of Administrative Hierarchy in the Study Area

Ward Heads adjudicate on cultural and civil matters that are within their ward purviews. This includes hearing and settling of disputes and non-criminal cases. Issues that are not satisfactorily resolved at the ward level is taken to the Barden Kude (Village Head). In the event that any matter is beyond the Barden Kude, or parties disagree with the judgment of the Barden Kude, the matter goes to the Hakimi (District Head). It is only when a case is not resolved by the district head that it goes to the Emir and his cabinet Counselors.

Ceremonially, the Emirate is the first port of call for prime guests to the Dutse Emirate. Governors, Ministers and Investors usually pay courtesy visits to the Emir as a mark of honour and to inform him of their intention, thereby receiving not only his royal blessings but also relevant information about the people and culture.

4.5.8.3 Demographic Characteristics

- **Population Size**

The total population of the study area is estimated at 5,180. This is based on household count survey carried out during the study. The disaggregated population of the villages/settlements and their location coordinates are given in Table 4.2

- **Gender Composition of Respondents**

The ratio of male to female respondents is 73:31. This representation can be adjudged to be reasonably gender fair on the consideration that females in the study area are culturally restrained from public accessibility. A method whereby our female survey team members had to penetrate the female occupied households was deployed to ensure that the opinions of the female gender were captured.

- **Age of Respondents**

The respondents are all full grown adults with least age of 18 years and highest age of 64 years. Majority of the respondents are between 20 and 44 years old. Table 4.24 presents the age distribution of respondents in the study area and is complemented by Figure 4.24 for graphic illustration.

Table 4.24: Distribution of Age of Respondents in the Study Area

Category	Frequency	Percentage (%)
>17<20	8	7.7
20-24	13	12.5
25-29	19	18.3
30- 34	16	15.4
35- 39	12	11.5
40 – 44	15	14.4
45 – 49	4	3.9
50 – 54	11	10.6
55-59	3	2.9
60 – 64	3	2.9

Source: GEHS Fieldwork 2015

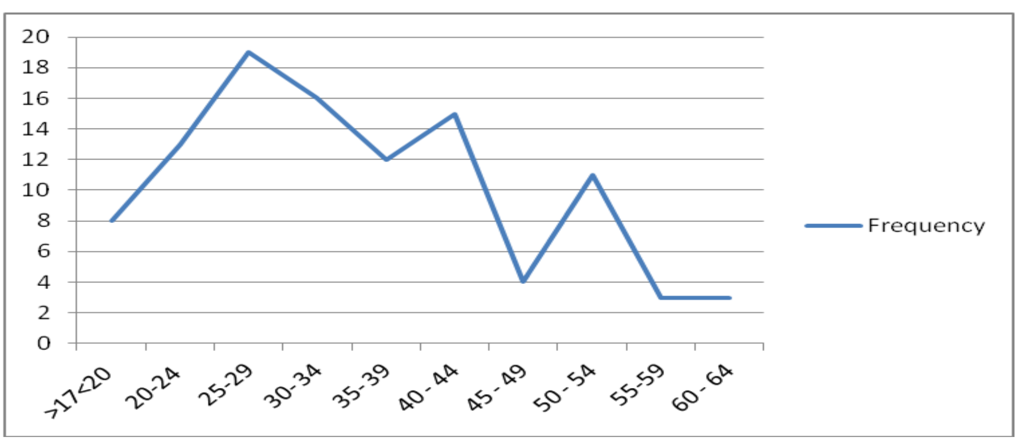

Figure 4.24: Age Grouping and Pattern of the Respondents in the Study Area

- **Marital Status**

Apparently, the sampled respondents are dominated by married persons. Figure 4.25 indicates that 97% of the respondents are married while 3% are single. There were no widows and divorced persons among the respondents. The dominance of married persons relative to singles is not quite a surprise phenomenon because people of the study area are known for early marriages. Given the age threshold of the respondents, it is expected that most of the people would be married.

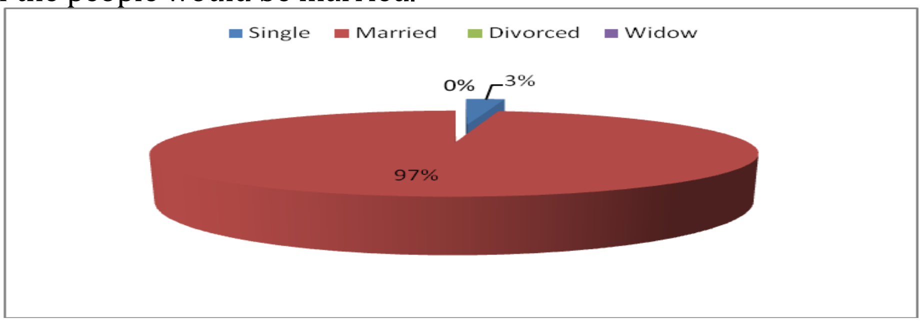

Figure 4.25: Marital Status of Respondents in the Study Area

- **No of Wives and Household Size**

Men in the study area marry between one and four wives. Figure 4.26 reveals that 46% of the married men have more than one wife, while 54% are monogamists. The proportion of persons with two wives is 36%; those with three wives are 6% while those with four wives constitute 4%.

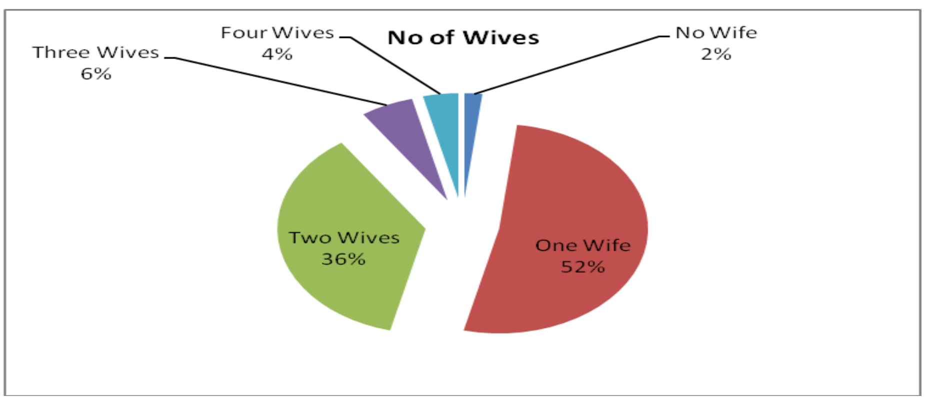

Figure 4.26: Pattern in the Number of Wives in Households of the Study Area

Overall, the proportion of polygamy to the total number of married persons in the study area is 46%. The consequence of this is reflected in the large number of children in many of the households as shown in Table 4.25 and depicted in Figure 4.27. About 16% of the households have 1 to 3 children, while about 10.6% have about 19 children or more. Majority of the people in the project area are found to be those with 4 to 6 children and 7 to 9 children which account for 22% and 24% respectively. When taken into account the relatively low income status of the residents of the study area, it will be arguably reasonable to state that a household of more than three children is in the threshold of large family size. Therefore, the proportion of households with large number of children is very significant and sums up to 84%.

Table 4.25: Number of Children in Households in the Study Area

Category	Frequency	Percentage (%)
One –Three	17	16.3
Four –Six	23	22
Seven – Nine	25	24
Ten – Twelve	12	11.5
Thirteen – Fifteen	7	6.7
Sixteen –Eighteen	9	8.7
Nineteen +	11	10.6

Source: GEHS Fieldwork 2015

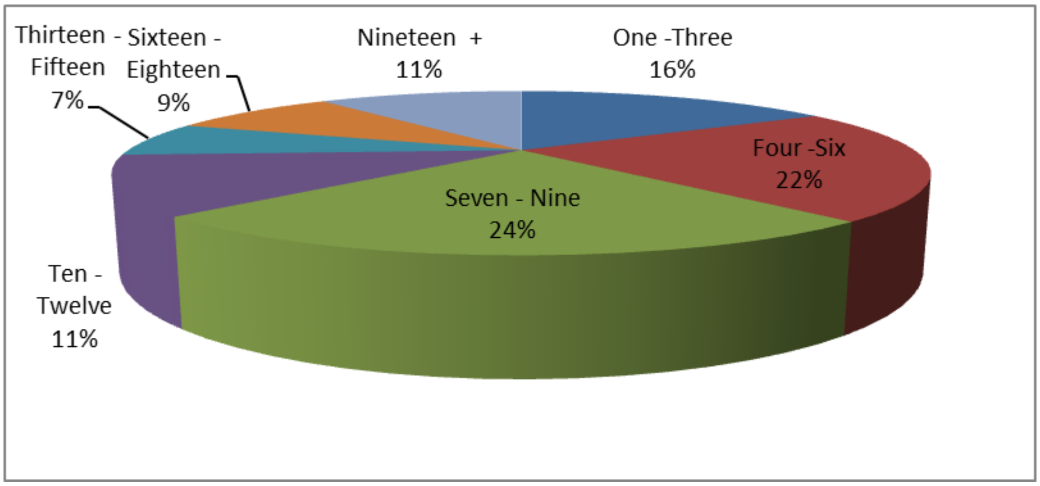

Figure 4.27: Distribution of Number of Children in Households in the Study Area

Similarly, it was found that 648 children were born in 101 married households in this survey, which implies an average of 6 children per household. Absolute poverty, sickness and spread of diseases are likely to brew should this reproduction trajectory remain constant without improvement in infrastructure and livelihood.

- **Age Category in Households**

Figure 4.28 below indicates the age categories of household members in the study area. The blue line represents male gender results while the red line is for the female gender. The trend shows that the population of younger generations is growing faster and higher than those of the older generation. For example, children 0-4 years are more in number and accounts for 21.7% of the total household population; followed by those within 5-9 years (16.8%). On the other hand, persons from 55 to 65 years and above are relatively small. The table shows that household members within 50-54 years are 16 representing 1.5%. Those that are within 55-59 years are 8 or 0.75%, while the population of persons within 60-64 years is 6 representing 0.56%.

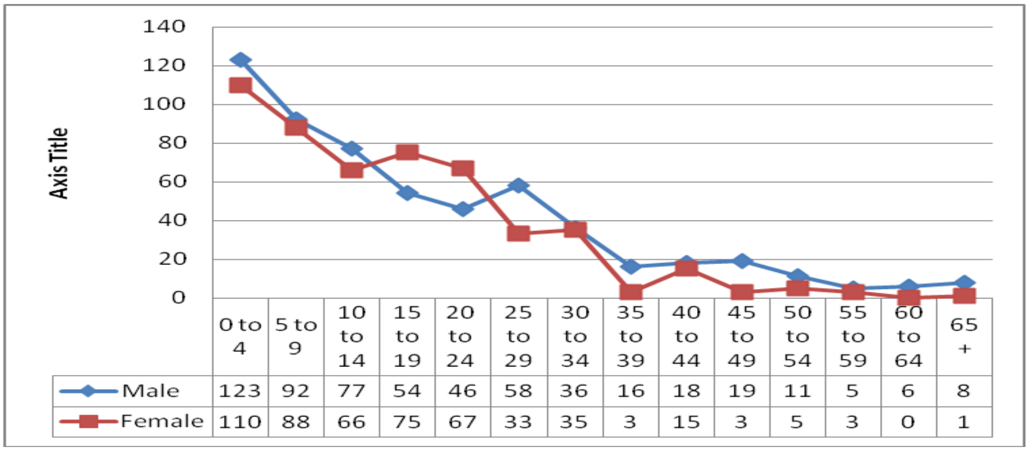

Figure 4.28: Age Category in Households in the Study Area

- **Vulnerable Groups**

These are persons and groups that will be more adversely affected than others by the project activities as a result of physical disability, age, cultural constraints and /or economic disadvantage. In this case, mitigation measures tailored to addressing adverse impacts at broad levels may either not adequately restore their livelihood or they may be denied of the mitigation measures/compensation due to their state of vulnerability. This group includes women, aged persons (60 years and above), orphans, physically disabled persons and the extreme low income people. This study however revealed that women are culturally not permitted to engage in public discussion even at focus group level. The study team however, obtained relevant information from them at their respective household levels by engaging female Hausa speaking field workers.

The field survey revealed that there are quite a number of vulnerable persons within households in the study area. In sum, about 89 vulnerable persons were recorded. This includes 52 males and 37 females. The category of vulnerability includes those above 60 years old, orphans, unemployed and persons physically disabled as depicted in Figure 4.29.

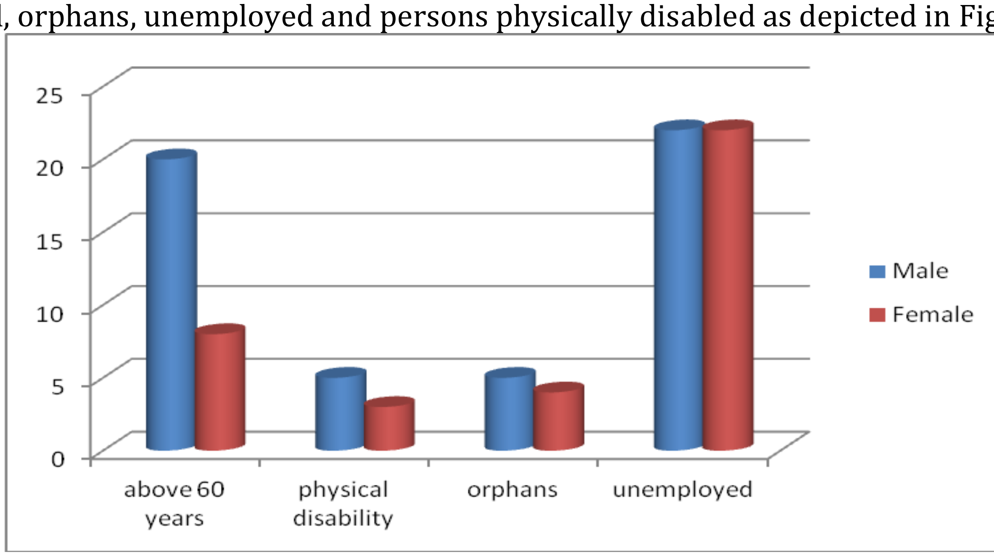

Figure 4.29: Distribution of Vulnerable Persons in the Study Area

The importance of the information on the vulnerability status of households in the proposed project community is amongst other things, to take this group into cognizance in project planning and implementation. For example, during payment of compensation or provision of employment, members of the vulnerable group may be disadvantaged to access the opportunities due to their respective vulnerability conditions; but special attention can be paid to them to ensure that they have equal access/benefit with others that are not vulnerable. They are also more vulnerable to diseases and injuries.

- **Religion**

The religion practiced in the study area is dominantly Islam. Figure 4.30 gives a graphic reflection of the predominant Muslim faith configuration in the project area.

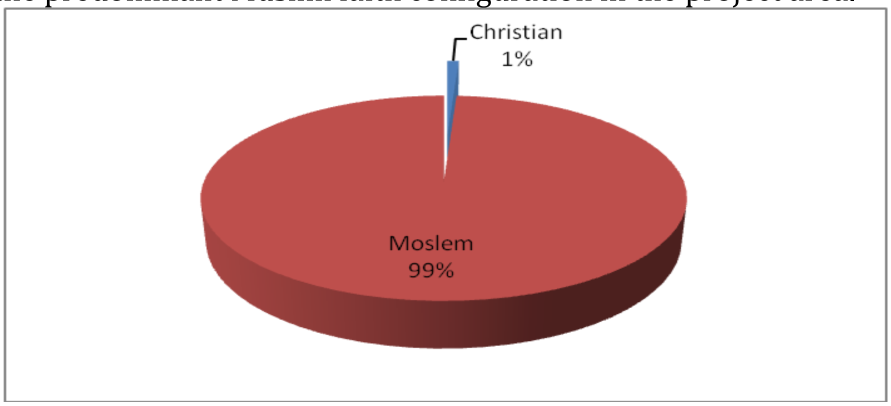

Figure 4.30: Religious Background of the Study Area

- **Local Culture, Customs and Festivals**

The people of the project area are known for amiability and respect for elders which is enshrined in their culture. They speak Hausa language and are predominant muslims. The women dress in Hijab which is a form of dressing in which the entire body from the head to legs are covered. The staple food of the people of the project area are 'Tuwo' (corn millet), and 'Tuwon-Shinkafa' (rice millet). These foods are accompanied with Hausa soup delicacies such as *Miyan-kubewa* and *Miyan-taushe*. Eid-el-Fitr and Eid-el-Kabir and the Gani (Durbar) celebrations are the widely religious and cultural celebrations witnessed in the study area. Eid-el-Fitr and Eid-el-Kabir celebrations are Muslim festivals. Gani (Durbar) festival is celebrated annually; and dates back to 14 century when horses assumed an important role in the history of Hausa states.

- **Educational Status**

The survey sought to investigate education attainment in the study area because this is important for several reasons. It helps to describe in partial terms the reasons for the nature of livelihood in the study area and of course, explains the probable reasons behind the income level and per capita of the people of the area. In other hand, it also plays a role in the present circumstance, as it will guide project proponent to know the kind of employment and roles the people of the study area are capable of playing during project implementation. As shown in Table 4.26 and Figure 4.31, those with primary education are highest in number and account for 34% of the respondents. This is followed by the proportion of people with Islamic education which stands at 28%, and secondary education (10%). Those without any form of education are about 25% while the proportion of persons that have attained tertiary education is 3%.

Table 4.26: Educational Status of Respondents in the Study Area

Category	Highest Education	Percentage (%)
No Formal	26	25
Primary	35	34
Secondary	11	10
Tertiary	3	3
Islamic	29	28
Total	104	100

Source: GEHS Fieldwork 2015

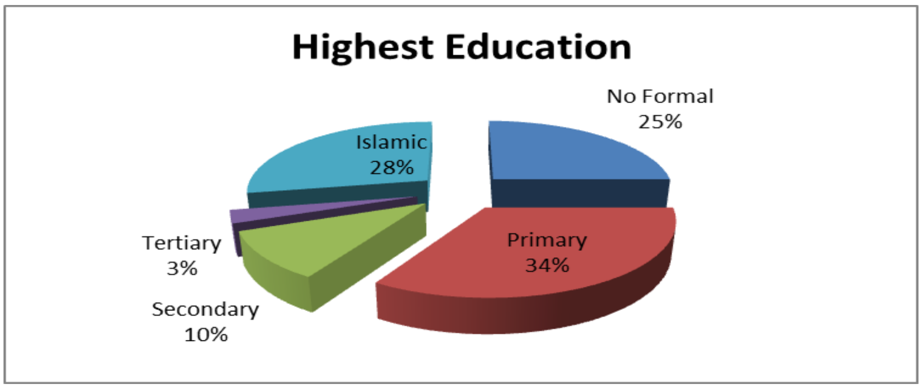

Figure 4.31: Highest Education Attainment by Community Members in the Study Area

More importantly, the survey probed for the educational status of respondents' households' members. The aim is to ascertain whether or not there is a change, and the nature of change that exists between the educational attainment of the current generation of parents (who mostly are represented by our respondents) and those of their offspring or children. We found a deficit ratio in the educational attainment. While 23% of the current parents are without formal education, it is established that about 43% of the school aged children in the households are without formal education or are not enrolled in school. Also, the proportion of persons with primary education among our respondents (current parents) accounted for 31% of our sample while the data for household educational status shows that only 16% of household members are either in primary school or have completed primary school (see Figure 4.32).

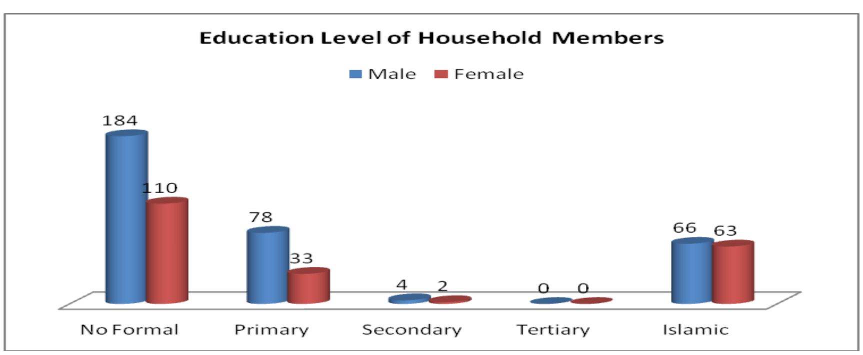

Figure 4.32: Trend in Education Attainment of Households by Gender Differential in the Study Area

- **Employment, Livelihood, and Labour Market**

Given the rural agrarian nature of the communities within the study area, most people within the active work force group engage in one form of agro-based activity or the other to fend for themselves and families. The common beliefs however is that those in farm based occupations are unemployed. This perception may have been based on the account of low income associated with farm based activities in the localities or on the fact that many of those in agro-based employment engaged in it for lack of alternative and therefore, do not have job satisfaction. Assessment of unemployment statistics in these local rural areas therefore is fraught with the challenges of definition of scope. In one definition, all the persons such as artisans, farm owners and farm based labourers might be catalogued as employed since they work and earn a living from their activities. On the other hand, some farmers and labourers without constant job/activities or those without job satisfaction can be graded as unemployed. Based on the later definition, the population of the unemployed in these communities is as high as one-third of its population.

In Figure 4.33 the various types of employments/livelihoods for the people of the study area are showcased. The blue bar represents primary occupation while the oxblood bar is for secondary occupation. In ranking order the priority livelihoods plied in the study area are farming, trading, auto mechanic services, artisanal works, public service and farm labour. Similarly, prominent secondary occupations are farming, trading, artisanal works and animal rearing. Key factors for predominantly farming livelihood in the study area are low level of education and the availability of land for farming. Survey from this study reveals that over 87% of the people of the study area are land owners by inheritance. About 12% of land owners acquired their land through lease, while 1% got their land ownership via community allocation.

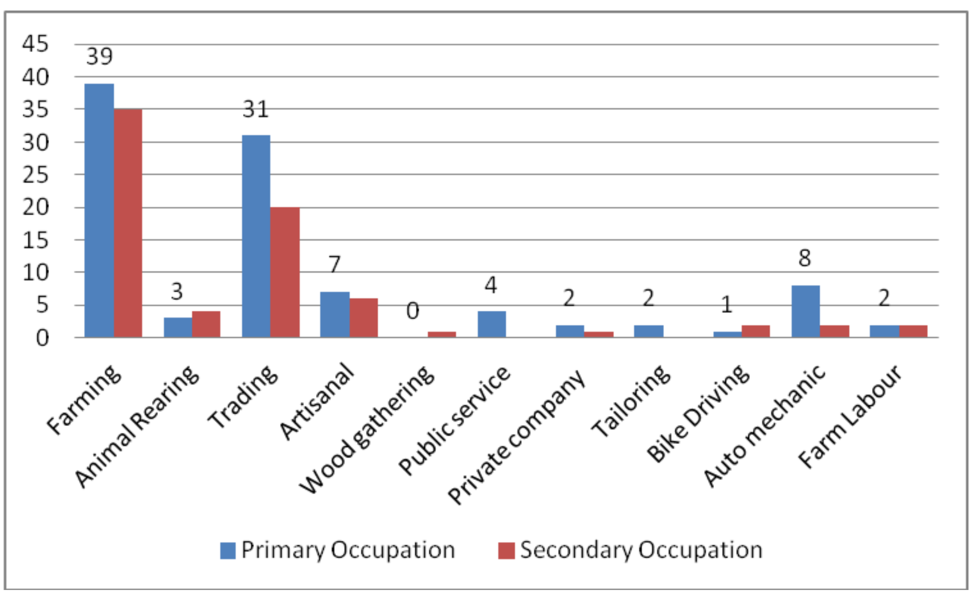

Figure 4.33: Primary and Secondary Livelihoods in the Study Area

- **Ownership of Livestock by Households**

Aside crop farming as the primary occupation in the study area, livestock rearing also features prominently. For example, many households own livestock such as cow, goat, poultry and sheep. Our survey shows that ownership of cow in the study area accounted for about 50% of the livestock even though the herd of cow owned is small (about 1 to 3 cows). At least, 30% of the households own or rear goats with some having as many as 10 to 16 in stock. The survey also shows that those who have poultry are many in the study area but, they are mostly at subsistence level as the average number of chicken owned per household ranged from 3 to 16 only (see Figure 4.34).

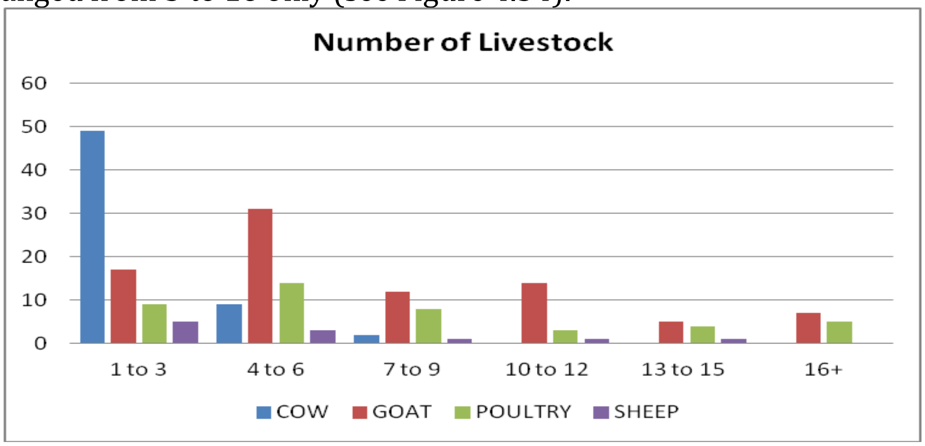

Figure 4.34: Distribution of Livestock Ownership in the Study Area

- **Income Distribution Pattern in the Study Area**

Although farming is the main livelihood in the study area, production is low and income from farming activities appear to be quite unsustainable for many households, and justifies the assumption that majority of the people of the study area are living in extreme poverty. Extreme poverty is defined as average daily consumption of USD 1.25 (N250) or less and means living on the edge of subsistence (United Nations Millennium Development 2000 and World Bank World Development Indicators 2010).

Table 4.27 provides data on the income distribution pattern in the study area while Figure 4.35 gives percentage illustration of persons that fall within the categorized income strata defined in the survey.

Table 4.27: Income Distribution Pattern in the Study Area

Income Grouping	Frequency	Percentage (%)
< N15,000	40	38
N15,000 to N29,000	25	24
N30,000 to N59,000	30	29
N60,000 to N99,000	5	5
N100,000 to N300,000	4	4
Above N300,000	0	0

Source: GEHS Fieldwork 2015

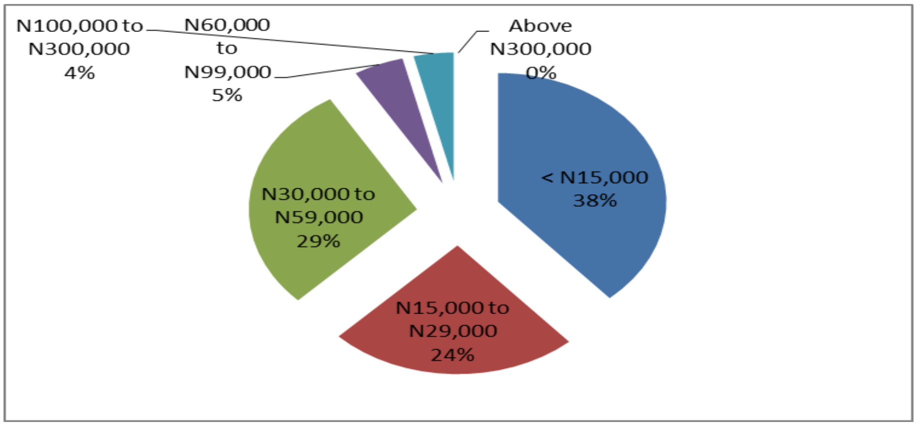

Figure 4.35: Income Distribution Pattern in the Study Area

As shown in Figure 4.35, household income is generally low in the study area with about 38% of the people earning less than N15, 000 per month while about 24% earn between N15, 000 to N29, 000. In cumulative terms, about 62% of households in the study area earn less than N30, 000 per month. Given the average number of persons in a household as 8 (children plus husband and wife) the average disposable income per head for each household is N3, 625 per month or N120 per day or equivalently USD 0.6. The proportion of people who earn between N100, 000 and N300, 000 per month is only about 4%. The low income scenario is not unconnected with the undeveloped and subsistence based agricultural practices, characterized by poor market accessibility, poor intra community and farm access road, lack of processing and storage facilities, lack of credit facilities as well as unavailability of power/electricity.

- **Household Spending Pattern**

Table 4.28 provides data on household spending pattern on food, school fees, transportation, healthcare and house rent in the study area. It shows the number of responses got for each of the items. For example, only 5 respondents stated that they spend money on house rent (less than N10,000). On the other hand, those that spend their incomes on school fees, transportation and healthcare are 55, 77 and 76 respectively. 2 respondents decline to state how much they spend on food consumption. They claim not to be aware of this given that they essentially cultivate and produce what they eat with their households.

Table 4.28: Household Spending Pattern (on selected items) in the Study Area

Items	Food	School Fees	Transportation	Healthcare	House Rent
<N10,000	27	42	66	61	5
N10,000 to N19,000	32	9	11	6	0
N20,000 to N29,000	10	4	0	9	0
N30,000 to N39,000	19	0	0	0	0
N40,000 to N49,000	6	0	0	0	0
N50,000 to N59,000	4	0	0	0	0
N60,000 +	4	0	0	0	0
Total No of Responses	102	55	77	76	5

Source: GEHS Fieldwork 2015

The economic theory that consumption is a function of income is tested in the household spending pattern in this study area. As shown in Table 4.28 and Figure 4.36, aside spending on food, all other spending (on school fees, transportation, health care, etc) are low and occur significantly at the level of less than N10,000 per month across the strata of income earners. The implication is that perhaps, due to low level of income, the people of the study area are unable most of the time to go for medical attention and/or pay their children school fees amongst other things. Those who have managed to fund their children education cannot afford to have them go to high profile schools where the cumulative fee or spending on education for all children in the household would exceed N10,000 per month.

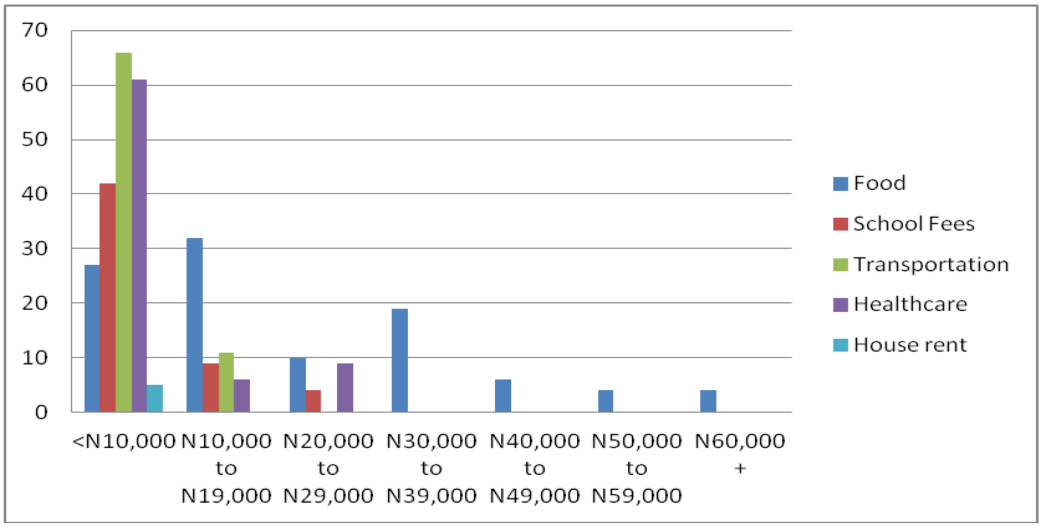

Figure 4.36: Spending Pattern by Households in the Study Area

4.5.8.4 Amenities, Infrastructure, and Social Services

- **Educational Institutions**

A few primary schools (not more than 3) are serving the 5 communities in the study area and their environs. The situation of the primary schools is even made worse by their dilapidated conditions and dearth of learning facilities.

- **Healthcare Facilities**

There are no healthcare facilities in the study area. The nearest health facility to the people of the area is the General Hospital in Dutse town which is located about 5 km away in Dutse town.

- **Transportation and Access roads**

Although taxis and tricycles are used for transportation within Dutse town, the same cannot be said about the villages situated within the study area. Apparently due to poor access road, vehicles do not find their ways into the study area and therefore constrains the people and their goods to be conveyed by motor-cycle and cow carts. Cost of transport from the project area (about 3.4km) to Dutse town by motor cycle is N100 and cost even higher on wet days.

- **Communication Services**

The entire study area has a good telecommunication coverage network. Available network providers in the area are MTN, Globacom, Airtel and Etisalat.

- **Source of Drinking Water & Water Consumption Needs**

Available to the communities of the study area are a few hand pump-boreholes but no pipe borne water. About 50% of the people of the area depend on hand dug well water for drinking, 44% depend on borehole while water vendors service 6% of the population mainly of those within the Mechanic settlement as shown in Figure 4.37.

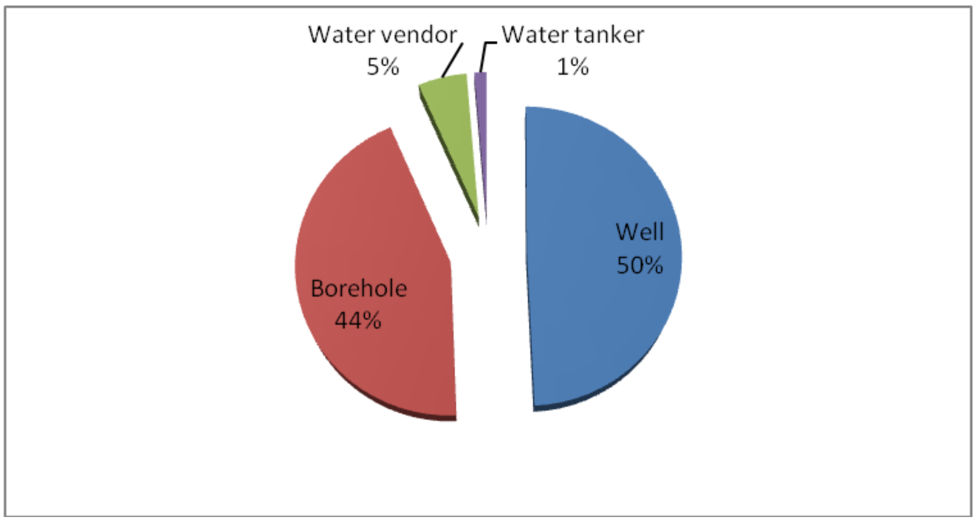

Figure 4.37: Sources of Drinking Water in the Study Area

As a result of fewer number of points for boreholes and hand dug wells, many villagers do trek long distances spanning about 30 to 50 minutes to fetch water. This poses some difficulty to the people against the backdrop that most families are large and require more number of trekking trips to fetch water that will be enough for their daily water consumption needs. The average daily water consumption needs by household is presented in Figure 4.38.

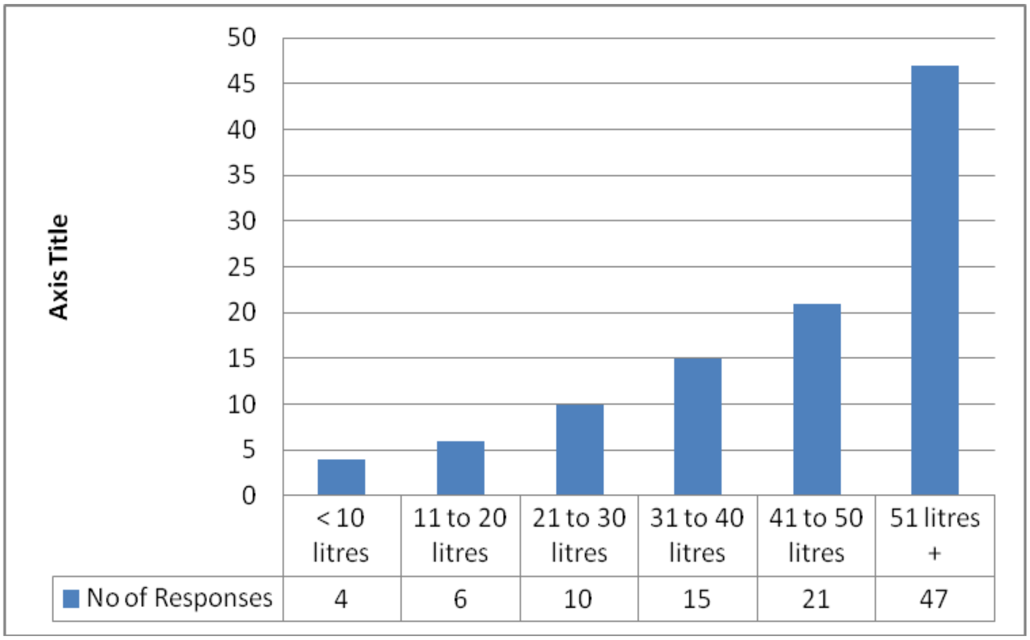

Figure 4.38: Distribution of Average Water Consumption Needs by Households in the Study Area

- **Major Markets**

The Emirate is exceptionally well endowed with major agricultural and livestock markets principally (Shuwarin, Sara, and Kiyawa) holding on Mondays, Tuesdays, and Fridays, respectively. They are conveniently situated along the major roads passing through the Emirate.

- **Source of Energy/Electricity**

The communities in the study area are not connected to the national grid, except for the Mechanic settlement, and therefore, lack access to electricity. The use of hurricane lamp is prominent as a means of household energy while other sources of household energy are private generators and use of touch light. Firewood is used for cooking in all households in the study area.

- **Willingness to Pay for Energy/Electricity**

When asked if they will be willing to pay for electricity bills when the service is provided, the people affirmed their willingness to pay with about 45% of them willing to pay on the average N500 monthly. Other responses were: those willing to pay N1000 (37%), those willing to pay N2000 (9%), those willing to pay N3000 (3%) and those willing to pay N4000 and N5000 respectively (1%). Figure 4.39 shows the amount of money respondents are willing to pay for electricity per month.

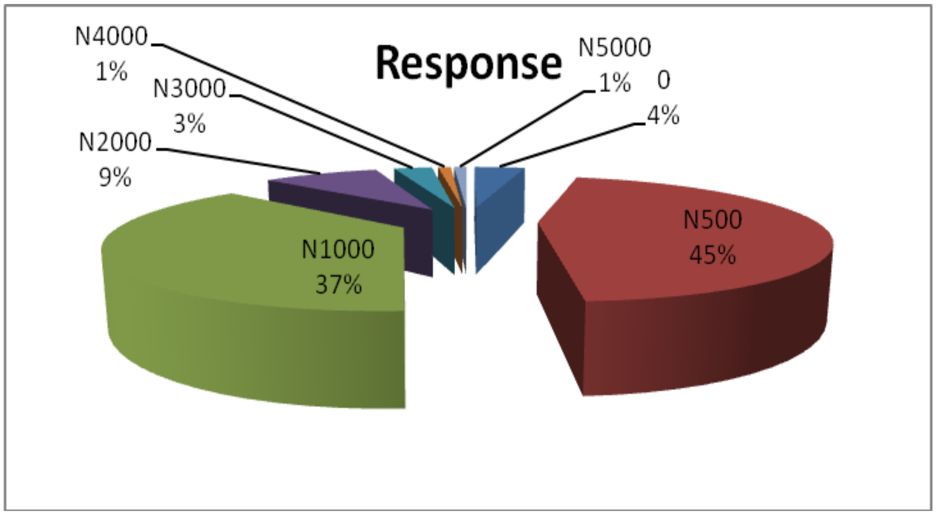

Figure 4.39: Amount of Money Respondents in the Study Area are Willing to pay for Electricity per Month

- **Waste Disposal and Sanitation**

Solid waste management in the study area is poorly handled and is characterized by open dump, disposal in nearby bush and by burning. Figure 4.40 provides a graphic explanation and distribution of methods of waste disposal in the project area.

Poor solid waste management is an environmental concern as it causes air pollution and could contaminate surface and underground water which could have far reaching adverse health impacts on the population in the area.

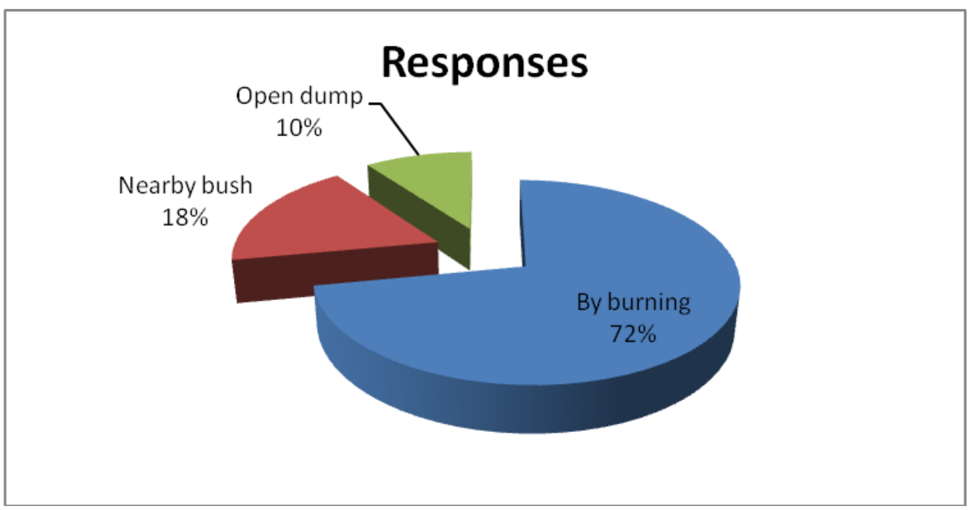

Figure 4.40: Distribution of Solid Waste Disposal Methods in the Study Area

- **Toilet Types Used by Households**

Figure 4.41 shows the types of toilets available to people in the study area. Pit latrine is used by over 85% of the population, about 6% of the people stated that they make use of water closet, 4% use ventilated pit latrine and bush respectively.

Although the respondents are completely entitled to the opinions they shared in this survey, we could not find any evidence for use of water closet in the community. Pit latrine and use of nearby bush around the farms were however observed as the means of passing human feces. The direct consequences of these methods of human waste disposal was not scientifically tested in the proposed project communities but according to UNICEF, these are not best practices and could increase the risk of transfer of pathogens between feces and food by flies. These pathogens from flies are major causes of infectious diarrhea and intestinal worm infections, but also typhoid, cholera, hepatitis, polio infection and trachoma.

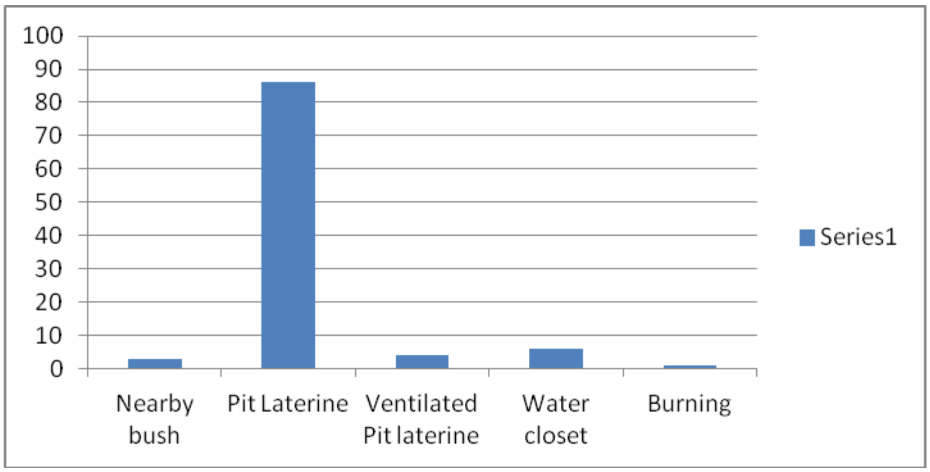

Figure 4.41: Toilet Types Used by Households in the Study Area

4.5.8.5 Historical and Cultural Heritage/Properties

There are no distinct cultural heritages or archeological monuments peculiar to the villages within the study area. However, memorable artifacts in the LGA (Dutse) include the Sawaba Monument and the Dutse Rock.

The famous Sawaba Monument is located in Dutse in the middle of Mallam Aminu Triangle. The monument came as a result of a meeting of eight people on August 8, 1948. They were Babajiya Mainaja, Garba Dida, Mudi Sipikin, Abdulquadri Danjaji, Abba Mekauru, Bello Ijimu, Musa Kaula and Magaji Dambata. These eight people came up with what is now regarded as the Sawaba Declaration. Sawaba means light in the Hausa language. The declaration seeks to establish an end to injustice, abuse of human rights, cheating and the oppression of the common man. This declaration later transformed into the first radical political party in the north known as Northern Element Progressive Union (NEPU). The Sawaba monument is painted symbolically in the colours of NEPU which are green, red, and black. The names of the eight men are written in the yellow line on the monument

The Dutse rocks are beautifully scattered around the Dutse town. The delicate ways the rocks sit on each other is awesome and are like little wonders all over the town. They add to the aesthetics of the town.

4.5.8.6 Land Ownership Structure
Ownership of land is largely by family inheritance. Residential housing, agriculture (farming and grazing), artisan workshops and institution building are the major constituents of land use.

4.5.8.7 Respondents Perceptions and Expectations from Proposed Project
The respondents indicated a positive perception about the proposed project. Prior to the ESIA stakeholder workshop, the proponent had carried out awareness programme about the proposed project. This has paid off in terms of the enthusiasm and interest the project has elicited from stakeholders and communities of the study area. Throughout the workshop stakeholders showed willingness to support the proposed project which they perceive as one that will engender employment and open their community up to rapid socio-economic boom. When asked about the expected benefits from the project in the order of priorities, the responses are as presented in Table 4.29.

Table 4.29: Prioritized Expected Benefits of Proposed Project

Expectations	No of Responses
Improved Health	83
Employment	79
Infrastructure Development	66
Economic Boom	53
Housing	40
Improved School Facilities	40
Safe Drinking Water	30

4.5.8.8 Respondents Concerns about Proposed Project
Concerns or worries expressed about the proposed project were aggregated and ranked. The most expressed concern is loss of land. In particular, the affected households and communities are worried about how and who will compensate for their loss agricultural land. Their opinion converged around best compensation measures where their compensation entitlement is not paid through a third party to avoid elite capture and denial or shortchange. Other fears expressed by the communities are:

- Fears that the project will worsen their health conditions;
- Dust will be generated during the construction phase of the project and could cause upper respiratory infectious diseases;
- Fear that farms will be destroyed while they are not certain that the proposed project will be implemented;
- Loss of jobs; and
- Fear of loss of source of income

In order to resolve these fears and sustain the project, the suggestions indicated in Figure 4.42 were made by the affected community members:

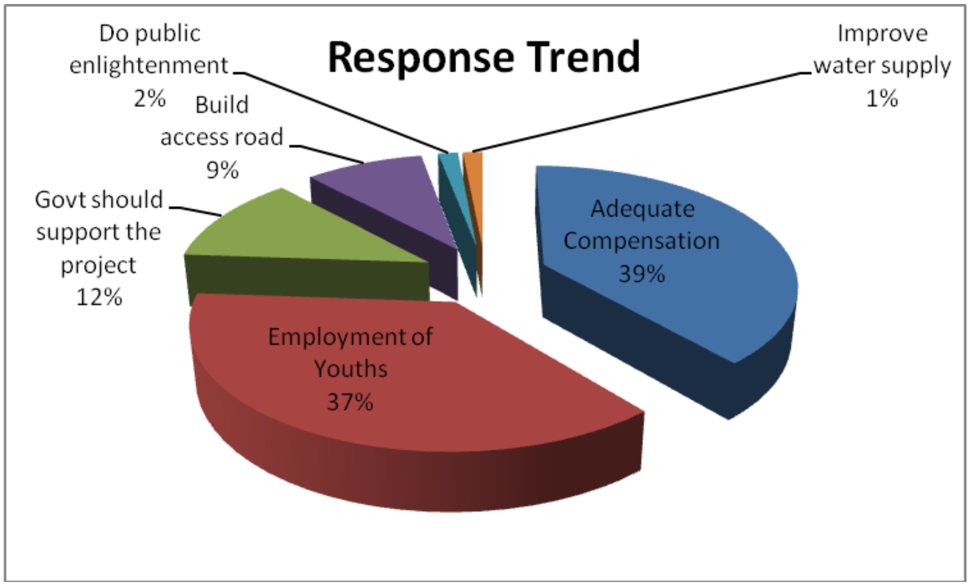

Figure 4.42: Suggested Measures towards Project Sustainability

As presented in the above chart, considerable attention will be given to the following to mitigate the perceived impacts by the affected communities and engender social responsibility:

- Pay adequate compensation to all owners of land and affected assets;
- Employ the youths of the community during and after the construction period of the project;
- Improve access road for movement of people and goods;
- Carry out more public enlightenment on the purpose and benefit of the solar power PV project;
- Assist the community with safe drinking water.

4.5.9 Community Health Status

The health status profile of the communities in the study area was defined in order to ascertain:

i. The health situation of the potential population and vulnerable groups whose health could be enhanced or placed at risk by the proposed project.
ii. The capacity and capability of the health system at the local project level in terms of availability, manpower and service delivery.

The information on the community health status was essentially obtained from secondary data sourced from the PHC Department of Dutse LGA of Jigawa State and the Dutse General Hospital which is the health facility patronized by majority of the affected communities in the study area. Primary health data was in addition obtained during the household survey, focus group discussions and in-depth interviews held with community leaders.

4.5.9.1 Morbidity Pattern

Information obtained from respondents during the household survey showed the common sicknesses and diseases in the study area to include cholera, cough, catarrh, diarrhea, dysentery and pneumonia. Others are malaria, skin rashes and typhoid. The most common with high risk of re-occurrence are malaria, typhoid, cholera and skin rashes.

Information on health conditions affecting households in the study area obtained from the health facility was elicited based on relevant Environmental Health Areas (EHAs) shown in Table 4.30. Analysis of the data revealed that malaria was the leading cause of morbidity amongst households in the study area during the 2 year period. This was consistent with the result of the household survey which also showed malaria as the most prevalent disease (see Figure 4.43)

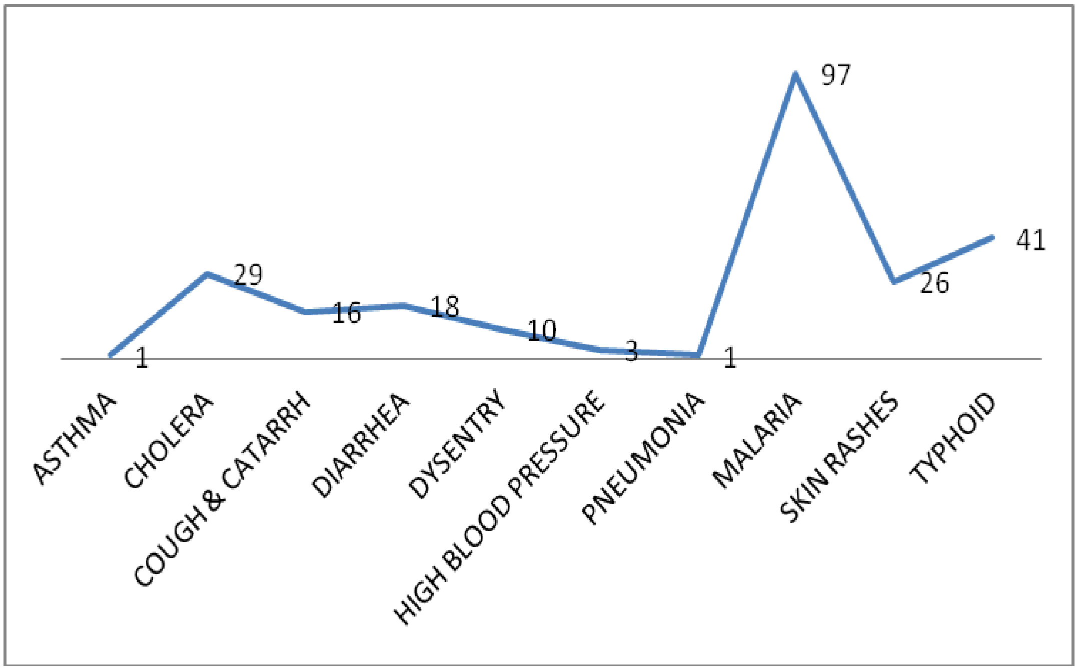

Figure 4.43: Common Sicknesses Prevalent in the Study Area

Table 4 .30: Dutse Morbidity Pattern in Health Facility used by Affected Communities in Study Area (2012 – 2013)

NO	DATA ELEMENT	MONTHS												
VECTOR RELATED DISEASES		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1.	Malaria – suspected	822	905	348	918	1144	1000	1409	1326	1441	1357	1120	1003	**12,793**
2.	Onchoceciasis – suspected	3	3	2	1	0	0	0	0	0	0	0	0	**9**
RESPIRATORY AND HOUSING ISSUES														
3.	Pneumonia case 5 years new	30	31	29	22	16	23	33	39	37	41	50	47	**398**
4.	Pneumonia 5 years and older	46	46	45	38	26	31	32	39	48	52	56	65	**524**
5.	Measles under 5 years suspected	41	68	12	23	22	18	22	32	36	61	49	64	**448**
6.	Measles – new cases (all ages)	51	73	64	55	45	39	40	56	61	47	42	44	**617**
7.	TB – on treatment	18	17	17	12	10	12	9	17	9	17	6	11	**155**
SEXUALLY TRANSMITTED INFECTIONS														
8.	Cases treated as STI – new	0	0	0	0	7	5	0	0	0	0	0	0	**12**
9.	HIV/AIDS clinical – suspected	69	75	74	83	96	94	77	86	79	86	77	63	**959**
10.	Hepatitis B – suspected	77	103	82	79	67	52	51	57	69	53	57	58	**805**
SOIL AND WATER SANITATION RELATED DISEASES														
11.	Guinea worm – suspected	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FOOD AND NUTRITION RELATED DISEASES														
12.	Severe malnutrition under 5 years admitted	101	112	134	155	180	145	144	130	140	70	47	52	**1410**
13.	Diarrhea with dehydration cases under 5 yrs new	81	75	73	95	75	106	113	185	178	106	82	65	**1234**
14.	Dysentery – suspected	82	82	71	78	64	66	80	99	108	86	96	90	**1002**
15.	Cholera cases	12	0	70	41	141	70	60	65	56	64	30	28	**637**
ACCIDENTS AND INJURIES														
16.	Road Traffic Accident (RTA)	524	593	522	513	524	445	425	459	407	395	364	346	**5517**
17.	Inter Personal Violence	158	142	170	139	130	121	102	79	77	59	47	53	**1277**

Source: Dutse General Hospital (2015)

4.5.9.3 Hospital Visits by Household

Responses from households in the study area confirm that 34% of the households have visited hospitals as many as 3 to 4 times in a month for treatment of one or more sicknesses such as malaria, typhoid, skin rashes, cough and catarrh. Also, about 42% of the households stated that members of their households have visited hospitals/pharmacies at least once a month in the past 12 months due to malaria, typhoid or cholera.

4.5.9.4 Health Institutions

4.5.9.4.1 Health Facilities

Information obtained from the PHC Department of Dutse LGA revealed that there are a total number of 49 health facilities in Dutse LGA, comprising 44 public and 5 private health establishments. There are however no healthcare facilities in the study area. The nearest health facility to the people of the area is the General Hospital in Dutse town (5 km away). Responses from household survey revealed that about 53% of the respondents stated that they use native medicines and herbs, 40% stated that they go to the Dutse General Hospital. Also, about 6% of the people prefer to go to the pharmacy also in Dutse town while 1% visit private clinics.

4.5.9.4.2 Health Personnel

Table 4.31 provides a breakdown of the types and numbers of health personnel in health facilities and MDAs in Dutse town.

4.5.9.5 Respondents Perception of Household Health Status

Based on the high turnover of medical visits or ill health in the study area, an attempt was made to hear from the households on how they can best qualify their own health status in general. The options were: excellent, good and poor. The outcome of the investigation shows as follows:

- 9% of the respondents stated that their families are in excellent stable health condition;
- 53% believe that their health status is good, and
- 38% confirms that their household health condition is poor and crises ridden.

4.5.9.6 Health Needs and Concerns

The health concerns of the affected communities in the study area include lack of health facilities, health personnel, sanitation services and poor nutrition. To remedy these concerns the respondents requested the following from project sponsor or government:

- Provision of medical facility and personnel such as health care center in their communities;
- Supply of infrastructure such as water, electricity and road. The demand for electricity ranked high, followed by water and road.
- Reduction in poverty level through employment creation and livelihood support that will boost their income in order to better improve on their nutrition.

Table 4.31: Types and Number of Health Personnel in Health Facilities and MDAs in Dutse Town.

Health Facility	Medical Doctors	Nurses & Midwifery	EHO	CHEW	Pharmacist	Laboratory Scientist	Medical Records	Radiologist	Physiotherapist	Others	Total
Genneral Hospital	13	62	3	73	8	25	5	8	5	19	221
RSSH	40	155	4	6	16	36	18	10	14	24	323
Min. of Health	6	3	15	-	-	-	-	-	-	-	24
Min. of Environment	-	-	10	-	-	-	-	-	-	-	10
JISEPPA	-	-	25	-	-	-	-	-	-	-	25
Wash Dept.	-	-	17	3	-	-	-	-	-	-	20
Police Hos.	2	4		4	4	4	2				20
FMC	2	3			3	3	3				14
FUDC	4	8			4	4	3				23
Sambo Clinic	1			4	1		1				7
TOTAL	68	235	74	90	36	72	32	18	19	43	687

Source: PHC Dept. Dutse LGA (2015)

Key: EHO – Environment Health Officers; CHEW – Community Health Extension Worker; RSSH – Rasheed Shekoni Specialist Hospital; JISEPA – Jigawa State Environmental Protection Agency; FMC – Federal Medical Centre; FUDC – Federal University Dutse Clinic

4.6 STAKEHOLDERS ENGAGEMENT

Stakeholder engagement is an integral part of the ESIA process. It is the basis for building strong, constructive and responsive relationships that are essential for the successful management of a project's environmental and social impacts. It is an ongoing process that involves the identification of the range of groups of people, organizations and agencies that are to be affected by a proposed project or those that might have a stake/interest in the project with a view to disclosing project information to them. It also involves consultation, interactions and negotiations between the project developer and host communities and other stakeholders in such a manner that a relationship engine block is built to serve the interest of all stakeholders and stimulate social responsibility and project sustainability.

In line with international best practice as prescribed in the FMEnv Procedural Guidelines on EIA, Operational policies of the World Bank, IFC Performance Standards on Environmental and Social Sustainability, and the Equator Principles, the ESIA study included consultations with relevant government MDAs, communities and social groups within the study area.

4.6.1 Objectives

The overarching objectives of stakeholder engagement are to:

i. Establish and maintain a constructive relationship with stakeholders over the life of the project.
ii. Build a culture of ownership and social inclusion in project development and implementation; and
iii. Mainstream transparency in project benefit allocations and eliminate "elite capture" tendencies that could create project induced disaffections and conflicts.

4.6.2 Stakeholder Composition

As part of the stakeholder engagement plan (SEP), affected groups, communities, and other stakeholders were identified for informed and meaningful consultation at the early stage of the ESIA process. The range of stakeholders identified included primary and secondary stakeholders. Primary stakeholders are the direct social groups and communities that will be affected by the activities of the project. They include land owners, farmers/owners of crops (in most cases, farm owners are also land owners in the proposed project site) and vulnerable groups as described in section 4.5.8.3. Secondary stakeholders comprise government MDAs and public institutions that may have interest in the project or those that have statutory functional/regulatory responsibility on the proposed project. It also included those with vested interest in the proposed project. Table 4.32 presents the different groups of stakeholders that were identified.

Table 4.32: Stakeholder Groups Identified for Engagement

S/N	PRIMARY STAKEHOLDERS *(Social groups and communities that will be affected by project activities)*	S/N	SECONDARY STAKEHOLDERS *(Agencies & public institutions with interest/statutory functional responsibility in the project)*
1.	**Land Owners** Made up of (a) People from 5 communities in the study area viz: - Katangar Lafia Village - Bakin Jeji Village - Kawaye Village - Bulori Village - Rahama Village (b) People, communities and agencies along the transmission route viz: - Sharafai Village - Jigawa State Tourism Board - Mechanic Village - Nigerian Security & Civil Defense Corps	1.	**MDAs with Functional Responsibility** - Federal Ministry of Environment - Jigawa State Ministry of Environment - Ministry of Power/Transmission Company of Nigeria - Dutse LGA -Department of Waste Management - **2. MDAs and CBOs with Vested Interest** - Invest Jigawa - Jigawa State Ministry of Land and Urban Development - Jigawa State Ministry of Water Resources - Traditional Council – the emirate council, district and village heads
2.	**Farmers and Crop Owners** These include: - Youths - Cattle owners/rearers - Women - Household Heads -		
3.	**Vulnerable groups** - Women - Aged persons(60yrs and above) - Orphans - Physically disable persons - Low income people -		

4.6.3 Engagement Plan and Consultation Process

The plan for engaging stakeholders throughout the lifecycle of the proposed project is described in Table 4.33. It identifies a broad spectrum of activities and events that will occur at different stages of the life cycle of the project and the targeted stakeholders that are required to be engaged, and how they should be engaged. The aim of this SEP is to have a clear cut plan/guideline that the project developer and/or those carrying out services on its behalf can follow to maintain social inclusion and responsiveness.

Table 4.33: Stakeholder Engagement Plan

Project Stage	Project Associated Activities	Target Group	Method/strategy
Pre-construction	• ESIA screening	• Federal and State Ministry of Environment	• Invitation by official letter to the Authority • Joint field visit with proponents' consultant team
	• Disclosure of project information • Planning and designing • Identification of transmission routes and areas of influence • ESIA scoping and study • ESIA disclosure and review workshop • Land acquisition and compensation	• Affected project communities including land owners, youths and administrative heads • Federal and State Ministry of Environment • Federal Ministry of Power/TCN • Jigawa State Ministry of Land, Housing, Urban Development and Regional Planning • Invest Jigawa • Dutse LGA • NGOs	• Invitation through the village heads, youth leader, and heads of Agencies/Associations • Invitation via village messenger • Distribution of fliers to the locals printed in Hausa language • Invitation by official letter to the Authority • Newspaper Advertisement • Radio Announcement
Construction	• Construction and installation works • Implementation of the ESIA/ESMP • Monitoring of the ESIA/ESMP implementation	• Affected project communities (youths, skilled & unskilled willing labour) • State Ministry of Environment • Federal Ministry of Power/TCN • Invest Jigawa • Dutse LGA (Waste Management Department)	• Invitation through the village heads, youth leader, and heads of Agencies/Associations • Invitation via village messenger • Distribution of fliers to the locals printed in Hausa language • Arrangement of monitoring responsibilities to stakeholder Agencies • Follow up calls by projects Environmental Officer or Engineer
Operation	• Audit/post construction impact evaluation • Service delivery/utility audit • Clearing of grasses around the site and transmission route • Maintenance of equipment • Replacement of wear & tear	• Households in the project communities • Traditional rulers, district and village heads in the project area • Invest Jigawa • Federal Ministry of Power/TCN	• Community based Interview, questionnaire survey by proponent or its consultant • Invitation through the village heads, youth leader, and heads of Agencies/Associations • Follow up calls by projects Environmental Officer or Engineer
Decommissioning	• Removal of obsolete installations	• Federal and State Ministry of Environment • Federal Ministry of Power/TCN • Dutse LGA (Waste Management Department)	• Invitation through the village heads, youth leader, and heads of agencies/associations • Follow up calls by projects Environmental Officer or Engineer

4.6.4 Stakeholder Consultations

The consultation process which is a continuum began on the 8th September 2015 with first level community wide scoping workshop that was held at the State Library Complex, Dutse. Small group and village consultations continued and summed up in a major public consultation that took place on the 28th of October 2015.

The consultative process commenced with a courtesy visit to the Emir of Dutse where the project proponent and ESIA Consultants informed his royal highness about the project and elicited his support and royal blessing. The different stakeholder consultations held with key interest groups and affected communities during the ESIA study are presented in Table 4.34 and discussed in the following section.

Table 4.34: Types of Stakeholders Consultations held with Key Interest Groups and Affected Communities in the Study Area.

Focus Group Discussions			
S/N	**Stakeholder Group**	**Community/Venue**	**Date**
1.	- Katangar-Lafia Youth Association - Farmers/Village Members	Katangar-Lafia	9th September, 2015
2.	- Hunters group - Farmers/Village Members	Bulori	10th - 11th September, 2015
3.	- Farmers/Village Members - Rahama Self Help Group	Rahama	12th September, 2015
4.	- Kawaye Youth - Farmers/Village Members	Kawaye	13th - 14th September, 2015
5.	- Farmers/Village Members	Sharafai	14th - 15th September, 2015
6.	- Farmers/Village Members	Bakin-Jeji	15th - 16th September, 2015
7.	- Mechanics	Mechanic Village	16th September, 2015
In-Depth Interview			
	Village Head	**Community**	**Date**
1.	Hamza Yusuf	Bakin-Jeji	9th September, 2015
2.	Inuwa Umaru	Katangar-Lafia	9th September, 2015
3.	Balarabe Mohamed (Chairman)	Mechanic Village	9th September, 2015
4.	Mallam Ali Bulori	Bulori	10th September, 2015
5.	Mohammed Shuaibu	Rahama	12th September, 2015
6.	Bello Ahmed Sahad	Kawaye	13th September, 2015
7.	Mallam Alhassan Bello	Sharafai	14th September, 2015

Stakeholder Workshops				
	Stakeholder Group	**Activity**	**Venue**	**Date**
1.	Major stakeholders (see table 4.27)	Scoping Workshop	Conference Hall, Dutse State Library	8th September, 2015
2.	Major stakeholders (see table 4.27)	Public Consultation	Conference Hall, Dutse State Library	28th October, 2015

4.6.4.1 Stakeholder's Scoping Workshop

Scoping exercise in ESIA is a preliminary exercise whose aim is to determine the scope and extent of information required in the ESIA study. Scoping provides the roadmap and directions for the ESIA process which if well planned and executed helps in identifying potential significant environmental and social impacts of the proposed development that need to be considered in depth as part of the ESIA. Scoping also identifies potential issues that are not considered likely to be significant and therefore can be "scoped out". In pursuant of this objective, a scoping workshop was held as a first level community wide forum on 8th September, 2015 at the Jigawa State Library, Conference Centre. Prior to the meeting stakeholders were duly informed through formal letters of invitation (See Appendix 4.4).

The stakeholder scoping workshop served as a platform to disclose the project information to the stakeholders and elicit inputs and concerns that would be mainstreamed into the ESIA study.

In specific terms, the objectives of scoping workshop were to:

i. Inform/acquaint the affected communities and other stakeholders of the proposed project and disclose necessary project information;
ii. Brief the affected communities and other stakeholders of the potential positive and negative impacts of the proposed project and how ESIA will be used to proffer mitigation measures for the adverse impacts and enhance the positive ones;
iii. Identify from the affected communities other issues (such as cultural heritage, livelihood effects and externalities) that may be affected by the proposed project;
iv. Discuss with the affected communities and other stakeholders of the potential alternative options;
v. Identify the owners of the land and farms that may be affected or acquired by the proposed project and consult on alternatives for compensation;
vi. Discuss community benefits and means of participation in the project implementation and operation; and
vii. Create an enlivened atmosphere and process where stakeholders can express their feelings and interest in project development.

- **Scoping Workshop Participation**

The stakeholder workshop was attended by representatives of the Emir of Dutse and the Permanent Secretary, FMEnv as well as officials of JISEPA, Invest Jigawa, TCN and Dutse LGA. Other participants included affected automobile mechanics, farmers, youths and affected land owners, from the project host communities including Bulori, Bakin Jeji, Rahama, Kawaye, Katangar Lafia and Sharifai. The attendance sheet of participants at the scoping workshop is attached as Appendix 4.5.

The key agenda of the workshop included:

- Introduction of stakeholders
- Opening Remark by Director NSPDL
- Project Information Disclosure by the MD, NSPDL
- Environmental and Social Impact Assessment and Need for Public Stakeholder Consultation by the ESIA Consultant
- Response by FMEnv and other stakeholders
- Closing Remark

- **Major Highlights and Issues/Concerns raised During Scoping Workshop**

The stakeholders were informed about the proposed project and the intention of the proponent to carry out an ESIA to ensure the environmental and socio-economic sustainability of the proposed project, and to identify major issues of concerns from stakeholders. They were given opportunity to express their concerns and share their views with regards to perception of the proposed project, as well as make contributions towards the development and sustainability of the proposed project. Issues regarding compensation and resettlement were also discussed, as this was a flash point in the discussions. The stakeholders' questions were attended to while remarks and concerns were noted and documented. The minutes of the scoping workshop is attached as Appendix 4.6 while highlights of the issues and concerns raised are summarized in Table 4.35.

Table 4.35: Highlights of Issues and Concerns at Stakeholders Scoping Workshop

Major Concerns and Questions			
Issues	**Description of Concerns**	**By Whom**	**Responses**
Compensation	• Local communities are expectant of compensation they might receive. • Who will pay compensation; the State or the project proponent? • Do not want third parties/community leaders to receive compensation for or on their behalf	Ibrahim Abduhamadu, land owner from Bakin Jeji, and Yahaya Buba also a land owner from Bulori	The ESIA socioeconomic expert responded that the project sponsor will pay compensation, and that it will follow a transparent process and best practice in addressing the issue of land compensation. He assured the people that they will not be short changed and that there will not be elite capture of any ones entitlement
Project Life Cycle	• After 25 years of project life cycle what will be the future of the communities in terms of energy/electricity supply?	Farm Owner	The MD, NSPDL answered that after 25 years, only the panels will be replaced to continue to generate energy as far as the government is desirous with the sustainability of the project
Harmattan Season	• How will the solar panels function at harmattan period?	Bello Ahmed, village head, Kawaye	The MD, informed that harmattan weather will not significantly affect energy supply because the energy stored in the panels can sustain the Solar system for 2 months
Employment	• Want the project proponent to engage their unemployed youths during implementation stage	Affirmed by many of the village representatives	The proponent welcomed the suggestion and informed that it is in their policy to work with locals during construction and operation stages of the project
Mechanic Settlement	• The present location is a new layout allocated to the auto-mechanic service operators by Jigawa State Government and what will be their fate if the solar power project will result to their displacement?	Balarabe Mohd, Chairman, Nigerian Automobile Technician Association	The automobile people were assured that, if it is confirmed that their land is within the 30 meter radius for the transmission right of way, NSPDL will liaise with the state government to ensure that they are resettled before displacement. They promised to carry the Auto mechanic people along in the process

Source: GEHS Fieldwork 2015

Plates 4.12 – 4.15 show pictures taken during the courtesy visit to the Emir's Palace and various activities during the scoping workshop.

Plate 4.12: Project Proponent (NSPDL Directors) & ESIA Consultants with the Emir of Dutse Alhaji Nuhu Sanusi

Plate 4.13: Project Proponent (NSPDL Directors) and Consultants during Scoping Workshop

Plate 4.14: Cross-Section of Participants During Scoping Workshop

Plate 4.15: Participant Making Comments During Scoping Workshop

4.6.4.2 Focus Group Discussions

The study plan was to interface with all the social groups in the project communities as much as possible to ensure reasonable social inclusion. In this regard, the study targeted to consult with women, youths and vulnerable people amongst others. However, due to cultural and religious constraints, the planned FGDs with women could not hold, rather, the female field workers in the ESIA team administered household questionnaire to the females in their respective households which also adequately captured the views and concerns of the women of the study area.

- **FGD with Vulnerable Groups**

The study did not identify any household head orphan in all the villages in the study area; but identified 3 aged men (2 from Bulori village and 1 from Kawaye village). There was no female vulnerable person by age. The aged vulnerable men live in mud houses made of corrugated roof. Their household size statistics are 7, 9 and 11 respectively. They all engage in subsistence farming and are all land owners in the proposed project area. These persons perceive the solar power PV project as one that will bring development to their localities when completed but shared common concerns are:

- How their due entitlements from compensation for their affected land will be paid to them and early;

- The need for employment for their children from the project and,
- The privilege to enjoy free electricity from the project when completed.

In response, the vulnerable persons were assured of assistance and priority during compensation payment and in the distribution of any other project benefits. However, they were informed that NSPDL will only generate electricity and sell to TCN which will be fed into the national grid for transmission and distribution. To this end, NSPDL will not be able to make promise with regard to free power supply to the community.

- **FGD with Youths and other Community Groups**

FGDs were held from 9th to 16th September, 2015 with youths and other community groups in 6 villages and the mechanic settlement. These include Bakin-jeji, Sharafai, katangar Lafia, Bulori, Rahama and Kawaye villages. The summary of the FGDs held in the communities and settlements in the study area is presented in Table 4.36 while Plates 4.16 and 4.17 show FGDs held in Rahama and Bulori villages. Details of the FGD proceedings are contained in Appendix 4.7.

Table 4.36: Summary of the Outcome of FGDs held with Youths and Other Community Groups

Village	Stakeholder Group	Variables	Details
Bakin-Jeji	Men and Youth	Introduction	The NSDP in Dutse was introduced to the group and sought to know their perception of the project
		Perception	The people of Bakin-Jeji were excited about the project
		Concern	The concerns were put as follows: "The main concern in this village includes lack of good access roads into the community, hospital, school and good drinking water. We only have a primary school in which the standard is very poor. We don't even have desk for our children to sit on. We don't even have a medical store or a chemist, we have to travel some distance in the town of Dutse to get drugs".
		Response	The ESIA team assured the community that their concerns will be documented in the ESIA report for the attention of the relevant authorities.
Sharafai	Men and Youth	Introduction	The objective of the ESIA was made known to the people just as the case with the Bakin-Jeji people above
		Perception	The Solar power panel project was well received by the people as one that will improve their socioeconomic life
		Concern	The major concern of the people is the compensation plan. Government has not clearly come out to tell them the modalities of payment. They are still in fear that government will pay them only what they feel like paying for this, no tentative date has been fixed for the payment
		Response	The people were assured that their concern will receive good attention. They were told that adequate resettlement of affected persons is a priority and will precede the project implementation
Katangar-Lafia	Katangar-Lafia Youth Association	Introduction	Katangan-Lafia Youth Group is a self-help group. The common interest is to help members in critical needs. For example, if a member's house or farm land is sub-merged/affected by flood or any other kind of unexpected disaster, the group contributes money to re-establish the individual.
		Perception about the project	The group believe that the project will affect their economic condition positively

		Concern	They are concerned with how they will be adequately compensated for their loss farm lands.
		Expectations from the project	The group states that many of them are without job and want NSPDL to give job to its people during the construction and operation work stages of this project. Apart from that, they also want clinic and safe drinking water.
Bulori	Hunters group	Introduction	They hunt for subsistence. Types of animals find around the proposed project site includes but not limited to rabbits, and bush fowl.
		Perception	They believe that the project will help bring employment and alleviate poverty
		Concern	Hunting has been reduced to subsistence level as human activities have led to the extinction or disperse of the bush animals that used to be available for hunting in the past 10 years
		Expectations from the project	Employment
Rahama	Rahama Self Help Group	Introduction	They are involved in farming and animal rearing.
		Perception about the project	The group believe that the project will affect their economic condition positively
		Concern	Loss of their land and pessimism of receiving compensation is their key concern
		Expectation	Employment, health centre
Kawaye	Kawaye youth	Introduction	The youth are mainly farmers and many of them said they are unemployed
		Perception	They believe that the project is a desirable one capable of opening the village up to development
		Concern	They are concerned with how they will be adequately compensated for their loss farm lands.
		Expectations from the project	Employment
Mechanic settlement	Auto mechanic and spare parts dealers	Introduction	The ESIA team informed the association about the project objective. They were told that the mechanic settlement was being consulted because there is a tendency that the transmission line will traverse through their land from the sub-station to the proposed solar panel farm.
		Concern	Abdulwahab Yinka: "What I want to advise on this issue is if the project will affect our people, we will want things to be done according to the law. People that this thing will affect will not end up without anything. If they are affected, we will like to know, what will be our fate having been officially relocated to this location by the government". How are we going to re-connect to our livelihood if displaced?
		Response	Even as we talk now, it has not been established, the exact route the transmission line will pass but there is something we are going to do shortly after now. We are going to take the coordinates of your land area, and super impose it on the map overlay for the transmission line. When we plot it, we will be able to know if it actually affected your location or not; and if does, we will also come back to tell you and find a way to go about it. The idea is that no one should be under a transmission line. Be assured that everyone affected will be resettled.

Source: GEHS Fieldwork 2015

Plate 4.16: FGD with Self Help Group in Rahama Village

Plate 4.17: FGD with Hunters Group in Bulori Village

4.6.4.3 In-Depth Interviews

Village Heads of each of the seven affected communities were interviewed to elicit in-depth information on the social nomenclature of the study area. The most attracting outcome of the respective interviews is that the villages are homogenous and share similarities in terms of cultural and religious practices, traditional political administration and conflict resolution practices. While all the villages live in deprivation of social amenities such as electricity and access road, the mechanic village differ completely having been connected to the national grid and accessible by car.

4.6.4.4 Public Consultation

A second stakeholder public consultation forum was held on the 28th of October, 2015 at the Jigawa State Library, Conference Centre. Prior to the meeting stakeholders were duly informed through formal letters of invitation and newspaper advertisement (See Appendix 4.8 for copy of newspaper advertisement). The outcome of the public consultation is summarized in Table 4.37 below. The list of participants and minutes of meeting are attached as Appendix 4.9 and 4.10 respectively.

Table 4.37: Summary of the Outcome of Stakeholders Public Consultation

Date	28th October, 2015
Venue	Jigawa State Library Conference Centre
Objective	To flash the issues raised during the stakeholder scoping workshop and deepen discussion on them; to inform stakeholders about progress made so far with project development and to elicit more concerns, mitigation measures and inputs from stakeholders
Participants	See Appendix 4.8
Recap of previous agenda/discussions	Issues that featured in the last meeting were recapped: loss of land and concerns on compensation, sustainability of the project after 25 years life cycle, issues of sustaining solar power during the cold/harmattan season, employment for youths and mechanic settlement displacement, etc.
Recap of project information	The director of NSPDL, Nasiru Isyaku gave a brief overview of the project development objective as was delivered during the stakeholders scoping workshop. The essence of the recap was for the benefit of those who were not present in the last scoping workshop.

Presentation of the need for ESIA and updates on ESIA preparation	The ESIA lead Consultant, Dr Okwuosa told the audience that ESIA was being conducted to identify impacts of the proposed project to humans and the environment, so as to avoid them, minimize or mitigate where the impacts cannot be avoided. She informed that the ESIA team has so far visited the project site and collected samples on vegetation, soil, water and soil. It intends to carry out analysis of these samples to determine the baseline conditions of the area with respect to health, economy and cultural imperatives. She stated that this will be useful not only to provide mitigation or enhancement measures but will be used to evaluate and monitor project performance. The participants were informed that the draft final report of the ESIA will be disclosed at the Dutse LGA and SME for their perusal and comments.
Concerns and Questions	• A community member from Bakin Jeji commended the project sponsor for the level of consultation and engagement so far. He advised that the communities should have free electricity from the project. • Another participant wanted to have the assurance that NSPDL will comply/implement ESMP to the later. • The issue of compensation was also rigorously canvassed. Most commentators wanted to know when they will be compensated and the process. • Another community member wanted to know how the project could give them employment and the kind of employment since many of their youths are not well educated or skilled
Response to concerns	• The project communities were informed that NSPDL would have been delighted to give free electricity as part of her social responsibility to the communities, but is constrained because the function of transmission and distribution of electricity is not within its purview; • The Director of NSPDL further told the participants that its organization will implement the ESMP to the later because it is a responsible firm with sound policies on Health, Environment and Safety; also, there are statutory organs of government with monitoring responsibility to ensure that NSPDL carries out the compliance of its ESMP implementation. • In terms of employment, the participants were told that NSPDL will keep to its promise of engaging locals during construction and operation phases. NSPDL will also train and transfer skills to the locals which will enhance their livelihood advantage. Aside direct employment, the people were enlightened that indirect jobs will result once there is electricity in the communities through economic activities that will be triggered or induced by the availability of power. • The auto mechanic services settlement members were informed that the project route has been traced using GIS technology and the outcome confirmed that the mechanic settlement will not be affected by the transmission installations. Therefore, there is nothing to worry about displacement. • The stakeholders were told to watch out and take advantage of the ESIA display which will be displayed at centers close to them such as the local government headquarters in Dutse and the Ministry of Environment to review the report and make their comments where necessary.

Source: GEHS Fieldwork 2015

4.7 Corporate Social Responsibility

Corporate Social Responsibility (CSR) is a commitment to improve community well-being through discretionary business practices and contributions of corporate resources. The World Business Council for Sustainable Development (WBCSD) describes CSR as "business' commitment to contribute to sustainable economic development, working with employees, their families, the local community, and society at large to improve their quality of life."

NSPDL has a policy of being a member of its business community. By implication, the staff and management of the organization integrate into host community's ideologies and serve her interest in the best possible areas, thereby adding values to the society in more ways than it is met. NSPDL CSR is predetermined on a two stand agenda:

i. Enhancing the well-being and socioeconomic profile of our host community members including youths and women; and
ii. Contribute to safe global environment through innovative green practices in our business conducts.

NSPDL CSR takes a responsive approach to the knowledge and skill needs of our host community. Our CSR interventions are not promises but actions that are easily seeable and accessible by the public and business community at large. In line with this, NSPDL shall pursue the following 5 point CSR mandates during the implementation of the proposed project in the host communities:

i. Ensuring that consideration for a minimum of 30% (up to 60%) of employee base for the proposed project are giving to members of host communities;
ii. Offering free training and skill transfer to project employees on PV technology that will enhance their capacity to play big roles in the industry and become big income earners;
iii. Ensuring that access road used for the operations of the proposed project are regularly maintained and accessible to the entire members of the communities;
iv. Involvment in tree planting and adapting feasible climate change measures to rescue our environment from environmental degradation and desertification; and
v. Being part of the community's public works and encouraging project employees as reasonably as possible to be involved in collective community works and projects.

NSPDL shall allocate funds for the development and implementation of CSR related projects for the benefit of the local communities. Such funds shall be managed by a body that is representative of the affected communities as well as vulnerable groups. All CSR programmes shall also be handled in a fully transparent manner that maximizes the benefits to the local communities. For example such funds could be used for:

- Installation of PV systems for use by community buildings; and
- Improving local social infrastructures such as schools, health facilities and water supply.

CHAPTER FIVE

ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

Impact assessment is a crucial step towards adequate management of environmental and social impacts of projects. A good assessment and management system are essential for continuous improvement of environmental and social performance. This Chapter therefore presents the findings from the overall assessment of the associated and potential environmental and social impacts of the proposed 80 MW_{AC} solar PV plant project as well as the methodology used to evaluate and determine their significance. It discusses associated and potential positive and negative environmental and social impacts of the proposed project and includes consideration of those impacts related to abnormal (accidental) occurrences in addition to those that might result from normal operations.

The main objectives of the impact assessment are to:

- Identify and evaluate potential environmental and social impacts of the solar PV plant, associated transmission facilities and other offsite infrastructure required to support the solar energy development and determine their significance.
- Isolate significant potential impacts requiring further management actions.
- Enable an adoption of a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, compensate/offset for potential impacts to workers, affected communities, and the environment.

5.2 Impact Assessment Approach & Methodology

The impact assessment approach and methodology is consistent with good international industry practice, International Organization for Standardization (ISO) 14001 requirements for risk and impact assessment and the IFC Performance Standards on Environmental and Social Sustainability (IFC 2012). The process of identification and assessment of potential impacts was based on recent, up-to-date primary information involving the use of empirical data obtained from field studies and detailed description of the project in its geographic, ecological, social and health context (the environmental and social baseline). This was used alongside a combination of other methods including checklists, matrix and professional experience and judgement. It also took into account findings and conclusions of ESIA of similar projects as well as the outcome of the engagement processes with affected communities.

The assessment was carried out in three stages as follows:

- Impact Identification – to specify the impacts associated with each phase of the proposed project life cycle;
- Impact Qualification – to characterize/forecast the nature, magnitude, extent and duration of the impacts; and
- Impact Evaluation – to determine the significance of all identified impacts.

The pathway and approach used for the assessment of the associated and potential impacts of the proposed project is shown in Figure 5.1.

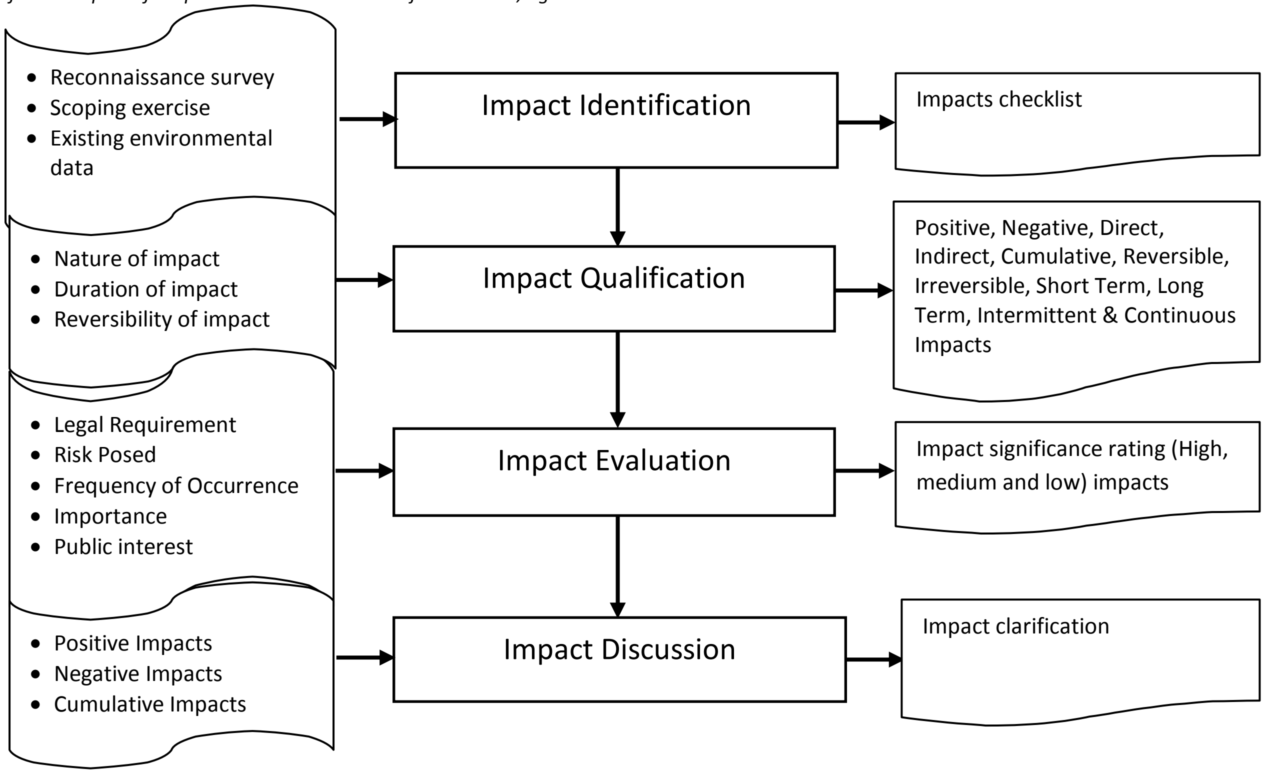

Figure 5.1: Impact Assessment Pathway

5.2.1 Impact Identification

The environmental and social impacts were identified in the context of the project AoI and were based on the existing environmental and social baseline data. A logical and systematic approach was used in order to capture all project - environment interactions capable of resulting in impacts. The impact identification process began during the reconnaissance survey and continued through the scoping exercise when significant issues and impacts were identified. The scoping helped to identify all areas of concern especially pertaining to proposed project activities likely to result in environmental and social impacts such that they will be addressed to the appropriate level of detail. To further identify the impacts, the environmental aspects of proposed project activities were matched with the existing description of the proposed project environment to develop a checklist of associated and potential impacts of the proposed project on the biophysical and social environment. The development of the checklist was carried out using the FMEnv, EIA Sectoral Guidelines for Power Sector Projects, IFC Performance Standards on Environmental and Social Sustainability (IFC 2012), and the World Bank Environmental Assessment Source Book, Volume 111 (Guidelines for Environmental Assessment of Energy and Industrial Projects, 1991). Other source references include the Equator Principles Applicable Environmental and Social Standards (2013), General and Industry specific Environmental, Health and Safety Guidelines (IFC) and other relevant international standard codes for Power and Energy projects.

The associated and potential impacts that could emanate from the proposed project are presented in Table 5.1.

Table 5.1: Identification of Associated and Potential Impacts of Proposed Project

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
A	***Pre-Construction Phase***			
1	Land acquisition	Land Take for project and RoW	• Land Owners/Users	• Loss/depletion of farm land. • Loss of land based livelihood. • Loss of economic trees including medicinal herbs. • Grievance and conflicts over land resettlement & compensation. • Exacerbated poverty condition due to loss of access to land (means of livelihood). • Reduction in food production and consumption.
			• Soil/Land	• Pressure on available adjacent land as a result of land take from farmers.
2	Mobilization of personnel, materials and equipment to site	• Movement of heavy duty vehicles bringing equipment to site • Dust and exhaust (gaseous) emissions • Noise and Vibration	• Air	• Deterioration of local air quality due to the release of fugitive dusts and gaseous pollutant emissions from heavy duty vehicles transporting equipment to site. • Noise and vibration disturbances from heavy equipment and truck traffic.
			• Soil	• Compaction of soil and predisposition to erosion as a result of use and stationary positioning of heavy duty vehicles.
			• Vegetation & Wildlife	• Plant mortality or reduced growth resulting from being trampled by foot and vehicular traffic. • Wildlife injuries and mortality resulting from being crushed by vehicular traffic. • Disturbance and displacement of terrestrial wildlife as a result of noise and vibration from heavy duty vehicles
			• Affected Communities (Pedestrians, Motorcyclists – Community Health, Safety & Security)	• Traffic Congestion and increased risk of Road Traffic Accidents (RTA) and Injuries (Traffic Safety). • Landscape disruption and visual intrusion due to presence of equipment, vehicles and trucks. • Risk of injuries to pedestrians and motorcyclists from collision with moving heavy duty vehicles (Pedestrian Safety). • Risk of security breaches (stock theft) and threat to lives and properties due to storage of materials and equipment on site. • Introduction of negative values and alien culture by the influx of migrant personnel. • Employment of local labour.
			• Workers	• Respiratory and eye related problems from exposure to fugitive dusts and gaseous emissions. • Risks of accidents and struck-by injuries from the movement of heavy duty vehicles.
3	Site (including transmission	• Use of heavy duty	• Air	• Deterioration of local air quality due to the release of fugitive dusts and gaseous

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
	line RoW) preparation and land clearing	motorized equipment for site clearing • Grubbing & Removal of trees • Dust and gaseous emissions • Noise and Vibration • Clearing of project site and RoW • Habitat destruction • Wastes		pollutant emissions from land clearing activities and heavy duty vehicles. • Noise and vibration disturbances from operation of machineries and motorized equipment.
			• Vegetation & Wildlife	• Loss of vegetation/habitat & natural carbon sequestration from vegetation clearing. • Introduction of invasive species and reduction in species diversity as a result of propagation of transported non-native species. • Destruction and displacement of wildlife. • Loss of ecosystem provisioning services such as fuel wood and economic trees.
			• Soil/Land	• Predisposition to soil erosion due to the removal of vegetal cover and exposure of soil surfaces to rain and wind. • Soil contamination from oil spills associated with heavy equipment operation and fueling activities. • Waste generation from accumulation of cleared vegetal materials. • Increased predisposition to arid microclimate and desertification due to reduced evapotranspiration from loss of vegetation.
			• Affected Communities (Livelihood)	• Employment of local labour.
			• Workers	• Respiratory and eye related problems for workers due to exposure to fugitive dusts and gaseous emissions. • Risks of worker exposure to noise emanating from machineries and associated safety concerns from poor communication. • Risks of worker exposure to poisonous plants and dangerous animals e.g. snakes, insects etc. • Risks of accidents and struck-by injuries from the movement heavy duty vehicles, machineries and falling trees.
4	Installation of structures (temporary construction camps and on-site facilities)	• Assembling of temporary on-site structures • Wastes	• Soil/Land	• Generation of construction wastes. • Soil contamination through indiscriminate dumping of waste.
			• Affected Communities(Community Health	• Noise and vibration disturbances in the adjoining settlements from use of machineries and motorized equipment.
			• Workers	• Risk of worker exposure to occupational health and safety hazards, viz: - Physical hazards – noise from operating machineries; - Ergonomic hazards from repetitive motion, poor manual handling, etc.;

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
				- Electrical hazards from use of tools and machineries. • Risks of occupational accidents and injuries to workers from operation of equipment, falls from elevation and poor housekeeping.
B	***Construction Phase***			
1	Access road construction and upgrade	• Grading and levelling of existing and new road surface. • Movement of heavy duty equipment • Dust and gaseous emissions. • Noise and Vibration	• Air	• Deterioration of local air quality due to the release of dust from exposed soil surfaces and exhaust emissions from heavy equipment and motorized vehicles. • Noise and vibration disturbances in the adjoining settlements from the operation of heavy duty equipment during road construction.
			• Soil/Land	• Predisposition to soil erosion due to compaction and exposure of soil surfaces to rain and wind during road grading and leveling. • Generation of solid wastes (excavation materials) from earth moving during construction.
			• Affected Communities (Infrastructure, Livelihood, Community Health & Safety)	• Opening up of access roads to adjoining settlements and remote areas to enhance easy movement of people and their farm produce. • Job creation and increased business. • Increased traffic and attendant risk of RTA and Injuries (Traffic Safety). • Risk of communicable diseases such as sexually transmitted diseases (STDs) including HIV/AIDS from influx of temporary construction workers.
			• Workers	• Risk of worker exposure to occupational health and safety hazards, viz: - Physical hazards from operating machineries and moving vehicles, exposure to weather elements (extremes of temperature), noise; - Chemical hazards from exposure to dust and exhaust emissions; • Respiratory and eye related problems for workers due to exposure to dusts and gaseous emissions. • Risks of occupational accidents and injuries to workers. • Risk of communicable diseases such as STDs including HIV/AIDS.
2	Civil Works (Excavation, leveling and compaction of site; Site fencing; Construction of buildings and foundations including onsite substation, connection building, control building, guard cabin, and	• Dust and gaseous emissions • Operation of heavy equipment • Wastes • Oil spills	• Air	• Deterioration of local air quality due to the release of dust from earthwork activities and exhaust emissions from operating vehicles and equipment. • Noise and vibration generation from operation of earth moving and excavation equipment, concrete mixers, cranes and heavy duty vehicles.
			• Soil/Land	• Soil erosion due to compaction, soil horizon mixing and exposure of soil surfaces to rain and wind during earth moving and excavation activities. • Soil contamination from accidental leakage/spillage of fuel, oil/lubricants from

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
	warehouse; Installation of water supply infrastructures {boreholes, pipe works and storage tanks})	• Employment		equipment and vehicles. • Change in land use pattern (land conversion/transformation) from agro-forestry to industrial use. • Generation of non-hazardous and hazardous wastes e.g. construction wastes (spoils, cement bags, scrap wood and metals) and other wastes from site offices, workshops (oily rags, used filters, used oil) and workers camps (sanitary wastewater, etc.).
			Vegetation & Wildlife	• Disturbance and displacement of wildlife as a result of ongoing noise and presence of workers on project site. • Wildlife habitat fragmentation due to ongoing construction activities preventing wildlife access. • Reduction in wildlife productivity and diversity due to displacement from natural habitat and subsequent competition in new habitat.
			• Groundwater	• Decrease quality and availability of groundwater resource from seepages of waste water, oil/fuel spills and water extraction.
			• Affected Communities (Livelihood, Infrastructure, Culture, Community Health, Safety & Security),	• Job creation via direct engagement by NSPDL and indirect employment through economic vendor activities such as food selling. • Stimulation of local socioeconomic activities arising from employment of locals during construction. • Improved livelihood and poverty reduction. • Landscape disruption and visual intrusion due to construction activities. • Increase demand on existing health and sanitation infrastructure due to influx of temporary workers and camp followers. • Increased social vices/crimes and dilution of indigenous culture, norms and traditions in nearby communities due to influx of migrant workers and business opportunists. • Risk of communicable and vector-borne diseases such as sexually transmitted diseases (STDs) including HIV/AIDS, malaria from influx of temporary construction workers and camp followers and stagnation of waste water. • Threat to community safety and security associated with presence of construction workers. • Risk of exposure to hazardous materials being used on project site during construction
			• Workers	• Risk of worker exposure to occupational health and safety hazards, viz: - Physical hazards – noise from operating machineries; - Chemical hazards from exposure to cement dusts, hazardous materials; - Ergonomic hazards from repetitive motion, poor manual handling, over-exertion,

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
				etc.; - Electrical hazards from use of tools and machineries. • Respiratory and eye related problems for workers due to exposure to dusts including cement dust and exhaust emission. • Risks of occupational accidents and injuries to workers from use of heavy equipment and cranes, falling objects, slips, trips and falls from poor housekeeping.
3	Installation of Mounting Structures and PV Modules	• Operation of equipment and machineries • Hazardous chemicals	• Air	• Noise generation from operation of equipment and machineries.
			• Soil/Land	• Generation of hazardous wastes from damaged PV panels, inverters, batteries and other electrical equipment. • Soil contamination from release of hazardous materials.
			• Groundwater	• Risk of groundwater contamination from leaching of hazardous materials.
			• Affected Communities (Community Health)	• Risk of drinking contaminated groundwater.
			• Workers	• Risk of exposure to hazardous chemicals such as Si, Se ,Cd and Pb dust particles from damaged PV panels, batteries etc. • Risks of occupational accidents and injuries to workers.
4	Installation of Equipment (MV power units – transformers, inverters and switchgears; generation meters, CCTV, SCADA etc)			
5	Erection of pylons and installation of 132 kV overhead HV transmission power lines.	• Noise • Wastes • Oil spills • Erection of towers • Laying of overhead lines	• Air	• Noise and vibration disturbances from operating equipment.
			• Soil	• Predisposition of soil to erosion from soil compaction and disturbances. • Construction site waste generation. • Soil contamination from accidental spills and leakage of fuel and oil.
			• Groundwater	• Risk of groundwater contamination from seepages of fuel and oil spills.
			• Workers	• Risks of fall from working at height on structures and other related occupational accidents and injuries to workers.
6	Electrical Works (wiring of panels and laying of underground/over-ground cables)	• Excavation and Trenching for underground cable laying • Dust and gaseous emissions. • Noise and Vibration	• Air	• Air quality deterioration from fugitive dust arising from excavation and trenching for underground cabling. • Noise and vibration disturbances from operation of equipment used for trenching
			• Soil/Land	• Generation of wastes. • Soil contamination from indiscriminate dumping of wastes and accidental leakage of fuel and oil.
			• Workers	• Risk of worker exposure to occupational health and safety hazards, viz:

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
		• Wastes • Operation of equipment and machineries		- Physical hazards – noise from operating machineries; - Chemical hazards from exposure to fugitive dusts; - Ergonomic hazards from awkward posture, poor manual handling, etc.; - Electrical hazards from exposure to live wire and the use of tools and machineries. • Risks of occupational accidents and injuries to workers.
7	Pre-Commissioning Testing of facilities	• Electricity	• Affected Communities • Workers	• Increased potential for fire outbreak due to failure of electrical installations. • Risk of exposure to electromagnetic radiations. • Risk of electrocution to workers from exposure to live power lines.
8	Demobilization of personnel, materials and equipment (Site clean-up)	• Movement of heavy duty vehicles • Dust and gaseous emissions • Noise and Vibration • Wastes • Removal of temporary structures	• Air	• Deterioration of local air quality due to the release of dust and gaseous emissions from vehicles. • Noise and vibration disturbances from operation of vehicles and dismantling activities.
			• Soil/Land	• Generation of wastes. • Soil contamination from indiscriminate disposal of wastes.
			• Affected Communities (Livelihood, Infrastructure)	• Loss of employment for workers including locals demobilized from project site. • Traffic congestion and increased risk of RTA and injuries.
			• Workers	• Respiratory and eye related problems from exposure to dust and gaseous emissions. • Risks of occupational accidents and injuries.
9	Capacity Building and Training	• Training of workers	• Workers	• Acquisition of new skills and development of human capacity especially by locals employed to work during construction.
C	***Operation Phase***			
1	Operation of PV panels and other associated components	• Electricity	• Air & Climate	• Noise generation from operating transformers. • Reduction/displacement of electricity generation in fossil-fuel-fired power plants by electricity from the solar energy facility will reduce the overall emissions of combustion-related pollutants. • Avoidance of fossil fuel utilization and reduced GHGs and other pollutant gas emissions.
			• Soil	• Soil erosion from soil compaction along access roads. • Waste generation from operational activities
			• Wildlife	• Wildlife collision with project facilities especially PV panels and transmission lines • Changes in bird and prey populations due to provisions made by solar panels for birds to perch. • Wildlife habitat fragmentation due to inability of wildlife to use solar plant as access.
			• Affected Communities	• Creation of employment and business opportunities.

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
			(Livelihood, Community Health)	• Creation of tourist attraction and recreational resources. • Visual intrusion and disruption to aesthetics especially due to highly reflective surfaces of PV panels. • Risk of electrocution and exposures of nearby community members to electromagnetic radiation emitted from on-site inverters. • Potential for fire outbreak due to failure of electrical installations
			• Workers	• Technology transfer and training of project staff on solar power plant management, operation and maintenance. • Risk of electrocution and exposures of workers to electromagnetic radiation emitted from on-site inverters.
			• Nation/Jigawa State	• Promotion of clean energy as an alternative energy source and the establishment of cleaner development mechanism (CDM). • Generation of renewable electricity to boost national power supply. • Increased revenue generation to government through permits and taxes. • Savings on cost of diesel for pumping & distributing water to citizens by the Jigawa State government ministry of water resources.
2	Transmission of power	• Power evacuation	• Air	• Noise impacts from corona discharge
			• Wildlife	• Mortality of birds from collisions with and/or electrocution by transmission lines.
			• Affected Communities	• Visual intrusion due to transmission power lines. • Risk of exposures of nearby community members to electromagnetic radiation from transmission line during power evacuation. • Risk of electrocution to community members and trespassers from direct and indirect contact with power lines especially from falling power lines.
			• Workers	• Risk of exposures of workers to electromagnetic radiation from transmission line during power evacuation. • Risk of electrocution to workers from exposure to live power lines.
			• Nation	• Supply of renewable electricity to boost national power supply. • Increase power transmission to homes and industries.
3	Routine maintenance/servicing of PV panels and associated components as well as maintenance of access to	• Dust and gaseous emissions • Operation of equipment and machineries	• Air	• Air quality deterioration due to the release of fugitive dusts and exhaust emission from vehicular movement. • Noise generation from mechanical repair activities, vehicular movement, maintenance equipment etc.
			• Soil	• Generation of industrial/ hazardous wastes (insulating oils e.g. polychlorinated biphenyls

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
	transmission line RoW	• Wastes • Water usage • Vegetal removal along RoW		(PCBs), liquid petroleum fuels, waste water, cleaning agents and solvents, damaged panels, transformers, batteries, herbicides for weed control, etc.) during routine maintenance. • Soil contamination form leachates of hazardous wastes.
			• Groundwater	• Groundwater contamination from waste water and hazardous chemicals. • Over-extraction (depletion) of ground water resource.
			• Vegetation & Wildlife	• Removal of vegetation and disruption of fauna habitat during maintenance activities.
			• Workers	• Risk of worker exposure to hazardous chemicals. • Risk of electrocution to workers from exposure to live power lines. • Risks of occupational accidents and injuries to workers from falls from heights, towers and use of machineries.
			• Nation	• Prevention of natural forest succession and establishment of tall trees. • Reduction in power outages from checked growth of tall trees and prevention of accumulation of vegetation within transmission line RoW. • Prevention of bush fires and ignition of forests.
D	***Decommissioning Phase***			
1	Removal of PV panels and equipment, as well as power transmission facilities; demolition of structures and evacuation	• Dust and gaseous emissions • Wastes • Demolition of structures • Removal of electrical facilities	• Air	• Air quality deterioration from the release of dust during demolition activities and exhaust emissions from vehicular equipment. • Noise and vibration distribution from demolition activities and movement of vehicles.
			• Soil/Land	• Predisposition to soil erosion as a result of ground disturbing activities. • Generation of industrial and hazardous waste including scrap metals, broken PV Panels, inverters, batteries, liquid petroleum fuels, etc. • Soil contamination from indiscriminate dumping of wastes.
			• Groundwater	• Groundwater contamination from seepage of hazardous materials.
			• Affected Communities	• Landscape disruption and visual intrusion due to the removal of solar plant. • Traffic Congestion and increased risk of Road Traffic Accidents (RTA) and Injuries (Traffic Safety).
			• Workers	• Risk of electrocution to workers. • Risks of occupational accidents and injuries to workers.
2	Site reclamation including ground stabilization and re-vegetation	• Dust and gaseous emissions • Wastes • Site clearing and	• Air	• Deterioration of local air quality due to the release of dust from site leveling activities and exhaust emissions from operating vehicles and equipment.
			• Soil	• Soil stabilization and regeneration. • Increase in land availability for agriculture and other purposes.

S/N	Envisaged Activities	Environmental Aspect	Environmental/ Social Receptors	Associated and Potential Risks and Impacts
		levelling • Revegetation	• Vegetation	• Restoration of vegetation and wildlife habitat.
			• Affected Communities (Livelihood)	• Loss of employment.
			• Workers	• Risks of occupational accidents and injuries to workers.

5.2.2 Impact Qualification

In order to further qualify the impacts of the various proposed project activities on the environment and the people, all identified impacts were characterised based on the nature, duration and reversibility of impacts as follows:

- Beneficial Impacts – these are impacts that have positive and beneficial effects.
- Adverse Impacts – these are impacts that have negative and untoward effects.
- Direct Impacts – these are impacts that are most obvious, result solely and are directly related to the proposed project and can be connected to the action that caused them.
- Indirect Impacts – these are secondary impacts that do not occur directly from a project activity but occur as a consequence of the project as a result of some intermediate step or processes.
- Cumulative Impacts – typically occur from the incremental impact of an action when combined with impacts from projects that have been undertaken recently or would be carried out in the near future.
- Reversible Impacts – these are impacts over which the components involved have the ability to recover after the disturbances caused by the impact.
- Irreversible Impacts – these are impacts whose effects are such that the affected environmental/socioeconomic component cannot be returned to its original state even after adequate mitigation measures are applied.
- Residual Impacts – these are impacts that their effects remain after mitigation measures have been applied.
- Short Term Impacts – these are impacts that last only within the period of a specific project activity.
- Long Term Impacts – these are impacts that have their effects remain after a specific project activity.

5.2.3 Impact Evaluation

The third stage in the assessment procedure involved the evaluation of the impacts identified in order to determine their significance. This was based on the methodological framework set by (ISO) 14001 – Environmental Management System (EMS). The evaluation of impact significance was based on the following clearly defined criteria:

- ✓ Legal/Regulatory requirement (L)
- ✓ Risk posed by impact (R)
- ✓ Frequency of occurrence of environmental impact (F)
- ✓ Importance of affected environmental component and impact (I)
- ✓ Public interest/concern & perception (P)

The above criteria and the rating adopted for the evaluation are described below:

5.2.3.1 **Legal/Regulatory Requirement (L)** – Is there a legal/regulatory requirement?

In the evaluation process, project activities that could result in impacts were weighed against existing legal/regulatory requirements to determine if the issue is affected by legislation or whether permits are required prior to the execution of such activities. Such legal/regulatory requirements were identified from the laws/guidelines, which have been reviewed in Chapter One of this report as well as those guidelines in the source references relating to the proposed project activity. The rating used for this criterion is as shown in Table 5.2.

Table 5.2: Legal/Regulatory Requirement Criteria

Legal/Regulatory Requirement	Rating	Condition
Low	1	No legal/regulatory requirement for carrying out project activity
Medium	3	Legal/regulatory requirement exist for carrying out project activity
High	5	A permit is required prior to carrying out project activity

5.2.3.2 **Risk Posed by Impact (R)** – What is the risk/hazard rating based on Risk Assessment Matrix (RAM)?

Risk is a measure of the likelihood and magnitude of an adverse effect. For the proposed project, associated risks with aspects of project activities were evaluated in terms of:

- Risk to human health;
- Risk to asset (commercial and economic risk);
- Risk to the biophysical environment; and
- Risk to the client's reputation.

Risks posed by potential impacts were evaluated based on the Risk Assessment Matrix (RAM) shown in Figure 5.2. Three criteria, namely: Consequence (C), Probability of occurrence (P) and Severity (S) were used as basis for ranking the risk.

- **Consequence (C):** This was used to determine the severity which was then summed with the probability of occurrence to determine the level of risk as illustrated below:
  - Low Risk where S + P is 2 ≤ 5
  - Medium Risk is where S + P is 6 ≤ 7
  - High Risk is where S + P is 8 ≤ 10

- **Probability (P):** The probability is further explained for clarity as the measure of the likeliness that an event will occur. For the purpose of this Report, the probability factor is quantified as whole numbers between 1 and 5 (where 1 indicates impossibility and 5 indicates absolute certainty). The higher the probability of an event within the scale, the more certain that the event will occur as described in Table 5.3.

Table 5.3: Description of Probability

S/No.	Occurrence	Description
1	Seemingly impossible	An event which has never occurred or is unheard of in the solar power industry
2	Not likely to occur in the project	An event which rarely occurs in the industry, although it may have occurred before but it is uncommon.
3	Possibility of occurring in the project	An event which is likely going to occur

4	Possibility of occurring more than once in the project	An event which the industry is familiar with and may occur more than once within a project
5	Possibility of repeated occurrence	An event which occurs frequently in the industry and may likely occur almost every day during the project.

Using the RAM in Figure 5.2, risk posed by potential impacts were assessed and ranked as presented in Table 5.4:

Table 5.4: Risk Criteria

Risk	Rating	Attribute – Environmental, Human Health, Safety and Reputation
Low	1	This means that no further mitigation action may be required
Medium	3	The impact can be mitigated with additional controls and modifications
High	5	This means that the impact require avoidance or major control/mitigation

	CONSEQUENCE				**INCREASING PROBABILITY**				
					1	**2**	**3**	**4**	**5**
SEVERITY	**People**	**Asset Damage**	**Environmental Effect**	**Reputation**	**Seemingly Impossible**	**Not Likely to Occur**	**Possibility of Occurring in the Project**	**Possibility of Occurring more than Once**	**Possibility of Repeated Incidents**
1	**Slight injury:** Superficial, does not require First-Aid treatment	**Slight:** Superficial equipment damage. Does not require any repairs	**Slight:** Insignificant effect that can immediately be corrected	**Slight:** No complaint or media attention	**Low Risk**				
2	**Minor injury:** Requires First-Aid treatment	**Minor:** Requires little repairs but can be used without repairs	**Minor:** Short term effects but not affecting ecosystem	**Limited:** Possible complaint, low media attention					
3	**Major injury:** Requires medical treatment.	**Localized:** Damage done to a specific part of the equipment which makes it un-useable without repairs	**Localized:** Serious medium term effects to a specific part of the environment	**Considerable:** Public complaint, moderate media attention, possible legal action			**Medium Risk**		
4	**Serious injury:** Partial disablement or severe injury	**Major:** Irreparable equipment damage, needs replacement	**Major:** Very serious, long term impairment of the environment	**National:** Several public complaint, damage to reputation within the country, public embarrassment, high media attention, legal action					
5	**Multiple fatalities:** Death or permanent disablement	**Extensive:** Irreparable multiple equipment damage	**Massive:** Irreversible harm on the environment	**International:** Irreversible damage to reputation both within and outside the country, very high level of public embarrassment, very high media attention					**High Risk**

Figure 5.2: Risk Assessment Matrix

5.2.3.3 **Frequency of Impact (F)** – What is the frequency rating of impact?

Evaluation of the frequency of occurrence was carried out and rated as "high", "medium" or "low" based on the outcome of the RAM, consultation with project proponent, experts and professional judgment. The weighing scale used for this criterion is presented in Table 5.5.

Table 5.5: Frequency Criteria

Importance	Rating	Attribute – Environmental, Human Health and Safety
Low	1	✓ Minor degradation in quality in terms of scale (<0.1% of study area), appearance and duration (e.g. only a few days). ✓ Rapid reversibility (change lasting only a few weeks before recovery, no lasting residual impact of significance) ✓ No potential for cumulative impact ✓ Very localized geographic extent of impact (e.g. not more than a few meters from impact source point) ✓ Low frequency of impact (occur in just about one occasion during the project execution period) ✓ Immeasurable change in social, cultural, economic activity of affected communities (e.g. a few jobs lost, etc.)
Medium	3	✓ Degradation in quality in terms of scale (>0.1% of study area), appearance and duration (e.g. a few months). ✓ Slow reversibility (change lasting only a few months before recovery, lasting residual impact of significance) ✓ Potential for cumulative impact ✓ Limited geographic extent of impact ✓ Intermittent frequency of impact (occur in only a few occasion during the project execution period) ✓ Measurable change in social, cultural, economic activity of affected communities (e.g. percent of jobs losses, etc.)
High	5	✓ Major degradation in quality in terms of scale (>1% of study area), appearance and duration (beyond duration of project). ✓ Irreversible or only slowly recoverable (change lasting more than one year, degradation of environmental ecosystem level (population, abundance, diversity, productivity) ✓ Existing cumulative impact ✓ Geographic extent of impact (Encompassing areas up to half the area of project coverage) ✓ High frequency of impact (occur continuously and almost and almost throughout the project execution period (about 12 months) ✓ Major change in social, cultural, economic activity of affected communities (e.g. percent of jobs losses, etc.)

5.2.3.4 **Importance of Impact (I)** – What is the rating of importance based on consensus of opinions?

The importance of target environmental component in respect of identified potential impact was determined and rated as "high", "medium" or "low". The ratings were based on consensus of opinions among consulted experts including project engineers and other stakeholders on the proposed project. The rating used for the criterion is outlined in Table 5.6.

Table 5.6: Importance Criteria

Importance	Rating	Attribute – Environmental, Human Health and Safety
Low	1	✓ Low Imperceptible outcome ✓ Insignificant alteration in value, function or service of impacted resource ✓ Within the compliance of regulations, no controls required
Medium	3	✓ Negative outcome ✓ Measurable reduction or disruption in value, function or service of impacted resource ✓ Potential for noncompliance with regulations
High	5	✓ Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) ✓ Detrimental and extended flora and fauna behavioral change (breeding, spawning, molting) ✓ Major reduction or disruption in value, function or service of impacted resource ✓ Impact during environmentally sensitive period ✓ Continuous noncompliance with regulations

- ***5.2.3.5*** **Public Interest/Concern & Perception (P)** – What is the rating of public perception and interest regarding the project and impacts based on consultation with stakeholders?

The opinions, views and concerns of interested parties including affected communities were solicited through consultations and questionnaire administration. The ratings were assigned as follows:

1 = Low perception and interest; 3 = Medium perception and interest; 5 = High perception and interest. The criteria used to assign the ratings are outlined in Table 5.7.

Table 5.7: Public Interest/Concern & Perception Criteria

Public Interest/Concern & Perception	Rating	Attribute – Environmental, Human Health & Safety
Low	1	✓ No risk of accident and/or death ✓ No risk to human health, acute and/or chronic ✓ No negative effect on means of livelihood ✓ No possibility of life endangered for on-site personnel ✓ Minor reduction in social, cultural, economic value
Medium	3	✓ Limited incremental risk to accidents and death ✓ Minimal report on risk to human health, acute or chronic ✓ Unlikely life endangered for on-site personnel ✓ Some reduction in social, cultural, economic value ✓ Possibility of adverse perception among population in the study area ✓ Potential for non-compliance
High	5	✓ Elevated incremental risk to accidents and death ✓ Increased risk to human health, acute and / or chronic ✓ Possibility of life endangered for on-site personnel ✓ Possibility of fuelling inter-communal conflict ✓ Major reduction in social, cultural, economic value ✓ Major public concern among population in the study area ✓ Continuance non-compliance with statutes

Overall Significance Ranking

Following the evaluation of each impact using the criteria discussed above, the significance of each impact was then rated as “Low”, “Medium” or “High” using the criteria below.

- **LOW:**

(L+R+F+I+P) = 0 - 8: *That is the sum of weight of Legal Requirement, Risk Factor, Frequency of Occurrence of Impact, Importance & Public Perception ranges between 0 and 8.*

- **MEDIUM:**

(L+R+F+I+P) = 9 - 14: *That is the sum of weight of Legal Requirement, Risk Factor, Frequency of Occurrence of Impact, Importance & Public Perception ranges between 9 and14.*

- **HIGH:**

(L+R+F+I+P)= $\geqslant$ 15: *That is the sum of weight of Legal Requirement, Risk Factor, Frequency of Occurrence of Impact, Importance & Public Perception is greater or equal to 15.*

OR

(F+I) > 6: *That is sum of weight of Frequency of Occurrence of Environmental Impact and Importance of affected Environmental Component is greater than the benchmark of 6.*

OR

P = 5: *That is the weight of public interest and perception of the potential impact is the benchmark of 5.*

The result of the impact characterization and evaluation exercise is presented in Table 5.8.

Table 5.8: Qualification and Evaluation of Associated and Potential Impacts of Proposed Project

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria					F+I	Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P		L+R+F +I+P	
Pre-Construction																			
Land acquisition	Loss/depletion of farm land	X		X		X	X			X		3	3	3	3	5	6	17	HIGH
	Loss of land based livelihood.	X		X			X			X		0	3	3	3	5	6	14	HIGH
	Loss of economic trees including medicinal herbs.	X		X		X	X			X		0	3	3	3	5	6	14	HIGH
	Grievance and conflicts over land resettlement & compensation.	X		X			X			X		0	3	5	3	5	8	16	HIGH
	Exacerbated poverty condition due to loss of access to land (means of livelihood).		X	X			X			X		0	3	3	3	3	6	12	MEDIUM
	Reduction in food production and consumption		X	X			X			X		0	1	3	1	3	4	8	LOW
	Pressure on available adjacent land		X	X			X			X		0	1	1	3	3	6	8	LOW
Mobilization of personnel, materials and equipment to site	Deterioration of local air quality due to the release of fugitive dusts & gaseous pollutant emissions from heavy duty vehicles.	X		X				X		X		0	3	3	1	3	4	10	MEDIUM
	Noise and vibration disturbances from equipment & truck traffic.	X		X				X		X		0	3	3	1	3	4	10	MEDIUM
	Compaction of soil and predisposition to erosion as a result of use and stationary positioning of heavy duty vehicles.	X		X				X		X		0	1	3	3	1	6	8	LOW
	Plant mortality or reduced growth as a resulting from being trampled by foot and vehicular traffic.	X		X				X		X		0	1	3	1	1	4	6	LOW
	Wildlife injuries and mortality resulting from being crushed by vehicular traffic.	X		X				X		X		0	1	3	1	1	4	6	LOW
	Disturbance and displacement of terrestrial wildlife as a result of noise and vibration from heavy duty vehicles.	X		X				X		X		0	1	3	3	1	6	8	LOW
	Traffic Congestion & increased risk of RTA and Injuries (Traffic Safety).	X		X				X		X		0	5	3	3	3	6	14	MEDIUM
	Landscape disruption and visual intrusion due to presence of equipment, vehicles and trucks.	X		X				X		X		0	3	1	1	1	2	6	LOW
	Risk of injuries to pedestrians and motorcyclists from collision with moving heavy duty vehicles (Pedestrian Safety).	X		X				X		X		0	5	3	3	5	6	16	HIGH
	Risk of security breaches (stock theft) and threat to lives and properties due to storage of materials and equipment on site.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Introduction of negative values and alien culture by the influx of migrant personnel.	X		X				X		X		0	1	3	1	3	6	4	LOW

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria					F+I	Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P		L+R+F +I+P	
	Employment of local labour.	X		X				X	X			3	3	3	3	5	6	17	POSITIVE
	Respiratory and eye related problems from exposure to fugitive dusts and gaseous emissions.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of accidents and struck-by injuries from the movement of vehicles.	X		X				X		X		0	5	3	3	3	6	14	MEDIUM
Site preparation and clearing	Deterioration of local air quality due to release of fugitive dusts & gaseous pollutant emissions from land clearing activities & heavy duty vehicles.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Noise and vibration disturbances from operation of machineries and motorized equipment.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Loss of vegetation/ habitat and natural carbon sequestration from vegetation clearing	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Introduction of invasive species and reduction in species diversity	X		X				X		X		0	1	1	1	1	2	4	LOW
	Destruction and displacement of wildlife.	X		X				X		X		0	1	1	1	1	2	4	LOW
	Loss of ecosystem provisioning services such as fuel wood & economic trees	X		X				X		X		0	3	3	1	3	4	10	MEDIUM
	Predisposition to soil erosion due to the removal of vegetal cover and exposure of soil surfaces to rain and wind.	X		X				X		X		0	5	3	3	3	6	14	MEDIUM
	Soil contamination from oil spills associated with heavy equipment operation and fueling activities.	X		X				X		X		0	1	3	3	1	6	8	LOW
	Waste generation from accumulation of cleared vegetal materials.	X		X				X		X		0	1	3	3	1	6	8	LOW
	Increased predisposition to arid microclimate and desertification due to reduced evapotranspiration from loss of vegetation.	X		X				X		X		0	1	1	1	1	2	4	LOW
	Employment of labour	X		X				X	X			3	3	3	3	5	6	17	POSITIVE
	Respiratory and eye related problems for workers due to exposure to fugitive dusts and gaseous emissions.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of worker exposure to noise emanating from machineries and associated safety concerns from poor communication	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of worker exposure to poisonous plants & dangerous animals e.g. snakes	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of accidents and struck-by injuries from the movement heavy	X		X				X		X		0	3	3	3	3	6	12	MEDIUM

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria					F+I	Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P		L+R+F +I+P	
	duty vehicles																		
Installation of structures (temporary construction camps and on-site facilities)	Generation of construction wastes.	X		X				X		X		0	1	3	3	1	6	8	LOW
	Soil contamination through indiscriminate dumping of waste	X		X				X		X		0	1	3	3	1	6	8	LOW
	Noise and vibration disturbances in the adjoining settlements from use of machineries and motorized equipment.	X		X				X		X		0	3	1	1	3	2	8	LOW
	Risk of worker exposure to occupational health and safety hazards	X		X				X		X		0	3	1	1	1	2	6	LOW
	Risks of occupational accidents and injuries to workers.	X		X				X		X		0	3	1	1	1	2	6	LOW
Construction																			
Construction/improvement of internal and external access roads	Deterioration of local air quality due to the release of dust from exposed soil surfaces and exhaust emissions from heavy equipment and vehicles.	X		X				X		X		0	5	3	3	3	6	14	MEDIUM
	Noise and vibration disturbances in the adjoining settlements from the operation of heavy duty equipment during road construction.	X		X				X		X		0	5	3	3	3	6	14	MEDIUM
	Predisposition to soil erosion due to compaction and exposure of soil surfaces to rain and wind during road grading and leveling.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Generation of solid wastes (excavation materials) from earth moving during construction.	X		X				X		X		0	3	1	1	3	2	8	LOW
	Opening up of access roads to adjoining settlements and remote areas to enhance easy movement of people and their farm produce.		X	X			X		X			0	3	3	3	5	6	14	POSITIVE
	Job creation and increased business		X	X			X		X			0	3	3	3	5	6	14	POSITIVE
	Increased traffic and attendant risk of RTA and Injuries (Traffic Safety).	X		X				X		X		0	5	3	3	5	6	16	HIGH
	Risk of communicable diseases such as STDs including HIV/AIDS from influx of temporary construction workers.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risk of worker exposure to occupational health and safety hazards	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Respiratory and eye related problems for workers due to exposure to dusts and gaseous emissions.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of occupational accidents and injuries to workers.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
Civil Works (Excavation, leveling	Deterioration of local air quality due to the release of dust from earthwork activities and exhaust emissions from operating vehicles	X		X				X		X		0	3	3	3	3	6	12	MEDIUM

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria					F+I	Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P		L+R+F +I+P	
and compaction of site; Site fencing; Construction of buildings and foundations including onsite substation, connection building, control building, guard cabin, and warehouse; Installation of water supply infrastructures {boreholes, pipe works and storage tanks})	and equipment.																		
	Noise and vibration generation from operation of earth moving and excavation equipment, concrete mixers, cranes and heavy duty vehicles.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Soil erosion due to compaction, soil horizon mixing and exposure of soil surfaces to rain and wind during earth moving and excavation activities.	X		X				X		X		0	3	3	3	1	6	10	MEDIUM
	Soil contamination from accidental leakage/spillage of fuel, oil/lubricants from equipment and vehicles.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Change in land use pattern (land conversion/transformation) from agro-forestry to industrial use.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Generation of non-hazardous and hazardous wastes	X		X				X		X		3	1	3	3	3	6	13	MEDIUM
	Disturbance and displacement of wildlife as a result of ongoing noise and presence of workers on project site.	X		X				X		X		0	1	1	1	1	2	4	LOW
	Wildlife habitat fragmentation due to ongoing construction activities preventing wildlife access.	X		X				X		X		0	1	1	1	1	2	4	LOW
	Reduction in wildlife productivity and diversity due to displacement from natural habitat and subsequent competition in new habitat.	X		X				X		X		0	1	1	1	1	2	4	LOW
	Decrease quality and availability of groundwater resource from seepages of waste water, oil/fuel spills and water extraction.	X		X				X		X		0	1	3	3	1	6	8	LOW
	Job creation via direct engagement by NSPDL and indirect employment through economic vendor activities such as food selling.	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Stimulation of local socioeconomic activities arising from employment of locals during construction.	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Improved livelihood and poverty reduction.		X	X			X		X			3	3	3	5	5	8	19	POSITIVE
	Landscape disruption and visual intrusion due to construction activities.	X		X				X		X		0	3	1	1	1	2	6	LOW
	Increase demand on existing health and sanitation infrastructure due to influx of temporary workers and camp followers.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Increased social vices/crimes and dilution of indigenous culture, norms and traditions in nearby communities due to influx of migrant	X		X				X		X		0	3	3	3	3	6	12	MEDIUM

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria					F+I	Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P		L+R+F +I+P	
	workers and business opportunists.																		
	Risk of communicable & vector-borne diseases such as STDs including HIV/AIDS, malaria from influx of temporary construction workers and camp followers and stagnation of waste water.	X		X				X		X		0	5	3	3	5	6	16	HIGH
	Threat to community safety and security associated with presence of construction workers.	X		X				X		X		0	3	1	3	3	6	10	MEDIUM
	Risk of exposure to hazardous materials being used on project site during construction	X		X				X		X		0	1	1	1	3	2	6	LOW
	Risk of worker exposure to occupational health and safety hazards	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Respiratory and eye related problems for workers due to exposure to dusts including cement dust and exhaust emission.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of occupational accidents and injuries to workers from use of heavy equipment and cranes, falling objects, slips, trips and falls	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
• Installation of Mounting Structures and PV Modules • Installation of Equipment (MV power units – transformers, inverters and switchgears; Meters, CCTV, SCADA etc)	Noise generation from operation of equipment and machineries	X		X				X		X		0	1	1	1	3	2	6	LOW
	Generation of hazardous wastes from damaged PV panels, inverters, batteries and other electrical equipment.	X		X				X		X		0	3	1	1	3	2	8	LOW
	Soil contamination from release of hazardous materials	X		X				X		X		0	3	1	1	3	2	8	LOW
	Risk of groundwater contamination from leaching of hazardous materials.	X		X				X		X		0	1	1	1	3	2	6	LOW
	Risk of drinking contaminated groundwater.	X		X				X		X		0	3	1	1	3	2	8	LOW
	Risk of exposure to hazardous chemicals such as Si, Se ,Cd and Pb dust particles from damaged PV panels, batteries etc.	X		X				X		X		0	1	3	3	1	6	8	LOW
	Risks of occupational accidents and injuries to workers.	X		X				X		X		0	1	1	1	1	2	4	LOW
Erection of pylons and installation of 132 kV overhead HV transmission power lines.	Noise and vibration distributions from operating equipment	X		X				X		X		0	3	1	1	3	2	8	LOW
	Predisposition of soil to erosion from soil compaction and disturbances	X		X				X		X		0	3	1	1	1	2	6	LOW
	Construction site waste generation.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Soil contamination from accidental spills and leakage of fuel and oil.	X		X				X		X		0	3	1	1	3	2	8	LOW
	Groundwater contamination from seepages of fuel and oil	X		X				X		X		0	1	1	1	3	2	6	LOW
	Risks of fall from working at height and other related occupational	X		X				X		X		0	3	3	3	3	6	12	MEDIUM

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria					F+I	Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P		L+R+F +I+P	
	accidents and injuries to workers.																		
Electrical Works (wiring of panels and laying of underground/over-ground cables)	Air quality deterioration from fugitive dust arising from excavation and trenching for underground cabling.	X		X				X		X		0	3	1	1	3	2	8	LOW
	Noise & vibration disturbances from operation of equipment for trenching	X		X				X		X		0	3	1	1	3	2	8	LOW
	Generation of wastes.	X		X				X		X		0	3	1	1	1	2	6	LOW
	Soil contamination from indiscriminate dumping of wastes and accidental leakage of fuel and oil.	X		X				X		X		0	3	1	1	3	2	8	LOW
Pre-Commissioning Testing of facilities	Increased potential for fire outbreak due to failure of electrical installations	X		X				X		X		0	1	3	3	1	6	8	LOW
	Risk of exposure to electromagnetic radiations.	X		X				X		X		0	1	1	1	3	2	6	LOW
	Risk of electrocution to workers.	X		X				X		X		0	5	3	5	5	8	18	HIGH
Demobilization of personnel, materials and equipment (Site clean-up)	Deterioration of local air quality due to the release of dust and gaseous emission from vehicles.	X		X			X			X		0	1	1	1	3	2	6	LOW
	Noise and vibration disturbances from operation of vehicles and dismantling activities	X		X			X			X		0	1	1	1	3	2	6	LOW
	Generation of waste	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Soil contamination from indiscriminate disposal of wastes	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Loss of employment for workers including locals demobilized from site.	X		X				X		X		0	3	1	1	3	2	6	LOW
	Traffic congestion and increased risk of RTA and Injuries.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
Capacity Building and Training	Acquisition of new skills and development of human capacity especially by locals employed to work during construction	X		X			X		X			0	3	3	5	5	8	16	POSITIVE
Operation Phase																			
Operation of PV panels and other associated components	Noise generation from operating inverters.	X		X			X			X		0	1	1	1	1	2	4	LOW
	Reduction/displacement of electricity generation in fossil-fuel-fired power plants by electricity from the solar energy facility will reduce the overall emissions of combustion-related pollutants.		X	X			X		X			3	3	3	5	5	8	19	POSITIVE
	Avoidance of fossil fuel utilization and reduced GHGs and other pollutant gas emissions.	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Predisposition to soil erosion from soil compaction along access roads	X		X				X		X		0	3	1	1	1	2	6	LOW

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria						Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P	F+I	L+R+F +I+P	
	Waste generation from operational activities	X		X				X		X		0	3	1	1	1	2	6	LOW
	Wildlife collision with project facilities especially PV panels and transmission lines	X		X			X			X		0	3	1	1	1	2	6	LOW
	Changes in bird and prey populations due to provisions made by solar panels for birds to perch.	X		X			X			X		0	1	1	1	1	2	4	LOW
	Wildlife habitat fragmentation due to inability of wildlife to use solar plant as access	X		X			X			X		0	1	1	1	1	2	4	LOW
	Creation of employment and business opportunities	X		X			X		X			3	5	3	5	5	8	21	POSITIVE
	Creation of tourist attraction and recreational resources	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Visual intrusion and disruption to aesthetics especially due to highly reflective surfaces of PV panels.	X		X			X			X		0	3	3	3	3	6	12	MEDIUM
	Risk of electrocution to workers	X		X				X		X		0	5	3	3	5	6	16	HIGH
	Exposures of workers and nearby community members to electromagnetic radiation emitted from on-site inverters.	X		X				X		X		0	1	1	1	1	2	4	LOW
	Potential for fire outbreak due to failure of electrical installations	X		X			X			X		0	3	3	3	3	6	12	MEDIUM
	Technology transfer and training of project staff on solar power plant management, operation and maintenance.	X		X			X		X			3	5	3	5	5	8	21	POSITIVE
	Promotion of clean energy as an alternative energy source and the establishment of cleaner development mechanism (CDM).	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Generation of renewable electricity to boost national power supply.	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Increased revenue generation to government through permits & taxes	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Savings on cost of diesel for pumping & distributing water to citizens by the Jigawa State government ministry of water resources.		X	X			X		X			3	3	3	5	5	8	19	POSITIVE
Transmission of power	Noise impacts from corona discharge	X		X			X			X		0	1	1	1	1	2	4	LOW
	Mortality of birds from collisions with and/or electrocution by transmission lines.	X		X			X			X		0	3	1	1	1	2	6	LOW
	Visual intrusion due to transmission power lines.	X		X			X			X		0	1	1	1	3	2	6	LOW
	Risk of exposures of workers and nearby community members to electromagnetic radiation from transmission line during power evacuation.	X		X			X			X		0	1	1	1	1	2	4	LOW
	Risk of electrocution to community members and trespassers from	X		X				X		X		0	5	3	3	5	6	16	HIGH

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation Assessment Criteria						Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	L	R	F	I	P	F+I	L+R+F +I+P	
	direct and indirect contact with power lines especially from falling power lines.																		
	Risk of electrocution to workers from exposure to live power lines	X		X				X		X		0	5	3	3	5	6	16	HIGH
	Supply of renewable electricity to boost national power supply.	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
	Increase power transmission to homes and industries.	X		X			X		X			3	3	3	5	5	8	19	POSITIVE
Routine maintenance and servicing	Air quality deterioration due to the release of fugitive dust and exhaust emission from vehicular movement.	X		X				X		X		0	1	1	1	3	2	6	LOW
	Noise generation from mechanical repairs activities, vehicular movement, maintenance equipment etc	X		X				X		X		0	1	1	1	3	2	6	LOW
	Generation of industrial/ hazardous wastes (insulating oils e.g. polychlorinated biphenyls (PCBs), liquid petroleum fuels, waste water, cleaning agents and solvents, damaged panels, transformers, batteries, herbicides for weed control, etc.) during routine maintenance.	X		X				X		X		3	3	1	3	3	4	13	MEDIUM
	Soil contamination from leachates of hazardous wastes.	X		X				X		X		0	3	3	3	3	4	12	MEDIUM
	Groundwater contamination from waste water and hazardous chemicals	X		X				X		X		0	1	3	1	3	4	8	LOW
	Over-extraction (depletion) of ground water resource.	X		X				X		X		0	1	1	3	3	4	8	LOW
	Removal of vegetation and disruption of fauna habitat for maintenance activities	X		X				X		X		0	1	1	1	1	2	4	LOW
	Risk of worker exposure to hazardous chemicals.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risk of electrocution to workers from exposure to live power lines.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of occupational accidents and injuries to workers from falls from heights, towers and use of machineries.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Prevention of natural forest succession and establishment of tall trees.	X		X			X		X			0	3	3	3	5	6	14	POSITIVE
	Reduction in power outages from checked growth of tall trees and prevention of accumulation of vegetation within transmission line RoW.	X		X			X		X			0	3	3	3	5	6	14	POSITIVE
	Prevention of bush fires and ignition of forests	X		X			X		X			0	3	3	3	5	6	14	POSITIVE
Decommissioning Phase																			
Removal of PV panels	Air quality deterioration from the release of dust during demolition	X		X				X		X		0	3	3	3	3	6	12	MEDIUM

PROJECT ACTIVITIES	ASSOCIATED AND POTENTIAL IMPACTS	Impact Qualification										Impact Evaluation						Total Score	Impact Significance
		Direct	Indirect	Reversibl	Irreversib	Cumulative	Long term	Short	Beneficial	Adverse	Residual	Assessment Criteria					F+I	L+R+F +I+P	
												L	R	F	I	P			
and equipment, demolition of structures and evacuation	activities and exhaust emissions from vehicular equipment.																		
	Noise and vibration distribution from demolition activities and movement of vehicles	X		X				X		X		0	3	1	1	3	2	8	LOW
	Predisposition to soil erosion as a result of ground disturbing activities.	X		X				X		X		0	3	1	1	1	2	6	LOW
	Generation of industrial and hazardous waste including scrap metals, PV panels, inverters, batteries etc.	X		X				X		X		3	1	3	3	3	6	13	MEDIUM
	Soil contamination from indiscriminate dumping of wastes.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Groundwater contamination from seepage of hazardous materials.	X		X				X		X		0	1	3	1	3	2	8	LOW
	Landscape disruption & visual intrusion due to the removal of solar plant.	X		X				X		X		0	1	1	1	1	2	4	LOW
	Traffic Congestion and increased risk of RTA and Injuries (Traffic Safety).	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
	Risks of occupational accidents and injuries to workers.	X		X				X		X		0	3	3	3	3	6	12	MEDIUM
Site remediation including leveling, filling and re-vegetation	Deterioration of local air quality due to the release of dust from site leveling activities, exhaust emissions from operating vehicles & equipment	X		X				X		X		0	1	1	1	3	2	6	LOW
	Soil stabilization and regeneration	X		X			X		X			0	3	3	3	3	6	14	POSITIVE
	Increase in land availability for agriculture and other purposes	X		X			X		X			0	3	3	5	5	8	16	POSITIVE
	Restoration of flora and fauna habitat	X		X			X		X			0	3	3	3	3	6	12	POSITIVE
	Loss of employment	X		X			X			X		0	3	3	3	3	6	12	MEDIUM
	Risks of occupational accidents and injuries to workers.	X		X				X		X		0	1	1	1	3	2	6	LOW

5.3 Impact Discussion

This section further discusses the associated and potential positive and negative environmental and social impacts of the proposed 80 MW_{AC} solar PV plant project. The proposed development will be a source of renewable electricity production and thus it is expected to have highly positive environmental and social impacts for the affected communities, people of Jigawa State and Nigeria at large. However the project will inevitably have some adverse impacts on the biophysical and social environment particularly during pre-construction (land acquisition), construction and decommissioning phases. The adverse impacts will largely be localized in spatial extent, short term and occurring within less sensitive environmental areas. These adverse negative impacts are manageable through the application of appropriate mitigation measures and can largely be avoided by sound design, good construction practices, effective maintenance and adequate supervision and enforcement during the project life cycle. The significant potential environmental and social impacts of the proposed project are discussed below and summarized in Table 5.9.

5.3.1 Potential Positive Environmental and Social Impacts

The significant potential positive environmental and social impacts of the proposed project are discussed in the following subsections.

5.3.1.1 Potential Positive Environmental Impacts

- **Cost Effective and Renewable Source of Energy Generation**

In general, solar power plants have proven to be sustainable, environmentally friendly requiring almost no maintenance. It is also the most affordable form of power for this part of the country. The only other option is to run diesel generators, which are expensive and pose many negative environmental impacts. The proposed project will serve as a cost effective and renewable source of energy generation.

- **Clean Energy Generation**

Unlike some other power generation options, the proposed solar power project will not likely cause the release of significant air pollutants or global warming emissions during operation as the use of fossil fuels will be avoided. Reduction/displacement of electricity generation in fossil-fuel-fired power plants by electricity from the solar energy facility will also reduce the overall emissions of combustion-related pollutants.

5.3.1.2 Potential Positive Social Impacts

The proposed project will most definitely be beneficial to the local economy as well as provide improvement on social infrastructure of both immediate and nearby communities of the project area. Economic benefits to the local population will likely be derived from employment opportunities, material supplies/awards of contracts and wages paid for sundry services rendered by the people of the area. These would lead to indirect and direct wealth creation and improvement on existing job opportunities (e.g. farming activities, etc) as the demand for local goods and services increases. The potential positive social impacts of the proposed project are discussed below:

- **Employment**

The proposed project will create employment to the locals directly and indirectly. Direct short term employment for community members is expected especially during the preconstruction and construction phases. Engagement of local unskilled labour will be required for site clearance, loading and offloading of materials, security services, etc. Semi-skilled job opportunities will also arise for local artisans (plumbers, electrical technicians, carpenters, masons, welders, etc.) during the implementation of construction activities. The project aims to employ a minimum of 30% (up to 60%) of unskilled and skilled labour from surrounding communities for construction. Indirect job opportunities will be created through increased economic activities that will be induced by the availability of electricity and access road amongst others that the project will have to offer to the community. Longer term job opportunities will be created during the operational phase through employment of permanent staff for the solar power plant management, operation and maintenance.

- **Increased Economic Activity**

The proposed project will trigger a short term increase in economic activity around the project areas from the influx of temporary construction labour force and camp followers. The labour force will require food and other retail items that are supplied by the retail shop outlets and local vendors. These are opportunities that youths and women can leverage on.

- **Improved Livelihood, Income, Welfare & Poverty Reduction**

Through direct and indirect employment that will result from the proposed project, it is likely that the overall income level of the people of the project area will be enhanced, thereby, resulting in higher household welfare and poverty reduction.

- **Infrastructural Development**

Infrastructural development may result from normal economic forces related to increased economic activity and from the proposed Solar PV Plant project. Moreover, availability of reliable energy is an essential element for economic and infrastructural development. Therefore, the energy to be generated from the proposed project will also be an essential ingredient to future development in the area. It will also act as a catalyst which will enable the emergence of other industries in the area.

- **Improved Access Road**

The construction and upgrade of access roads to provide for reliable construction and operation access to sites will be of long term benefit to the community in the transportation of farm produce and goods to the markets.

- **Skill Transfer**

The proposed project will transfer skills to the locals through direct training on various activities and aspects of the project. During the first phase of construction, it is planned that a highly-skilled team of solar energy technicians will train about 200 -300 potential local employees preferably from Jigawa State where possible. This skill transfer is expected to build the capacity of the locals and enhance their livelihood skill potentials.

- **Generation and Improved Electricity Supply and Reliability**

The proposed solar power project will generate and supply electricity to boost national power supply and thus increase electricity reliability. The boost in power supply will help meet the increasing electricity demand and reduce losses and the frequency of power outages in Nigeria and Jigawa State in particular.

- **Increase Revenue Generation**

The proposed project will be a source of revenue generation for the private sector and government through the payment of taxes and other necessary permits. This will in turn boost the nation's economic growth.

- **Cost Savings for Government**

The power project when completed will result in cost reduction for Jigawa State government agencies, particularly the Ministry of Water Resources which has to rely on diesel to pump and distribute water across Dutse and its environs at high financial costs.

5.3.2 Potential Negative Environmental and Social Impacts

The potential negative environmental and social impacts as related to the different phases of project implementation are discussed in the following subsections:

5.3.2.1 Potential Negative Environmental Impacts

- ❖ **Impact on Air Quality**
- ***Air Quality Deterioration***

The proposed project development could affect air quality especially during the preconstruction, construction and decommissioning phases of the project.

Preconstruction activities likely to pose adverse impact on air quality include mobilization of equipment and materials to site as well as site preparation and land clearing (grubbing and tree removal). Due to the size of the proposed development, large volumes of traffic are anticipated during this phase. It is envisaged that about 500 truckloads transporting 300 – 400 40-foot containers, as well as up to 5 digger loaders for land clearing and 5 to 10 trucks (with cranes) would be required for construction phase. Consequently, fugitive dusts will be released from soil disturbances and engine exhaust emissions from heavy equipment and vehicles. Movement of heavy duty vehicles will also contribute to air emissions of criteria pollutants such as SO_2, CO, VOC and GHGs such as CO_2 and NO_2. Impacts of dust and gaseous emissions during this phase are considered to be significant particularly given the close proximity of human settlements to the unpaved existing access roads. However, the impact is adjudged of medium significance given the short period of activities in this phase. In addition, these emissions are anticipated to be generated in small concentrations and dispersed rapidly. Dust suppression methods, such as the use of water, will also be employed to minimize the amount of effect on the local surroundings.

During construction, activities such as topsoil stripping, road construction/improvement, ground excavation, drilling, buildings/structure erection and mechanical installations may result in the release of fugitive dust from exposed soil surfaces as well as exhaust emissions from heavy equipment and vehicles. These impacts will inevitably be felt by on-site workers and inhabitants of adjoining communities due to their close proximity especially to the access roads. Baseline survey revealed that the existing access road passes by the outskirts of Katangar Lafiya village and consequently, the village is likely to be more affected than others in the project area. Although these impacts are expected to be highly localized, temporary and transient in nature, they are considered to be of medium significance due to their potential effects on construction workers and human settlements.

The anticipated impacts on air quality during decommissioning will be similar to the construction phase as activities will entail demolition and dismantling of solar facilities and other support facilities such as buildings and structures. This impact is also adjudged to be of medium significance.

It is instructive to note that the emissions of GHGs in the implementation of the proposed project can be considered negligible when compared with the GHGs emission reduction that will result from the solar PV plant replacing fossil-fuel-based power generation. The offsets or reductions that would result from the use of solar technology to produce electricity would reduce the contribution to global climate change. No noticeable long-term effect on the local or regional air quality is therefore expected.

- ***Noise and Vibration***

Activities during the preconstruction, construction and operation phases of the project may generate noise and vibration impacts.

During pre-construction and construction, major noise sources will be from vehicular traffic and the operation of heavy equipment such as earth moving and excavation equipment, concrete mixers and cranes. Average noise levels for typical construction equipment range from 74 dB(A) for a roller to 101 dB(A) for a pile driver at a distance of 15m from source (Hansen et al, 2006). Except for pile drivers and rock drills most construction equipment has noise levels ranging from 75 – 90 dB(A) at a distance of 15m. Construction noise is however unavoidable and could pose significant risks to construction workers and nuisance to members of adjoining communities. The impact is however adjudged medium in view of the fact that noise generating activities will be short term and will occur during the day when noise is better tolerated because of the masking effect of background noise.

Noise generating activities will be very minimal during the operational phase of the project and will likely emanate in the form of buzzing and humming from transformers.

No major vibration causing equipment will be used during the implementation of the project and as such potential vibration impacts on surrounding communities will likely be negligible. There are however no vibration sensitive structures in the proposed project area.

❖ **Impact on Soil**

The development of the proposed project may have impacts on soils over an area equivalent to the sum of the footprints of all structures and associated infrastructures including the transmission line RoW. The potential impacts may include soil compaction with predisposition to soil erosion and soil contamination. These impacts are likely to be significant during the preconstruction, construction and decommissioning phases of the project.

- ***Soil Erosion***

Ground disturbing activities during preconstruction and construction phases will inevitably predispose top soil to erosion menace. Activities such as site clearing with removal of vegetation, excavation, soil stockpiling and vehicular traffic especially on unpaved road surfaces can result in soil compaction, soil horizon mixing and attendant predisposition to soil erosion. Construction of associated infrastructures such as access roads, power transmission line and other facilities such as control building, substation, sanitary facilities etc. will also have the potential to predispose soil to erosion. This impact is considered to be of medium significance in view of the predominant sandy texture of soils and strong winds in the project AoI which makes the soils prone to erosion from wind and rain. Appropriate measures will however be put in place to preserve the health and functioning of the soils.

- ***Soil Contamination***

Accidental leakages or spills of hazardous materials such as fuels, oils and lubricants used in operating and maintaining vehicles and equipment as well as from their improper handling and storage may cause direct contamination to soil especially during construction and operation phases of the project. Poor disposal of industrial/hazardous wastes (insulating oils e.g. PCBs, liquid petroleum fuel, cleaning agents/solvents, damaged panels, transformers, batteries and broken solar PV panels) during operation (maintenance) and decommissioning phases may also lead to significant contamination of soils in the project area. Special handling of hazardous materials will however be ensured to prevent soil contamination. This impact is considered of medium significance because of the potential risk to other resources such as humans, groundwater, vegetation and wildlife.

❖ **Waste Impact**

Section 3.16 of this report discusses the nature, type and estimated amount of wastes expected to be generated during the entire life cycle of the proposed project. Waste materials of significance will inevitably be generated during the construction, operation and decommissioning phases of the project.

Wastes emanating during the construction phase will likely include non-hazardous materials such as packaging materials (wooden pallets, cardboard, cartoons, etc.), scrap metals, bricks/concrete wastes and domestic wastes from site offices and workers camp (food wastes, cans, tins, etc.). Wastes generated during decommissioning would largely be derived from dismantling and demolition activities and will be much similar to the wastes generated during construction. Large volumes of solid wastes will likely be generated during facility dismantlement. Much of this waste will however have recycling options and are anticipated to be stored on-site for a short period. Impacts of this category of waste are considered to be of medium significance as they can be easily managed through the adoption of effective waste management practices.

However, during construction, operation and decommissioning activities there may be generation of hazardous wastes such as used lead-acid batteries, oily rags, insulating/spent oils, oil filters, cleaning solvents etc. (from on-site maintenance of vehicles and equipment) and damaged PV panels, transformers, etc. In addition, during the decommissioning phase, liquid wastes will be generated during the purging of plant systems with water and organic solvents. As stated earlier, special handling of solar panels containing toxic materials will be ensured to prevent their accidental breakage and preserve any opportunities for the recycling of the solar cell materials. It is instructive to note that the high performance solar cell materials in the PV panels contain only small amount of toxic metals which under normal conditions are secured within sealed solar panels and present no hazards to workers and the public.

Although, minimal amount of hazardous waste is expected, impact of hazardous waste during these phases is however considered to be of medium significance due to the potential for hazardous waste contamination of soil and groundwater and its attendant health hazards. A robust site specific waste management plan will however be implemented to prevent untoward impacts on these receptors.

❖ **Impact on Ecology and Biodiversity**

The development of the proposed project will likely have negative impacts on terrestrial vegetation, wildlife and biodiversity especially on the project site and transmission RoW. These impacts will be most significant during site preparation and clearing and will include direct impacts from habitat removal and indirect impacts. The significant potential impacts on terrestrial vegetation and wildlife are discussed below.

❖ **Impact on Vegetation**

- ***Loss of Vegetation/Habitat***
- ***Habitat Fragmentation***

Site clearing activities during the preconstruction phase will inevitably lead to loss of vegetation with attendant loss/fragmentation of fauna habitat. The vegetation communities present within the boundaries of the 200 hectares proposed project site is expected to be removed. Field survey revealed that the natural vegetation in the proposed location has been significantly converted by farming activities; however, there are scattered natural vegetation and economic trees which will likely be removed. The plant communities that could be affected by project development include *Adansonia digitata*, *Acacia sieberiana* and *Balanites aegyptiaca* being common woody species while *Setaria pallid fusca*, *Digitaria exiles* and *Urelytrum gigantium* are the dominant grass species in the project area. Significant loss of vegetation is not likely to occur along the 3.66km transmission line RoW as grasses and low shrubs will be allowed to thrive but scattered tall trees will only be removed. These impacts are considered to be of medium significance, given the sparse nature of natural vegetation on the site and the plan to ensure that land clearing activities will be restricted and localized.

The loss of vegetation is not likely to contribute significantly to desertification as low-growing vegetation will be allowed to grow under and around the panels during the operational phase to allow for soil stabilization, storm water control, and provision of habitat. Similarly, areas along RoW that would be temporarily affected by construction activities would be restored as well as other temporarily disturbed project areas. This will further reduce the impact of habitat fragmentation and vegetation loss and will enhance carbon sequestration. It is instructive to note that there are no rare communities, endangered species, riparian areas and wetlands identified within the boundaries to be cleared.

- ***Introduction of Invasive Species and Reduction in Species Diversity***

Disturbed soils especially during site clearing, road construction and civil work activities may provide an opportunity for the introduction and establishment of non-native invasive species that are generally tolerant of disturbed conditions. Seeds or other propagules of invasive species may be transported to the project site from infested areas by heavy equipment or other vehicles that will be used at the site. Invasive plant species typically develop high population densities and tend to exclude most other plant species, thereby reducing species diversity and potentially resulting in long-term effects. This impact is considered to be of low significance as vegetation growth on the site following construction will be subject to operational controls that will prevent proliferation and spread of weeds.

- ***Loss of Ecosystem Services***

Site clearing and vegetation removal may lead to loss of ecosystem provisioning services such as provision of fuel wood and economic trees. Plant species of economic value likely to be affected include *Acacia senegal*, one of the dominant woody species in the area that produces gum arabic used in the manufacture of writing ink, hair glazing cream, mucilage for pharmaceuticals, and glues in plywood industries, while its leaves and pods are used as livestock feed; *Acacia albida* and *Piliostigma reticulatum* which form good fodder, fuel wood and industrial raw materials; and *Vitellaria paradoxa* which produces shea butter used in producing hair and body creams. There could also be loss of fuel wood which is a major source of energy for cooking in the affected communities. This impact is considered to be of medium significance in view of its importance to owners of these economic trees. It is however planned that affected owners will be adequately compensated for this loss.

Impact on Wildlife

Activities during the preconstruction and construction phases of the proposed project have the potential to negatively impact wildlife. These potential impacts are discussed below:

- ***Wildlife Injuries and Mortality***

Mobilization to site, site clearing, road construction and excavation activities during preconstruction and construction phases could result in the direct injury or death of wildlife species. Wildlife species, especially those not mobile enough to avoid these activities, such as reptiles, small mammals and those in burrows, may be crushed to death. In addition, if clearing or other construction activities occurred during the dry season, bird nests and eggs or nestlings could be destroyed. This impact is however considered to be of low significance in view of the low population of wildlife species within the boundaries of the proposed project site. There is also the likely possibility that more mobile wildlife species may migrate to adjoining habitats and avoid destruction..

- ***Wildlife Disturbance and Displacement***

Activities during preconstruction and construction phases may result in disturbances to wildlife in the project area due to noise emanating from equipment, heavy duty vehicles and from the presence of construction workers on site. This impact is also considered to be insignificant as it would generally be temporary and intermittent. Adequate measures will however be put in place to reduce the intensity of noise from these activities.

- ***Wildlife Collision with Project Facilities***

During operation, the presence of the solar energy facilities may likely create a physical hazard to some wildlife. In particular, birds could collide with the solar facilities especially the large array of PV panels and the transmission line, while mammals could collide with project fencing. This impact is considered to be of low significance as ground-level collisions at solar energy project sites would be infrequent, since the human activity, noise, and limited quantity and quality of habitat within the project site would discourage the presence of most wildlife in the immediate project area.

❖ ***Impact on Water***

The project area is largely dependent on groundwater therefore water use by the proposed project is a significant consideration for groundwater resource impact. The project has the potential to negatively impact on the quality and quantity (availability) of groundwater resource especially during the construction and operation phases.

- ***Impact on Groundwater Quality***

Groundwater quality could be negatively affected through seepages of waste water, spilled oil, fuels and other hazardous materials as discussed earlier. However, with the mitigation measures planned to be put in place through the implementation of the project specific waste management plan, it is expected that contamination of underground water will be highly unlikely. This impact is thereby considered of negligibly low significance.

- ***Impact on Groundwater Quantity***

Water will be required for various uses during the construction and operational phases and groundwater is expected to be drawn from local aquifers to meet the project's water need. Major water use activities during construction will relate to fugitive dust control, concrete preparations for foundations of buildings and mounting structures, vehicle washing and workforce sanitary/domestic activities.

During the operational phase groundwater is expected to be extracted for the cleaning of panels to reduce yield losses that may arise from soiling of the panels especially during the dry season. As discussed in section 3.15.2 the total amount of water that will be required during the operational phase is estimated at 55,200,000 litres per year. In view of the fact that there are no surface water bodies in the project area, all non-potable water required during construction and operational phases will likely be taken from groundwater resources.

Given the rich potential of groundwater resources in Jigawa State, the extraction of groundwater to meet the water requirement during the implementation of the project is not likely to exceed the sustainable yield of the groundwater basin. In view of this, the potential impact is considered to be of low significance. However adequate measures will be taken to conserve water usage during project implementation. It is instructive to note that 25% of the 3555 Mm^3 of groundwater available for utilization in Jigawa State has been recommended for use for solar power development in the State by the Ministry of Water Resources.

5.3.2.2 Potential Negative Social Impacts

The significant potential negative social impacts of the proposed project are discussed below.

- **Impact of Land Acquisition and Involuntary Resettlement**

Land acquisition and expropriation for the proposed project will lead to economic displacement of persons thus triggers the IFC Performance Standard 5: Land Acquisition and Involuntary Resettlement. In specific terms the following negative impacts may result from acquisition of about 200 hectares of land for the proposed solar PV plant project:

- **Loss/Depletion of Farmland**

The proposed land acquisition is large and will ultimately lead to loss of land and/or depletion of land for agricultural activities and other land uses. The 200 hectares of land required for the proposed project will be acquired from local farmers currently using the land for agricultural related purposes essentially farming and grazing. This impact is considered to be significant in view of the predominance of agro based livelihood which is the main stay of the local economy in the area.

- **Loss of Land based Livelihood**
- **Exacerbated Poverty**

The involuntary displacement of local farmers from their farmlands will likely have significant impact on the livelihood of these farmers. Reduction of agricultural land available to them for food production as a result of land take may adversely impact on their income. In addition, it is anticipated that a variety of natural and land based resources such as medicinal herbs and wildlife species (bush animals) which are dependent upon by the locals as source of proteins will be removed as a result of the proposed project. These economic trees provide income and shelter. Clearing of vegetation for the implementation of the proposed project may therefore likely lead to loss of income for the affected persons in the community. Jeopardized livelihood may predispose the affected persons to poverty.

- **Grievance and Conflicts**

The tendency for grievance and conflict to result and escalate in the proposed project area are envisaged from loss of agricultural land, economic trees, non-compensation payment and/or inadequate implementation of compensation. Therefore, well planned measures are required to ensure that grievances are avoided or mitigated so as not to impede project sustainability.

- **Reduction in Food Production and Consumption**

Land take will inevitably reduce land available for farming in the proposed project area. Consequently, this may result in reduction in food production and subsequent consumption by peasant farmers who may not have enough other lands for farming. These could lead to increase of hunger and nutritional deficiencies especially amongst the vulnerable groups in the communities.

The above highlighted potential impacts are considered the most significant and sensitive socioeconomic impacts of the proposed project as field study already revealed farming as the predominant occupation in affected communities. If not properly managed economic displacement may result in long-term hardship and impoverishment for the affected farm/land owners and their dependents. Although there will be no physical displacement as a result of the proposed project, the potential impacts of land acquisition are still considered to be of high significance due to the severity of their consequences on the affected persons, their communities and local economy in the proposed project area.

❖ **Traffic Impact**

The implementation of the proposed project will significantly lead to increase in traffic flow in the project area especially during the preconstruction and construction phases of the project.

The impact is likely to be felt more during preconstruction especially during mobilization which will entail the transportation of all equipment, materials and personnel to the project site. During this phase, all PV modules, electrical and structural equipment are planned to be shipped through Lagos port and then trucked to the project site via road. About 500 truckloads transporting 300-400 40-foot containers, 5 digger loaders and up to 10 trucks with cranes are expected to be delivered to the site through the site access road.

Consequently, the existing access road currently being used by community members largely with the aid of motorcycles, animal-carts and by foot to convey their farm produce may become congested. This temporary increase in traffic congestion during this period may have attendant negative impacts which may include the following:

- Increased delay and congestion for road users which may have severance effect especially for rural and non-motorized road users such as pedestrian, cyclists, and those using animal-cart by making it difficult for them to cross the road.
- Increase in potential accident rates and fatalities.
- Increase in fugitive dust and gaseous emissions as well as elevated noise levels.

During construction, traffic is expected to have reduced and be limited to the transportation of on-site workers and delivery of locally sourced materials such as gravel, sand, cements etc. During this phase, traffic may be evident at certain times during working hours, especially if there are slow moving heavy vehicles transporting material to and from the site. Traffic impacts during these phases are considered to be of medium significance considering that activities during this phase will be short term and intermittent but with potential to cause significant disruption to traffic flow in the rural area and potential increase in RTA.

Impacts from traffic are not expected to occur during the operation phase due to minimal number of personnel that will be present within the solar plant. Therefore, increased traffic load is not considered a significant impact.

Anticipated traffic impacts during decommissioning are similar to those of the preconstruction phase, where a large fleet of heavy vehicles may similarly be required to evacuate disassembled parts of the solar plant facility. Traffic impact during decommissioning is equally adjudged to be of medium significance.

❖ **Impact of Landscape Disruption and Visual Intrusion**

While the interest in solar power systems and their benefits has continued to grow, a common concern surrounding these systems is their potential to reflect sunlight and how this reflection can impact surrounding sensitive receptors including humans, animals and structures. Visual impact is perceived depending on viewer's distance, angle and location, viewing duration, visibility factors, landscape setting, viewer activity, sensitivity, and cultural factors (Torres-Sibille et al. 2008). Visual changes associated with the proposed solar plant may arise during the project life cycle.

During preconstruction and construction phases, potential visual impacts may include contrasts to natural landscape resulting from vegetation clearing, the presence of equipment, trucks and other vehicles with associated occasional, road traffic and parking as well as the presence of workers. Movement of vehicles on unpaved surfaces as well as operation of equipment may produce visible fugitive dust and exhaust plumes. Visual impacts would vary in frequency and duration throughout the course of preconstruction and construction specifically not lasting more than 12-14 months. The impact is thereby considered to be of low significance.

During operation, the presence of large array of solar panels may cause glint (a momentary flash of light) and glare (a more continuous source of bright light) from the surface of the panels. There are several factors that may influence glint and glare from solar power generating systems. These factors include the type of solar power generating system used, the surface type of a solar panel and siting of solar panels. In comparison with CSP systems, solar PV which will be installed for the proposed project is more compatible with land use because it is designed to absorb light (rather than reflect it), thereby minimizing potential impacts of glint and glare. Solar PV panels are designed to absorb as much light as possible in order to increase electricity production efficiency. Due to this design, all light that passes through the front surface of the panel is trapped in the layers below and reflection is only limited to the front surface. PV panels are constructed of dark, light-absorbing materials and covered with an anti-reflective coating in order to limit reflection. The technology utilized on PV panels ensures that they reflect as little as 2% of the incoming sunlight depending on the angle of the sun and assuming the use of anti-reflective coatings.

However, PV panel surface remains relatively smooth and homogenous and, as such, is physically capable of producing a concentrated reflection, just as a calm lake can on a wind-free day. Moreover, the percentage of reflection off of a solar panel significantly increases as the sun moves away from perpendicular to the panel. It is at glancing angles, when the sun is low on the horizon (toward sunrise and sunset), that glare can be an issue to viewers because the solar panel is absorbing much less of the incoming light. It is instructive to note that the plant is not located close to the main roads and thus not likely to pose risks to traffics. Impact will largely be felt by members of adjoining communities. This impact is thereby considered to be of medium significance.

During decommissioning, the immediate visual impacts would be similar to those encountered during construction but likely of shorter duration. These impacts may likely result from the removal of aboveground structures and equipment, the presence of workers and equipment with associated dust, gaseous emissions and waste. The impact at this stage will occur for a short term and thereby considered to be of low significance as the site will be restored to pre-project conditions. The newly disturbed soils might not create visual contrasts that could persist for long before revegetation would begin to disguise past activity.

- ***Loss of Employment***

It is envisaged that about 200 -300 workers will be employed during construction, majority of which will be unskilled local workers. This category of workers will inevitably lose their jobs after construction. However, the experience gained and training offered during their employment will enhance their chances of securing similar jobs in the future. In addition, some of the workers would have become financially empowered to start a new venture of their own. Given that the project area has been earmarked as solar village by Jigawa State government, more related jobs will be created by emerging solar facilities. Retrenched workers would have been sufficiently trained to enhance their chances of securing related jobs on the new plants. This impact is thereby considered to be of a low significance. In the same manner, it is envisaged that about 20 -30 workers employed to work on the facility during operation will inevitably lose their job during decommissioning of the project. As this is a long term employment lasting for about 20 years, it is expected that majority of the workers would have become empowered to start a new venture of their own or move to another employment. This impact is thereby considered to be of medium significance.

❖ **Impact on Community Infrastructure**

- ***Pressure on Existing Infrastructures in Nearby Communities***

Arrival of construction workers during construction and associated influx of "camp followers"[1] business opportunists in the project area may put pressure on existing facilities in the adjoining communities. The only visible infrastructure in the nearby communities as recorded during baseline socioeconomic survey are essentially boreholes, some of which are dilapidated and non-functional.

There are no functional health facilities, public toilets and electricity in majority of the settlements in the project AoI. Influx of people into this area is highly likely to impose serious pressure on these limited facilities and may lead to rapid damage. This impact is thereby considered significant but with medium magnitude.

❖ **Impact on Culture**

- ***Increased social vices/crimes and dilution of indigenous culture, norms and traditions***

Influx of temporary construction workers and "camp followers" may put the cultures, norms and traditions of nearby communities at risk of being diluted or influenced by alien culture and negative values.

Alien cultures undesirable to the communities are those practices that degrade the existing social values such as stealing, disrespect, smoking, alcoholism, nude dressing and rape. Being a prominent religious (Muslim) community, it is important to guide against activities of migrant workers that may cause provocation to the indigenes. Alien lifestyles could generate intolerance and grievance which may affect the disposition of the community to the project and, possibly elicit unfriendly treatment to the migrant workers. This potential impact is considered of medium significance.

❖ **Impact on Community Health, Safety and Security**

Proposed project activities especially during preconstruction, construction and decommissioning phases may increase community exposures to risks and impacts. The potential risks and impacts to community health and safety are discussed below according to the following EHAs as recommended in IFC's publication on Introduction to Health Impact Assessment.

- ***Vector Related Health Impacts***

This impact may occur especially during construction and operation phases of the proposed project during which breeding grounds for disease vectors may be created.

[1.] These are individuals and families that will be newly attracted to the area because of the economic and employment opportunities. This will include job seekers, small traders, food sellers, etc.

During construction, open trenches and ditches as well as poorly disposed drums and other containers may become breeding sites for mosquitoes, with subsequent increased risk of malaria for workers and community members residing around the project area. This impact is however adjudged low as good housekeeping and the implementation of the waste management plan by the contractor will largely reduce the risk of this impact. On the other hand, this impact may be more significant during operation phase when large volume of waste water is expected from panel washing. Inefficient management of waste water and lack of adequate drainage system may lead to temporary water pool in and around the site which may encourage the breeding of mosquitoes with attendant increase in vector borne diseases such as malaria. This impact is thereby considered to be of medium significance as it can be adequately managed by ensuring the provision of adequate drainage system around the site.

- ***Respiratory and Eye Related Health Impacts***

Preconstruction and construction activities especially mobilization, site clearing, construction of access roads, civil works as well as decommissioning activities will release fugitive dusts from exposed soil surfaces and poisonous gases from exhaust of operating equipment and moving heavy duty vehicles. These pollutants could cause deterioration of air quality and may have untoward impacts on community health. Short term exposure to fugitive dusts and high concentration of toxic emissions such as CO, $SO_{x,}$ NO_x etc may cause respiratory and eye related problems such as asthma, inflammation of the airway, nasal and eye irritation especially in sensitized people that reside in communities that are in close proximity to the access road. Vulnerable groups such as the elderly, children and people with existing respiratory diseases in these communities are likely to be at particular risk. These health impacts are considered to be of medium significance as exposures are likely to be short term and intermittent.

- ***Sexually Transmitted Infections: HIV/AIDS***

There is the potential for increased behavioural diseases, particularly during construction, due to increased concentration of people such as construction workers, migrant settlers and "camp followers" with diverse cultural and social backgrounds. Inevitable interactions among these migrant population and inhabitants of nearby communities may cause mixing of high and low prevalence groups thereby leading to increased prevalence of STIs especially HIV/AIDS. The risk of this STDs can be heightened by the improved access road which can facilitate the movement of high risk groups into rural settings. This impact is considered to be of medium significance giving the high number of migrant population expected during construction and behavioural changes due to poor standards of living and poverty around the project area which may aggravate the risks of exposure.

- ***Water and Sanitation Related Health Impacts***

Empirical studies on groundwater quantity in the project area have revealed that abstraction of underground water for use during operation phase especially for panel washing and domestic activities by operational staff may not pose significant threat to the availability of water in the area. Consequently, the potential for outbreak of sanitation related diseases such as dysentery, cholera etc. that might have resulted from shortage of water for domestic purposes in nearby communities is considered negligible. This may however be of concern with the increase demand on existing sanitation infrastructure from influx of migrants that may render available sanitary facilities in the project area inadequate during construction. This impact is considered to be of medium significance.

- ***Food and Nutrition***

Acquisition of about 204 hectares of land from indigenous farmers who are currently cultivating the land for peasant farming may lead to reduction in food production, consumption and subsequently nutritional deficiencies. Children in affected households and communities are more at risk from serious complications due to nutritional deficiencies than adults. Effect may include skin problems, stunted or defective bone growth and kwashiorkor. This impact is considered to be significantly low as there are other available lands for farming in the area and adequate compensation will be paid for land to ensure affected farmers are able to replace their land or venture into other businesses for sustenance.

- ***Accidents and Injuries:***

- ***Risk of Road Traffic Accidents***

Increased vehicular traffic and congestion during preconstruction and construction activities due to the movement heavy duty trucks and other vehicles on site access roads may increase the risk of road traffic accident and injuries to pedestrians, motorcyclists and other road users. The significance of this impact is rated high as accidents can lead to serious injuries and ultimately death of affected persons.

- ***Risk of Electrocution***

During operation phase, the presence of the high voltage power lines connecting the new plant with the existing substation may pose safety risks to members of nearby communities. Direct contact with high voltage electricity or from contact with tools, vehicles, ladders or other devices that are in contact with high voltage electricity could result in electrocution. This impact is considered to be of high significance as its consequences may be severe and fatal. However, signs and barriers will be mounted and awareness will be created for the people and staff to observe safety measures and avoid all areas of high tension potentials to reduce the risk of electrocution. Since the facility will be enclosed, the risk of nearby communities being electrocuted from electrical installations in the plant is considerably reduced.

- ***Risk of fire Outbreak***

During operation phase, there is risk of fire outbreak which may result from failure of electrical installations. Fire outbreak may pose significant risk to the solar plant, workers and neighbouring communities. This impact is thereby considered to be of medium significance. Fire management and prevention plan will be implemented on site to prevent fire and contain any eventuality of fire.

- ***Hazardous Material Exposure***

Usage of hazardous materials and generation of hazardous wastes during construction and operation may expose members of nearby communities to toxic chemicals which may cause poisoning, skin burns and cancer. To avoid this impact, hazardous materials such as paint containers, oil drums etc shall be kept securely to prevent community members from using them for domestic purposes, such as water storage without proper cleaning. Although there is a potential for soil contamination from accidental leakages/spills of hazardous materials such as fuels, oils and lubricants from vehicles and equipment or poor on-site storage during construction and operation phases, however, contamination of underground water is highly unlikely. Consequently, ingestion of potentially toxic compounds including cadmium and lead compounds in water is considered negligible. Impacts of community exposure to hazardous materials are therefore considered to be of low significance as good housekeeping and implementation of waste management plan by the contractor will largely reduce public exposure to hazardous materials.

- ***Risk of Exposure to Electromagnetic Waves***

Electromagnetic fields (EMFs) are invisible fields of electric and magnetic forces associated with the movement of charged particles. EMFs are produced by natural sources, such as the movement of liquid magma below the earth's crust as well as human-made sources, most often involving the production and distribution of electricity. Some of the components used in modern solar systems, particularly the PV panels, inverters and HV transmission lines, radiate radio frequency electromagnetic radiation, which may affect people with electromagnetic hypersensitivity living nearby. Some of the milder symptoms of this syndrome may include headaches and restlessness. The current scientific consensus is that no causal relationship exists between exposure to low-level power frequency EMFs and any adverse health effects including cancer.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) exposure limit guidelines suggest that the general public may not be exposed to static magnetic fields in excess of 4 million milligauss. The practical limit of solar power system design ensures that the strength of any static magnetic fields from solar arrays would not approach the ICNIRP's exposure limits. The impact is thereby rated to be of low significance as the strength of magnetic fields resulting from the proposed solar PV array will not approach the levels considered a risk to human health.

- ***Security Challenges***

Security challenges may arise in the project area due to the storage of equipment and materials on site prior to construction and from vandalization of solar PV panels and other installed equipment. Storage of these materials may attract thieves and hoodlums to the area with increased risks of threats to lives and properties. However, the site is planned to be fenced from the surrounding communities and a CCTV surveillance system will be installed around the fence line and access points. In addition a site security plan will be developed and implemented. In view of this, the potential security risk is considered to be of medium significance.

❖ **Impact on Occupational Health and Safety**

Occupational health and safety issues will likely be of concern particularly during preconstruction, construction and decommissioning phases of the proposed project. Activities such as mobilization of equipment and materials, site clearing, installation of site utilities as well as construction activities involving use of heavy duty vehicles and equipment, road construction, civil works and equipment installation may increase construction workers exposure to occupational health and safety hazards. Consequently, there may be potential risks to workers' health and safety with increased predisposition to accidents and injuries. Occupational health and safety hazards likely to occur include:

- Physical hazards from exposure to excessive noise from operating machineries, exposure to electromagnetic radiations and extreme weather conditions;
- Chemical hazards from exposures to fugitive/cement dusts, exhaust emissions, hazardous materials;
- Biological hazards from exposure to dangerous animals e.g. snakes during site clearing, from exposure to communicable diseases e.g. STDs;
- Ergonomic hazards from poor manual handling, over exertion, awkward posture, etc;
- Electrical hazards from exposure to live power lines and use of tools and machineries;

Other health and safety concerns include risks of:

- Trip and fall hazards including falls from working on heights during erection of towers and the laying of overhead HV power lines.
- Accidents and struck-by injuries from movement of heavy vehicles and the use of heavy equipment and cranes;
- Fire outbreak from failure of electrical installations.

Although the outcome of these health and safety hazards can potentially be fatal to workers, these impacts are however considered to be of medium significance due to the robust site-specific HSE Plan that will be developed and implemented by the contractors. Enforcement of this Plan will ensure the protection of workers health and safety and the prevention of serious accidents and injuries.

5.3.3 Significant Impacts Peculiar to the Construction and Operation of Transmission Line

This section describes the potential significant environmental impacts that may arise during the erection of pylons and installation of 132 kV overhead HV transmission power line's component of the proposed project. The potential impacts of operation of the high voltage lines are also enumerated. It is instructive to note that majority of the significant impacts associated with the transmission line during the preconstruction phase of the project have been discussed alongside the proposed project impacts in the preceding subsections.

❖ Significant Potential Environmental Impacts

- **Waste generation**

During construction of the transmission infrastructure, industrial type wastes routinely associated with construction activities may be generated. These wastes may include non-hazardous waste such as scraps and packaging materials which may be cardboards and wooden pallets. Hazardous waste may also be generated in small quantity due to the use of hazardous materials on site. Hazardous waste may include spent oils and lubricants from construction vehicles and equipment, as well as spent solvents, cleaning agents, paints, and other corrosion control coatings applied to pylons and other structures. During decommissioning, all the component of the transmission infrastructure will be removed. It is expected that majority of these components will be reused or recycled with damaged ones disposed appropriately. Overall, Impact of waste during construction and decommissioning is thereby considered to be of medium significance.

❖ Significant Social Impacts

- **Risks of fall from working at height**

In addition to the general occupational health and safety risks to workers, construction and maintenance of the transmission infrastructures will pose significant risk of fall from height. The height of the pylons may range from 25 and 34 m depending on site conditions. Falling from such a height may lead to fatal consequences for workers. The impact is thereby rated to be of medium significance as a site-specific HSE Plan will be developed and implemented for the project.

- **Risk of electrocution to workers from exposure to live power lines**

During operation, maintenance workers may be exposed to the risk of electrocution when working on the transmission facility. Direct and indirect contact with energised 132 kV lines may be fatal and even lead to death in extreme situations. The impact is rated to be of medium significance as appropriate measures will be put in place to prevent the occurrence.

- **Risk of electrocution to community members and trespassers from direct and indirect contact with power lines.**

During operation, falling high voltage lines may pose significant risks to community members especially those whose activities and farmlands are located near the lines and those whose path may cross the RoW. Although this impact is unlikely, however, the consequences of its occurrence may be fatal to affected persons. The impact is adjudged to be of medium significance.

Table 5.9 Summary of Significant Associated and Potential Impacts of Proposed Project

Project Phases	Environmental	Social
POSITIVE IMPACTS		
Pre-construction	—	• Employment of local labour.
Construction	—	• Opening up of access roads to adjoining settlements and remote areas to enhance easy movement of people & their farm produce. • Job creation via direct engagement by NSPDL and indirect employment through economic vendor activities e.g food selling. • Stimulation of local socioeconomic activities. • Improved livelihood and poverty reduction. • Acquisition of new skills and development of human capacity.
Operation	• Reduction of overall emissions of GHGs as a result of cost effective and renewable source of energy generation. • Avoidance of fossil fuel utilization and reduced GHGs and other pollutant gas emissions. • Promotion of clean energy as an alternative energy source and the establishment of Cleaner Development Mechanism (CDM).	• Creation of employment and business opportunities. • Creation of tourist attraction and recreational resources. • Technology transfer and training of project staff on solar power plant management, operation and maintenance. • Generation of renewable electricity to boost national power supply. • Increased revenue generation to government through permits and taxes. • Savings on cost of diesel for pumping & distributing water to citizens by the Jigawa State ministry of water resources. • Increase power transmission to homes and industries. • Reduction in power outages.
Decommissioning	• Soil stabilization and regeneration • Restoration of flora and fauna habitat	• Increase in land availability for agriculture and other purposes.
NEGATIVE IMPACTS		
Pre-construction	• Deterioration of local air quality due to the release of fugitive dusts & gaseous pollutant emissions • Noise disturbances from equipment & truck traffic. • Loss of vegetation/habitat fragmentation. • Predisposition of soil to erosion	• Loss/depletion of farm land. • Loss of land based livelihood and exacerbated poverty. • Loss of economic trees including medicinal herbs. • Grievance & conflicts over land resettlement & compensation. • Loss of ecosystem provisioning services e.g. economic trees • Traffic congestion & increased risk of RTA and Injuries. • Risk of security breaches and threat to lives and properties. • Risks of exposure to occupational health and safety hazards, accidents and injuries
Construction	• Deterioration of local air quality. • Noise disturbances. • Soil erosion and contamination. • Generation of non-hazardous and	• Change in land use pattern (land conversion/transformation) from agro-forestry to industrial use. • Increased traffic and attendant risk of RTA and

	hazardous wastes.	Injuries. • Risk of communicable & vector-borne diseases such as STDs including HIV/AIDS, malaria. • Threat to community safety and security. • Increase demand on existing health & sanitation infrastructure • Increased social vices/crimes and dilution of indigenous culture, norms and traditions in nearby communities • Risk of worker exposure to OHS hazards, accidents and injuries.
Operation	• Generation of industrial/ hazardous wastes • Soil contamination form leachates of hazardous wastes. • Potential for fire outbreak due to failure of electrical installations	• Risk of electrocution. • Visual intrusion and disruption to aesthetics. • Risk of worker exposure to OHS hazards, accidents and injuries.
Decommissioning	• Air quality deterioration • Generation of industrial and hazardous waste. • Soil contamination from indiscriminate dumping of wastes.	• Traffic Congestion and increased risk of RTA and Injuries. • Risks of occupational accidents and injuries to workers. • Loss of employment

5.4 Cumulative Impacts

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected communities.

The purpose of this proposed project-initiated cumulative impact assessment is to determine how the multiple and successive environmental and social impacts from the proposed solar PV project under consideration and other existing developments in the project area may combine with potential impacts from anticipated future developments to cause cumulative impacts of significant magnitude that would not be expected to result from the proposed project as a stand-alone development.

5.4.1 Cumulative Impact Assessment (CIA)

CIA is the process of analyzing the potential impacts and risks of proposed developments in the context of the potential effects of other human activities and natural environmental and social external drivers on the environment over time, and proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible.

Specifically, the key analytical task during this CIA is to discern how the potential impacts of the proposed solar PV development may combine cumulatively, with the potential impacts of current and future developments as well as other human activities and natural stressors such as droughts or extreme climatic events to pose a significant threat to any VEC.

5.4.2 Objectives

The following are the objectives of the proposed project-initiated CIA:

- To assess the potential impacts and risks of the proposed solar PV project over time, in the context of potential effects from other developments and natural environmental and social external drivers on some components that may be at risk.
- To verify that the proposed solar PV project's cumulative social and environmental impacts will not exceed a threshold that could compromise the sustainability or viability of valued ecosystem components (VECs) that may be at risk.
- To confirm that the proposed solar PV project's value and feasibility are not limited by cumulative social and environmental effects.
- To support the development of governance structures for making decisions and managing cumulative impacts at the appropriate geographic scale (e.g., airshed, town, regional landscape).
- To ensure that the concerns of affected communities about the cumulative impacts of the proposed development are identified, documented, and addressed.

5.4.3 CIA Methodology

Specifically, for the proposed solar PV project, cumulative impact was assessed using the following assessment criteria:

- The outcome of scoping exercise including the identification of VECs of interest in the project area.
- VECs known or suspected to potentially be affected by the proposed solar PV project (based on prior sectoral assessments and the impact identification section of this ESIA).
- Existing cumulative impact issues within the area.
- Concerns for cumulative impacts identified in consultation with stakeholders, including potentially affected communities
- Visible developments in the area including the new Federal University Dutse.
- The initiative of Jigawa state government to earmark about 500 hectares of land in the project area for the development of a solar village. This initiative is targeted at encouraging other investors to bring their solar power development to Jigawa State.
- Overview of ongoing and reasonably foreseeable future activities.

5.4.4 Cumulative Impact Discussion

Based on the above criteria, the potential cumulative impacts on important resources that may result from the construction, operation, and decommissioning of the proposed solar plant when added to other past, present, and reasonably foreseeable future actions are discussed below.

❖ **Visual Impact and Landscape Disruption**

The concept of the solar village will lead to the development of multiple new solar projects within the same view shed (area visible from a reference point). This will inevitably result in additive visual disturbances. Logically, many new solar facilities similar in size and character constructed in the same view shed will inevitably result in greater cumulative visual impacts than only the proposed 80 MW_{AC} solar PV project under consideration. It is envisaged that solar PV technology will be adopted by the future solar plant developments and as such they may not result in significant glinting, glare, and other visual effects which may ultimately result in health and safety issues. However, aggregation of solar PV panels over a large area of land as well as associated infrastructures such as new roads, transmission lines, drainage facilities, fences etc may bring about significant contrast to natural rural landscape in the project area.

- **Over-extraction of Groundwater**

Land use survey revealed that there is no surface water in the entire project area. Consequently, the inhabitants of the area depend largely on groundwater for drinking, domestic use and livestock farming. The proposed project will therefore depend largely on groundwater sources during construction and operation of the facility. Taking into consideration water demand of the proposed project and the quantity of water available in the area, available records have revealed that abstraction of water for the project especially during operational phase for panel washing will not pose any significant threat to the sustainable yield of underground water resource in the area.

Given that the area has been earmarked as a Solar Village by the Jigawa State Government, in the same manner, other future solar projects may also largely depend on available groundwater resource in the area. Hence, there may be potential for over-extraction of ground water due to the cumulative effects of water extraction to meet demands of the different solar plants. Given the volume of water available in the area and the water demand of solar PV technology, the rate of cumulative water extraction by these facilities may however not exceed the rate of aquifer recharge. It is however important to reduce collective over-reliance on groundwater and remove any possibility of depletion of this valued resource. There is therefore the need for collective water conservation measures to be implemented during the operation of the different solar plants. These measures may include water recycling, rain water harvesting and supplemental water supply from other sources.

- **Impact on Soil**

The primary concern for soil resources from solar power plant development is the large area of land that will inevitably be disturbed for the construction of the plant and associated facilities. The entirety of areas where solar power plants are built will have to be graded to produce a very smooth and flat surface for solar panels. Such grading will render large areas susceptible to soil erosion. While soil erosion mitigation measures will be in place, some soil loss will be unavoidable, given the large areas that will potentially be disturbed, the soil conditions (dry and predominantly sandy) and the occurrence of very high winds in the areas. The proposed solar village development and associated infrastructure will be a major contributor to cumulative impacts on soil from foreseeable development in the area.

❖ **Loss of Vegetation**

The construction of the solar village will require significant removal of vegetation over a large portion of land that will be acquired. Land use survey of the project AoI revealed that about 80% of available land is either currently being cultivated or left to fallow indicating that natural vegetation has been significantly converted by agro-related practices in the area. Given the analysis above, the cumulative impacts of natural vegetation removal may be largely dependent on the size of land earmarked for the solar village and the distribution of natural vegetation within its boundaries. In addition, the cumulative direct impacts on plant communities from these foreseeable developments in the area could be reduced by deliberately avoiding destruction of some species of ecological, cultural and economic importance such as *Azadirachta indica* (Neem tree), *Senna obtusifolia*, *Parkia biglobos, Vitellaria paradox and Acacia senegal* during site clearing.

❖ **Loss of Farmland**

Participants at the scoping workshop revealed that part of their land in close proximity of the proposed project was acquired by the Federal Government to build the Federal University Dutse. With the acquisition of additional approximately 200 hectares for the proposed project and potential for further land acquisition for the development of the proposed solar village, the effect of land acquisition in the area is considered cumulative. These multiple development springing up in the area will inevitably remove or reduce many current land uses. The primary effects would be on access for farming and grazing.

Multiple solar parks' contributions to cumulative impacts on land in the area will also result from land acquisition for RoWs for transmission lines, access roads, and other associated facilities. This will further limit other land uses within the area. Loss of farmland could have grave consequences in affected rural communities whose livelihood and sustenance depend primarily on peasant farming. Cumulative land acquisition may lead to involuntary resettlement, loss of economic trees, reduction in food production and consumption, long term hardship and impoverishment for the affected communities as well as associated grievances and conflicts.

CHAPTER SIX

MITIGATION AND ENHANCEMENT MEASURES

6.1 Introduction

This Chapter describes technically[1] and financially feasible[2] measures that will address the potentially significant environmental and social impacts of the proposed project identified in Chapter 5. For each resource, mitigation measures that will be used to avoid, minimize, compensate for or offset potential negative impacts, and enhance positive impacts have been developed. The proposed measures are commensurate with the nature and magnitude of the potential impacts.

6.2 Mitigation Approach

The proposed mitigation measures were derived from comprehensive reviews of the proposed project activities, published data regarding solar energy development impacts, existing relevant mitigation guidance prescribed in the FMEnv EIA Guidelines for Power Sector, the outcome of the engagement process with affected communities and Good International Industry Practice (GIIP). These measures were also consistent with those prescribed in the World Bank General and Industry specific EHS guidelines and the IFC Performance Standards on Environmental and Social Sustainability.

The approach adopted for selecting appropriate mitigation measures followed a mitigation hierarchy that favours the avoidance of impacts over minimization, and where residual impacts remain, compensate/offset for impacts to workers, affected communities and the environment, wherever technically and financially feasible. The mitigation hierarchy is discussed below and presented in Figure 6.1.

- **Avoidance:** To avoid the impact altogether by not using certain type of resources, or areas considered to be environmentally sensitive nor taking certain actions or parts of an action that could result in negative impacts. This is considered to be the most acceptable form of mitigation.

- **Minimization:** To minimize impacts by limiting or reducing the degree, extent, magnitude or duration of adverse impacts. Negative impacts can be minimized through environmental and social measures/treatments/design. Available options to minimize negative impacts include abate, rectify, repair, and/or restore impacts.

- **Compensation:** To compensate for the impact by replacing or providing substitute resources especially for unavoidable and residual impacts. This does not eliminate the adverse impact but seeks to offset it with an (at least) comparable positive one.

[1] Technical feasibility is based on whether the proposed measures and actions can be implemented with commercially available skills, equipment, and materials, taking into consideration prevailing local factors such as climate, geography, demography, infrastructure, security, governance, capacity, and operational reliability.
[2] Financial feasibility is based on commercial considerations, including relative magnitude of the incremental cost of adopting such measures and actions compared to the project's investment, operating, and maintenance costs, and on whether this incremental cost could make the project nonviable to the client.

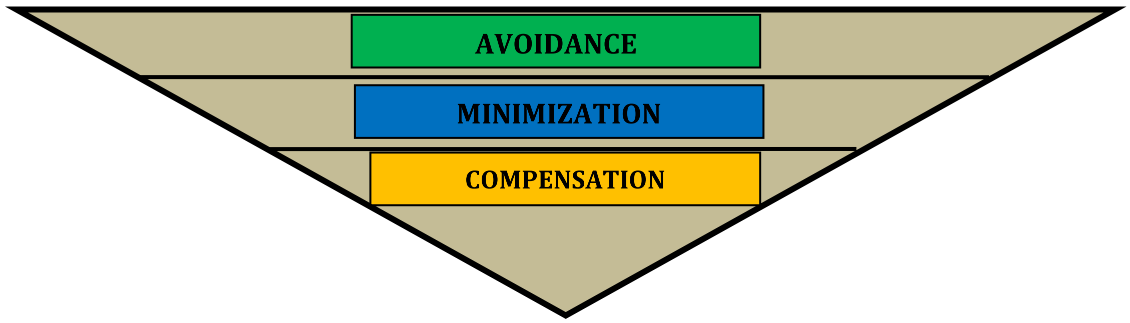

Figure 6.1: Mitigation Hierarchy

6.3 Discussion of Mitigation Measures

This section presents the mitigation measures proffered for the significant potential negative environmental and social impacts of the proposed project. The proposed measures mainly relate to the adoption of best environmental practices throughout the project lifecycle and the application of best engineering practices during construction. The mitigation measures will be included in the bid documents for the EPC contractor to implement.

6.3.1 Mitigation Measures for Potential Negative Environmental Impacts

The mitigation measures recommended to address the significant potential negative impacts on the biophysical environment are discussed in the following sub sections:

6.3.1.1 Air Quality

❖ ***Air Quality Deterioration***

To minimize fugitive dust and exhaust emissions NSPDL shall through its EPC contractor:

- Implement dust suppression techniques such as, use of (i) water suppression for control of loose soil materials on unpaved surfaces and (ii) covered trucks for transporting loose materials that may generate dust.
- Ensure emissions from road and off-road vehicles comply with specified national standards.
- Conduct regular visual inspection of dust pollution and ensure appropriate intervention if dust levels are high.
- Pave access roads with gravel to minimize release of dust.
- Implement routine preventative maintenance including tune-ups on all heavy equipment to meet the manufacturer's specification in order to ensure efficient combustion and minimal emissions.
- Ensure speed limits are reduced and enforced especially on unpaved roads to minimize airborne fugitive dusts.
- Train drivers/ workers on proper operation of vehicles and equipment to include fuel efficiency and anti-idling techniques.
- Limit soil disturbance activities and travel on unpaved roads during periods of high wind.
- Reroute access roads away from immediate outskirt of communities as much as possible.

❖ ***Noise***

In order to reduce potential noise impacts on neighboring communities, workers and wildlife, NSPDL shall through its EPC contractor:

- Restrict all haulage and noise generating activities to working hours during the day when noise is better tolerated.
- Site stationary noise generating construction equipment with consideration of distances from the noise sources to nearby communities and sensitive receptors.
- Select and use (where feasible) vehicles and equipment with lower sound power levels.
- Install suitable mufflers on engine exhausts and compressor components.
- Ensure the maintenance of all equipment in accordance to manufacturer's specifications.
- Ensure vehicle travelling within and around project area are operated in accordance with speed limits to reduce vehicle noise levels.
- Develop a mechanism to record and respond to noise complaints.
- Provide and enforce the usage of hearing protection devices (ear plugs/muffs) for workers exposed to noise levels >90 dB(A) for a duration of more than 8 hours per day.
- Institute a Hearing Protection Program for workers in work areas with noise in excess of 85 dB(A).

6.3.1.2 Soil

The main objective of the mitigation measures for soil resources is to preserve the health and functioning of soils in the project area. Implementing the proposed measures will reduce the likelihood of soil impacts becoming impacting factors on other important resources such as groundwater, vegetation, wildlife and humans. The mitigation measures for avoiding or minimizing such impacts as related to soil erosion and contamination are discussed below.

❖ ***Soil Erosion***

In order to avoid or reduce soil predisposition to erosion, NSPDL through its EPC contractor shall reduce or control ground- disturbing activities and develop an Erosion Control Plan (ECP) that will include the following measures:

- Avoidance of vegetation and trees removal to the extent possible.
- Restriction of vegetation removal to construction site only in order to minimize the footprint of disturbed areas.
- Protection of all vegetation not required to be removed against damage.
- Re-vegetation of all bare and exposed soils with native vegetation immediately after construction to prevent erosion.
- Implement soil conservation measures such as stockpiling topsoil or gravel for the remediation of disturbed areas.
- Usage of erosion protection structures such as sediment traps, riprap, gabions, etc. wherever possible to capture run-off sediments.
- Usage of gravel to cover unpaved access road surface for added protection against erosion and run-off.

- Scheduling ground-disturbing activities to avoid heavy rainfall and high wind periods to the extent that is practical.
- Designing channels and ditches for post construction flow.

❖ ***Soil Contamination***

To avoid/minimize soil contamination from accidental leakage/spillage of fuel, oils, and hazardous wastes NSPDL through its EPC contractor shall:

- Ensure compliance with all applicable national and international laws and regulations and conform to relevant industry standards.
- Prepare and implement a Spill Prevention and Emergency Response Plan (SPERP) to address the possibility of accidental releases of all hazardous materials stored on-site. The SPERP shall inter-alia:
  - Contain procedures for timely notification of appropriate authorities;
  - Provide spill/emergency contingency planning for abatement/stabilization of release, recovery of spilled product and remediation of affected area;
  - Be supported by the strategic deployment of spill response materials and equipment including Personal Protective Equipment (PPE);
  - Provide for prompt response to spill.
- Ensure that vehicle refueling and maintenance as well as storage of diesel and oil shall conform to best practices to ensure there are no spillages or leakages. Specifically;
  - Fuel storage tanks/drums shall be leak-proof and checked daily. The tanks/drums shall be installed above ground in a bunded area and shall be replaced in cases of leakage;
  - Procedures for storage, handling of hazardous wastes and raw materials (e.g. batteries, chemicals, fuels) shall be prepared, implemented, monitored and enforced; and
  - Workers shall be trained on the correct transfer and handling of fuels and oil.
- Ensure all vehicles are in proper working condition to avoid leaks of motor oil, hydraulic fluid and other hazardous materials.
- In case of suspected or confirmed soil contamination, shall ensure identification of the root cause of the uncontrolled release and correction to avoid further releases and associated adverse impacts.

6.3.1.3 Solid Waste Generation

In order to avoid the potential impacts of non-hazardous and hazardous wastes to human health and the environment, NSPDL through its EPC contractor shall:

- Ensure compliance with all applicable national and international laws and regulations on non-hazardous and hazardous waste management.
- Develop and Implement a site-specific Waste Management Plan (WMP) that addresses issues linked to waste minimization, generation, transport, disposal, and monitoring.
- Establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- Ensure the WMP address all solid and liquid waste likely to be generated during the implementation of the project and inter-alia include:

- Characterization of waste streams expected to be generated at the site;
- Procedures for hazardous waste determination;
- Waste storage locations;
- Waste specific management and disposal requirement; and
- Waste minimization procedures.

- Implement feasible waste prevention, reduction, reuse, recovery and recycling measures.
- Identify and implement pollution prevention opportunities such as use of material substitution for less hazardous alternatives, recycling and waste minimization.
- Minimize hazardous waste generation by segregating hazardous from nonhazardous wastes.
- Create waste collection areas with clearly marked facilities such as colour code bins and provide equipment for handling waste.
- Ensure that hazardous wastes are stored in properly labelled closed containers placed away from direct sunlight, wind and rain and provide secondary containment with 110% of storage containers.
- Ensure hazardous materials and waste storage areas are formally designated and access restricted to authorized persons.
- Ensure proper disposal/treatment of waste by government approved waste vendor.

6.3.1.4 Liquid Waste/Wastewater

In order to avoid, minimize and control the adverse impacts of liquid waste to human, health, safety and the environment, NSPDL through its EPC contractor shall:

- Ensure water use efficiency to reduce the amount of wastewater generation.
- Ensure the use of non-toxic detergent for panel cleaning to avoid the release of hazardous substances in wastewater.
- Ensure adequate drainage systems are constructed around the site to ensure smooth flow of storm water/waste water.
- Ensure proper monitoring and disposal of wastewater including sanitary waste.

6.3.1.5 Ecology and Biodiversity

Many mitigation measures are similar for the different types of ecological resources (plant communities, habitat and wildlife) and are applicable for ecological resources in general. In order to eliminate or minimize the impacts of the proposed project on ecological resources, NSPDL through its EPC contractor shall:

- Avoid the removal of natural vegetation and trees, especially species of *Acacia senegal* and *Phoenix dactylifera* which mostly occur in isolation.
- Restrict the removal of natural vegetation to construction site only.
- Retain all short (<18 cm) native vegetation to the maximum extent possible.
- Retain native root structure within the project area to facilitate recovery of vegetation cover, retain soil stability and minimize erosion.
- Clearly define work areas to avoid unnecessary disturbance of areas outside development footprint.

- Implement soil conservation measures such as stockpiling topsoil or gravel for the remediation of disturbed areas.
- Avoid the use of herbicides on site.
- Ensure work personnel limit their activities within the RoW during erection of towers and laying of overhead transmission line.
- Compensate for economic trees at full replacement cost.
- Revegetate temporary disturbed areas with native species immediately following the completion of construction activities to ensure all temporary use areas are restored.
- Develop and implement a project specific Integrated Vegetation Management Plan (IVMP) to revegetate part of the solar array area.
- Employ noise reduction measures (see 6.3.1.1) to minimize impacts on wildlife.
- To the extent possible schedule vegetation clearing to occur outside of bird breeding season.
- Relocate any reptile or amphibian species found in harm's way away from construction activity.
- Ensure waste especially food remnants, are stored within closed containers on-site, to avoid attracting birds to the site.

6.3.1.6 Groundwater

The main objective of mitigation measures for groundwater resources is to promote the sustainable use of water resources through conservation practices and avoid, minimize and control adverse impacts on human health and the environment. To this end NSPDL through its EPC contractor shall:

- Ensure water use efficiency to reduce the amount of wastewater generation.
- Encourage the harvesting and usage of storm/rainwater to reduce over reliance on groundwater.
- Ensure project design have measures for adequate water collection, spill control and leakage control system.
- Install water measuring meters to monitor groundwater use.
- Ensure regular maintenance of plumbing systems, and early identification and repair of leaks.

6.3.2 Mitigation Measures for Potential Negative Social Impacts

The mitigation measures recommended to address the significant potential negative impacts on the social environment are discussed in the following sub sections:

6.3.2.1 Land Acquisition and Involuntary Resettlement

As discussed in Chapter 3, NSPDL has taken significant efforts in evaluating site options in order to minimize economic displacement especially on the poor and vulnerable members of the communities. To further minimize negative social and economic impacts of land acquisition and involuntary resettlement NSPDL in collaboration with Jigawa State Government shall:

- Develop and implement a Resettlement Action and Livelihood Restoration Plan (RALRP) to compensate affected persons and/or communities.

- Avoid forced eviction of farmers from their farmlands.
- Ensure all issues relating to compensation are handled in a transparent, consistent and equitable manner.
- Ensure adequate engagement with affected persons and communities throughout the process of land acquisition.
- Ensure disclosure of relevant information and participation of affected communities and persons continue through implementation, monitoring and evaluation of compensation payments.
- Ensure affected land owners are adequately compensated for loss of land and economic crops at full replacement cost.
- Provide alternative income earning opportunities such as credit facilities, training or employment opportunities to assist affected persons.
- Provide opportunities to affected persons and communities to derive appropriate development benefits such as employment, from the project.
- Establish a grievance mechanism to receive and address specific concerns about compensation.

6.3.2.2 Loss of Employment

Mitigation measures proposed to minimize effect of job loss after construction and decommissioning phases of the proposed project shall include the following:

- Carrying out an analysis of alternatives to retrenchment e.g. employee capacity building programs; long-term maintenance works etc. prior to implementing any collective dismissals after construction.
- Development and implementation of a retrenchment plan to reduce the adverse impacts of retrenchment on workers.
- Ensuring compliance with all legal and contractual agreement with public authorities, workers and their organizations.
- Ensuring all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner.
- Provision of a grievance mechanism for workers to raise workplace concerns.

6.3.2.3 Road Traffic

In order to minimize potential impacts of traffic congestion and risk of RTAs, NSPDL through its EPC contractor shall:

- Ensure regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents such as those caused by equipment malfunction or premature failure.
- Engage drivers with appropriate class of driving license and at least three years of driving experience.
- Train drivers on defensive driving techniques, haulage safety and pedestrian safety.
- Develop and implement a Traffic Management Plan (TMP). Safe traffic control measures to include:
  - Establishment and strict enforcement of speed limits;

  - Employment of appropriate road safety signages and on-site trained flag-men with high-visibility vests to direct traffic and warn of dangerous conditions; and
  - Minimization of movement at peak hours of the day.
- Ensure coordination with emergency agencies to ensure that appropriate first aid is provided in the event of accidents.
- Where possible, use locally sourced materials to minimize transport distances.

6.3.2.4 Landscape Disruption and Visual Intrusion

Mitigation measures proposed to minimize effect of contrast to natural landscape and visual disturbances especially during operation phase of the proposed project shall include the following:

- Ensuring selection of solar panels backs that are colour-treated to minimize visual contrast with natural landscape setting.
- Ensuring coatings and painting on selected PV panels and associated infrastructures have little or no reflectivity.
- Retaining natural vegetation wherever possible within the solar plant.
- Ensuring paintings and surface treatments of associated buildings blend with the existing form, line, color, and texture of the landscape as much as possible.
- Ensuring grouped buildings and structures are painted the same colour to reduce visual complexity and colour contrast.
- Ensuring selection of non-specular conductors and non-reflective coatings on insulators for transmission facilities.

6.3.2.5 Community Infrastructure

In order to minimize pressure on community infrastructure NSPDL shall as part of its CSR:

- Promote access to community services by supporting infrastructural development in host communities (See Chapter 4, Section 4.7)

6.3.2.6 Culture

Mitigation measures proposed to avoid or minimize social vices and crimes and protect community culture include the following:

- Development of an induction program including a code of conduct for all workers. The code of conduct will address the following aspect:
  - Respect for local residents;
  - No hunting or unauthorized taking of products or livestocks;
  - Zero tolerance of illegal activities such as prostitution, illegal sale or purchase alcohol, purchase or consumption of drugs, illegal gambling or fighting;
  - Description of disciplinary measures for infringement of the code of conduct and/or company rules.
- Ensuring a copy of the code of conduct is presented to all workers and signed by each worker.
- Improving awareness of and sensitivity of workers to local cultures, traditions and lifestyles.

- Ensuring affected communities are assisted and have a voice in appropriation of mitigation measures.
- Development and implementation of a grievance procedure and raising awareness of grievance procedures amongst affected communities.
- Provision of a grievance register and grievance officer.
- Promotion of the establishment of local vigilante groups at community level in consultation with the Police authorities.

6.3.2.7 Community Health, Safety and Security

It is expected that the mitigation measures proffered for the environmental and socioeconomic determinants of health in section 6.3.1 and 6.3.2 will address many of the potential impacts on community health and safety. In order to further safeguard the health and safety of affected communities and maximize opportunities for health enhancement, the following specific mitigation measures shall be implemented:

❖ ***Sexually Transmitted Infections/HIV/AIDS***

Mitigation measures proposed to prevent the risk of STIs such as HIV/AIDS include the following:

- Institution of HIV prevention program to include peer education, condom distribution and Voluntary Counselling and Testing (VCT).
- Undertaking health awareness and education initiatives on STIs amongst workers and in affected communities.

❖ ***Risk of Electrocution***

Mitigation measures proposed to prevent risk of electrocution to community members and trespassers include the following:

- Restriction of unauthorized access to all areas of high tension potential to prevent electrocution.
- Establishment of “No Approach” zones around or under high voltage power lines in conformance with TCN requirements.
- Use of proper signage (In English and local languages) and engineering barriers (e.g. fencing) to limit access to electrically energized equipment and conductors in order to prevent access to electrical hazards by unauthorized individuals and wildlife.

❖ ***Security Challenges***

Mitigation measures proposed to ensure the security of lives and properties include the following:

- Fencing of solar facilities from surrounding communities.
- Installation of CCTV surveillance system.
- Deployment of competent security personnel to secure project site.
- Adequate training of security personnel.
- Disclosure of on-site security arrangements to the public especially members of nearby communities

6.3.2.8 Occupational Health and Safety

The objectives of mitigation measures for avoiding, minimizing and controlling occupational health and safety potential impacts of the proposed project are to: (a) promote safe and healthy working conditions as well as protect the health of workers; and (b) prevent accidents and injuries that may arise as a result of project activities. To this end, NSPDL through its EPC contractor shall provide a safe and healthy work environment taking into consideration the inherent risks in and specific classes of hazards in the work environment including physical, chemical, biological, ergonomic and electrical hazards. Mitigation measures will include the provision of preventative and protective measures in the following order of priority, elimination, substitution, engineering controls, administrative control and provision of PPE as a last resort.

The application of prevention and control measures will be based on a comprehensive hazard analysis and the development of a project specific Occupational Health and Safety Plan (OHSP). The OHSP will inter-alia entail:

- Provision of health and safety orientation training and hazard specific training;
- OHS responsibilities;
- Site health and safety rules and instructions;
- Safe work practices;
- Daily toolbox talks;
- OHS Communication including Incident/Accident reporting;
- Emergency contingency plan;
- Provision and enforcement of use of PPE.

The OHS Plan shall be subject to third party/ independent audits to ensure its effectiveness.

Mitigation measures to prevent falls, accidents and struck by injuries shall include:

- Training of workers on proper use of scaffolds and ladders.
- Usage of fall prevention and protection devices, including safety belt, full body harnesses, shock absorbing lanyards or self-retracting inertia and other fall arrest devices attached to fixed anchor point or horizontal life-lines to protect workers.
- Provision of rescue and/or recovery plans, and equipment to respond to workers after an arrested fall.

Mitigation measures proposed to prevent fire outbreak shall include the following:

- Ensuring solar plant is designed and constructed in full compliance with Nigeria's building codes, Fire Service regulations, other applicable emergency and legal/insurance requirements, and in accordance with an internationally accepted life and fire safety (L&FS) standard.
- Usage of fire resistant materials.
- Installation of appropriate fire safety and protection system and equipment.
- Training of workers on fire prevention techniques and the use of different fire extinguishing agents and equipment for fire protection.
- Ensuring routine inspection and prompt repair of any malfunctioning electrical installations.

- Development and implementation of Emergency Response and Contingency Plan to respond to on-site emergency issues

Other control measures shall include:

- Implementation of explicit plans regarding initial response, triage, communication and transportation of casualties in the event of medical emergencies.
- Prohibition of drug and alcohol use by workers while on the job.
- Adequate provision and training of first aiders at site.

6.4 Residual Impacts

This Section highlights potential impacts whose effects may persist even after the application of mitigation measures. While the mitigation measures proposed in this Report may be highly effective, there is the likelihood that some residual effects may result especially from impact of land acquisition and associated socioeconomic consequences. The key potential residual impacts likely due to the implementation of the proposed project are the loss/depletion of farm land and associated loss of land based livelihood.

Although the residual effects of these impacts are anticipated to be within acceptable limits after the application of the proffered mitigation measures, it is however imperative to proffer additional proactive measures to assure social sustainability of the project and enhance the livelihood of affected communities. To this end, NSPDL shall undertake the following measures:

- Provide alternative income earning opportunities to land owners such as credit facilities, skill acquisition training and employment opportunities to assist affected persons;
- Engage competent resettlement professional to undertake monitoring of mitigation measures and continual assessment of residual effects to ensure they are within acceptable limits and to enable early detection and correction of unforeseen or emerging situations; and
- Ensure Completion Audit is undertaken upon substantial implementation of all mitigation measures and once displaced persons have been provided adequate opportunity and assistance to sustainably restore their livelihoods. As a minimum, the completion audit shall include a review of the totality of mitigation measures implemented, a comparison of implementation outcomes against objectives set in Chapter 7 of this Report, and a conclusion as to whether the residual impact monitoring process can be ended.

These additional measures are necessary in view of the outcome of the socioeconomic baseline survey conducted as part of this ESIA study which revealed that the people of affected communities are classified as "extreme poor" based on United Nations Standards. On the other hand, the benefits of the proposed project especially the provision of employment opportunities and associated economic boost is anticipated to improve the overall standard of living in affected communities.

6.5 Discussion of Enhancement Measures

Having identified the potential positive environmental and socioeconomic impacts of the proposed project in Chapter 5 of this report, this section describes measures proposed to further enhance these positive impacts in order to ensure overall sustainability of the project.

6.5.1 Enhancement Measures for Potential Positive Environmental Impacts

Most of the positive environmental impacts of the proposed project are those related to the utilization of renewable resources and avoidance of fossil fuel with attendant reduced GHGs and other pollutant gas emissions during operation. To enhance these impacts, NSPDL shall ensure peak electricity generation from the solar plant through proper maintenance of the facility and prompt replacement of damaged/faulty PV panels and other equipment.

6.5.2 Enhancement Measures for Potential Social Impacts

Besides the generation of renewable energy to boost electricity generation which will largely benefit Jigawa State and the Nation at large, there are other inherent benefits of the project which can be enhanced to boost local socioeconomic status of the state and especially in affected communities. Such positive impacts are those related to direct or indirect employment opportunities that will inevitably be created during project implementation and operation. These positive impacts are discussed in Chapter 5.

❖ **Direct Employment**

The recommended measures proposed to be implemented by NSPDL (through its EPC/O&M Contractors, where applicable) to enhance the impact of direct employment during preconstruction, construction and operation phases of the project in order to improve local economy shall include the following:.

- Development and implementation of a Labour and Employment Plan (LEMP) in line with international employment guidelines and IFC Performance Standard 2: Labour and Working Conditions. The Plan shall detail percentages and numbers of workforce to be sourced from the local areas and various demographics.
- Notification of Community representatives and Dutse LGA of the specific jobs and skills required for the project prior to commencement of recruitment.
- Initiation of training and skills development programs prior to the commencement of construction to ensure members of local workforce are up-skilled and can be employed on the project or other industrial developments in the area.
- Ensuring construction jobs are targeted to the local people.
- Ensuring technology transfer by training indigenous people on solar plant management, operation and maintenance such that maintenance jobs can also be targeted at local people.
- Promotion of fair treatment, nondiscrimination, and equal opportunity of workers.
- Protection of workers, including vulnerable categories of workers such as women and migrant workers.
- Promotion of safe, healthy working conditions & the health of workers.

- Provision of a grievance mechanism for workers to freely raise workplace concerns.
- Prohibition of employment of minors and avoidance of the use of forced labor.

❖ **Procurement and Indirect Employment**

The construction and operation of the proposed solar PV power facility will create opportunities for the supply of goods and services to the project and in turn, indirect employment will be created in the supply chain. Business opportunities will also arise for the local hospitality industry for housing site personnel. Other opportunities may be possible for local companies to provide catering, waste/recycling and landscaping facilities as well as goods and service providers such as quarrying, carpentry, road work etc.

The following enhancement measures will be implemented to ensure that business opportunities emanating from the project are maximized:

- Local and regional procurement targets will be included in the project's LEMP
- NSPDL shall include requirements for local employment in the contract that they establish with the EPC/O&M Contractors and require that the contractor recruits in accordance with the NSPDL's recruitment policy and request for proposal (RFP) documents.

❖ **Provision of Access Roads**

Opening up of access roads during construction will ultimately have a positive effect on members of the adjoining communities and remote areas as it will enhance easy movement of people and their farm produce.

The measures proposed for NSPDL to further enhance the positive impact of the access roads include the following:

- Improving the roads by paving the surface to assure their durability; and
- Ensuring adequate maintenance of the road to assure sustainability.

Table 6.1: Enhancement and Mitigation Measures

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
A	***Pre-Construction Phase***				
1	Land acquisition	**Impact on Land Owners/Users** Loss/depletion of farm land	HIGH	• Develop and implement a Resettlement Action and Livelihood Restoration Plan (RALRP) to compensate affected persons and/or communities. • Avoid forced eviction of farmers from their farmlands. • Ensure all issues relating to compensation are handled in a transparent, consistent and equitable manner. • Ensure adequate engagement with affected persons and communities throughout the process of land acquisition. • Ensure disclosure of relevant information and participation of affected communities and persons continue through implementation, monitoring and evaluation of compensation payments. • Ensure affected land owners are adequately compensated for loss of land and economic crops at full replacement cost. • Provide opportunities to affected persons and communities to derive appropriate development benefits such as employment, from the project. • Establish a grievance mechanism to receive and address specific concerns about compensation.	MEDIUM
2		Loss of land based livelihood.	HIGH		MEDIUM
3		Loss of economic trees including medicinal herbs.	HIGH		LOW
4		Grievance and conflicts over land resettlement & compensation.	HIGH		LOW
5		Exacerbated poverty condition due to loss of access to land (means of livelihood).	HIGH		LOW
6	Mobilization of personnel, materials and equipment to site	**Impact on Air Quality & Noise Level** Deterioration of local air quality due to the release of fugitive dusts and gaseous pollutant emissions from heavy duty vehicles.	MEDIUM	• Implement dust suppression techniques such as, use of (i) water suppression for control of loose soil materials on unpaved surfaces and (ii) covered trucks for transporting loose materials that may generate dust. • Ensure emissions from road and off-road vehicles comply with specified national standards via regular in-situ-measurement. • Conduct regular visual inspection of dust pollution and ensure appropriate intervention if dust levels are high. • Pave access roads with gravel to minimize release of dust.	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
				• Implement routine preventative maintenance including tune-ups on all heavy equipment to meet the manufacturer's specification in order to ensure efficient combustion and minimal emissions. • Ensure speed limits are reduced and enforced especially on unpaved roads to minimize airborne fugitive dusts. • Train drivers/ workers on proper operation of vehicles and equipment to include fuel efficiency and anti-idling techniques. • Limit soil disturbance activities and travel on unpaved roads during periods of high wind. • Reroute access roads away from immediate outskirt of communities as much as possible.	
7		Noise disturbances from equipment and truck traffic.	MEDIUM	• Restrict all haulage and noise generating activities to working hours during the day when noise is better tolerated. • Select and use (where feasible) vehicles and equipment with lower sound power levels. • Install suitable mufflers on engine exhausts & compressor. • Ensure the maintenance of all equipment in accordance to manufacturer's specifications. • Ensure vehicle travelling within and around project area are operated in accordance with speed limits to reduce noise levels. • Develop a mechanism to record and respond to noise complaints. • Provide and enforce the usage of hearing protection devices (ear plugs/muffs) for workers exposed to noise levels >90 dB(A) for a duration of more than 8 hours per day. • Institute a Hearing Protection Program for workers in work areas with noise in excess of 85 dB(A).	LOW
8		**Impacts on Affected Communities (Pedestrians, Motorcyclists – Community Health, Safety & Security)** Traffic Congestion & increased risk of RTA and Injuries (Traffic Safety).	MEDIUM	• Ensure regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents such as those caused by equipment malfunction or premature failure. • Engage drivers with appropriate class of driving license and at least three years of driving experience.	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
9		Risk of injuries to pedestrians and motorcyclists from collision with moving heavy duty vehicles (Pedestrian Safety).	HIGH	• Train drivers on defensive driving techniques, haulage safety and pedestrian safety. • Develop and implement a Traffic Management Plan (TMP) and safe traffic control measures shall include: - Establishment and strict enforcement of speed limits; - Employment of appropriate road safety signages and on-site trained flag-men with high-visibility vests to direct traffic and warn of dangerous conditions; and - Minimization of movement at peak hours of the day. • Ensure coordination with emergency agencies to ensure that appropriate first aid is provided in the event of accidents. • Where possible, use locally sourced materials to minimize transport distances.	LOW
10		Introduction of negative values and alien culture by the influx of migrant personnel.	HIGH	• Develop an induction program including a code of conduct for all workers. The code of conduct will address the following aspect: - Respect for local residents; - No hunting or unauthorized taking of products or livestocks; - Zero tolerance of illegal activities such as prostitution, illegal sale or purchase alcohol, purchase or consumption of drugs, illegal gambling or fighting; - Description of disciplinary measures for infringement of the code of conduct and/or company rules. • Ensure a copy of the code of conduct is presented to all workers and signed by each worker. • Improve awareness of and sensitivity of workers to local cultures, traditions and lifestyles. • Ensure affected communities are assisted and have a voice in appropriation of mitigation measures. • Develop and implement a grievance procedure and raise awareness of grievance procedures amongst affected communities. • Provide a grievance register and grievance officer.	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
				• Promote the establishment of local vigilante groups at community level in consultation with the Police authorities.	
11		Security challenges due to storage of materials and equipment on site.	HIGH	• Deploy competent security personnel to secure project site. • Disclose on-site security arrangements to the public especially members of nearby communities.	LOW
12		Employment of local labour.	POSITIVE	• Develop and implement a Labour and Employment Plan (LEMP) in line with international employment guidelines and IFC Performance standard 2: Labour and Working Conditions. The Plan should detail percentages and numbers of workforce to be sourced from the local areas and various demographics. • Notify community's representatives and Dutse LGA of the specific jobs and skills required for the project prior to commencement of recruitment. • Initiate training and skills development programs prior to the commencement of construction to ensure members of local workforce are up-skilled and can be employed on the project or other industrial developments in the area. • Ensure construction jobs are targeted to the local people. • Promote the fair treatment, nondiscrimination, and equal opportunity of workers. • Protect workers, including vulnerable categories of workers such as women and migrant workers. • Promote safe, healthy working conditions & the health of workers. • Provide a grievance mechanism for workers to freely raise workplace concerns. • Prohibit employment of minors and avoid the use of forced labor.	HIGHLY POSITIVE
13		Respiratory and eye related problems from exposure to fugitive dusts and gaseous emissions.	MEDIUM	• See A6 • Provide and enforce usage of appropriate PPE.	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
14		Risks of accidents and struck-by injuries from the movement of vehicles.	MEDIUM	• Plan and segregate the location of vehicles traffic, machine operation and walking areas. • Control vehicle traffic through the use of one-way traffic routes. • Establish speed limits and use on-site trained flagmen with high visibility vests or outer clothing covering to direct traffic. • Ensure mobile equipment is outfitted with audible reverse alarms. • Provide and enforce usage of appropriate PPE.	LOW
	Site preparation and clearing	**Impacts on Air and Noise Level**			
15		Deterioration of local air quality due to release of fugitive dusts & gaseous pollutant emissions from land clearing activities & heavy duty vehicles.	MEDIUM	See A6	LOW
16		Noise disturbances from operation of machineries and motorized equipment.	MEDIUM	• See A7	LOW
17		**Impacts on Ecology and Biodiversity** Loss of vegetation/ habitat and habitat fragmentation	MEDIUM	• Avoid the removal of natural vegetation and trees to the extent possible, especially species of *Acacia senegal* and *Phoenix dactylifera* which mostly occur in isolation. • Restrict removal of natural vegetation to construction site only. • Clearly define work areas to avoid unnecessary disturbance of areas outside development footprint. • Retain all short (<18 cm) native vegetation to the maximum extent possible. • Retain native root structure to facilitate recovery of vegetation cover, retain soil stability and minimize erosion. • Compensate for economic trees at full replacement cost. • Revegetate temporary disturbed areas with native species immediately following the completion of construction activities to ensure all temporary use areas are restored. • Develop and implement a project specific Integrated Vegetation Management Plan (IVMP) to revegetate part of the solar array area. • To the extent possible schedule vegetation clearing to occur	LOW
18		Loss of ecosystem provisioning services such as fuel wood & economic trees	MEDIUM		LOW
19		Predisposition to soil erosion due to the removal of vegetal cover and exposure of soil surfaces to rain and wind.	MEDIUM		LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
				outside of bird breeding season. • Implement soil conservation measures such as stockpiling topsoil or gravel for the remediation of disturbed areas. • Avoid the use of herbicides on site.	
20		**Social Impact** Employment of labour	POSITIVE	See A12	HIGHLY POSITIVE
21		**Impacts on Occupational Health and Safety** Respiratory and eye related problems for workers due to exposure to fugitive dusts and gaseous emissions.	MEDIUM	• See A6 • Provide and enforce usage of appropriate PPE.	LOW
22		Risks of worker exposure to noise emanating from machineries and associated safety concerns from poor communication	MEDIUM	• Develop and implement project specific OHS Plan. The OHSP will inter-alia entail: - Provision of health and safety orientation training and hazard specific training; - OHS responsibilities; - Site health and safety rules and instructions; - Safe work practices; - Incident/Accident reporting; - Emergency contingency plan; - Provision and enforcement of use of PPE. - Implementation of explicit plans regarding initial response, triage, communication and transportation of casualties in the event of medical emergencies; - Prohibition of drug & alcohol use by workers while on the job; - Provision and training of first aiders at site.	LOW
23		Risks of worker exposure to poisonous plants & dangerous animals e.g. snakes	MEDIUM		LOW
24		Risks of accidents and struck-by injuries from the movement heavy duty vehicles	MEDIUM		LOW
B	*Construction Phase*				
1	Construction/ improvement of internal and external access roads	**Impacts on Air Quality and Noise Level** Deterioration of local air quality due to the release of dust from exposed soil surfaces and exhaust emissions from equipment and vehicles.	MEDIUM	• See A6	LOW
2		Noise and vibration disturbances in the adjoining settlements from the operation of heavy duty equipment during road construction.	MEDIUM	• See A7	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
3		**Impact on Soil** Soil erosion due to compaction and exposure of soil surfaces to rain and wind during road grading and leveling.	MEDIUM	• Avoid vegetation and trees removal to the extent possible. • Restrict vegetation removal to construction site only in order to minimize the footprint of disturbed areas. • Protect all vegetation not required to be removed against damage. • Re-vegetate all bare and exposed soils with native vegetation immediately after construction to prevent erosion. • Use erosion protection structures such as sediment traps, riprap, gabions, etc. wherever possible to capture run-off sediments. • Use gravel to cover unpaved access road surface for added protection against erosion and run-off. • Schedule ground-disturbing activities to avoid heavy rainfall and high wind periods to the extent that is practical. • Design channels and ditches for post construction flow.	LOW
4		**Social Impact** Opening up of access roads to adjoining settlements and remote areas to enhance easy movement of people and their farm produce.	POSITIVE	• Improve access road by paving the surface to assure their durability.	HIGHLY POSITIVE
5		Job creation and increased business	POSITIVE	• Ensure local and regional procurement targets are included in the project's LEMP • Include requirements for local employment in the contract establish with EPC/O&M Contractors and require that the contractor recruits in accordance with the NSPDL's recruitment policy and request for proposal (RFP) documents. • Also see A12	HIGHLY POSITIVE
6		**Impact on Community Health and Safety** Increased traffic and attendant risk of RTA and Injuries (Traffic Safety).	HIGH	• See A8	LOW
7		Risk of communicable diseases such as STIs including HIV/AIDS from influx of temporary construction workers.	HIGH	• Institution of HIV prevention program to include peer education, condom distribution & Voluntary Counseling and Testing (VCT). • Undertaking health awareness and education initiatives on STIs amongst workers and in affected communities.	LOW
8		**Impact on OHS** Respiratory and eye related problems for workers	MEDIUM	• See A6 • Provide and enforce usage of appropriate PPE.	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
		due to exposure to dusts and gaseous emissions.			
9		Risk of worker exposure to occupational health and safety hazards	MEDIUM	See A22-24	LOW
10		Risks of occupational accidents and injuries to workers.	MEDIUM		LOW
11	Civil Works (Excavation, leveling and compaction of site; Site fencing; Construction of buildings and foundations including onsite substation, connection building, control building, guard cabin, and warehouse; Installation of water supply infrastructures {boreholes, pipe works and storage tanks})	**Impact on Air & Noise Level** Deterioration of local air quality due to the release of dust from earthwork activities and exhaust emissions from operating vehicles and equipment.	MEDIUM	See A6	LOW
12		Noise generation from operation of earth moving and excavation equipment, concrete mixers, cranes and heavy duty vehicles.	MEDIUM	See A7	LOW
13		**Impact on Soil** Soil erosion due to compaction, soil horizon mixing and exposure of soil surfaces to rain and wind during earth moving and excavation activities.	MEDIUM	• Schedule ground-disturbing activities to avoid heavy rainfall and high wind periods to the extent that is practical. • Implement soil conservation measures such as stockpiling topsoil or gravel for the remediation of disturbed areas. • Design channels and ditches for post construction flow.	LOW
14		Soil contamination from accidental leakage/spillage of fuel, oil/lubricants from equipment and vehicles.	MEDIUM	• Ensure that refueling, maintenance as well as storage of diesel and oil conform to best practices to ensure there are no spillages or leakages. Specifically; - Fuel storage tanks shall be leak-proof and checked daily. The tanks shall be installed in a bunded area and shall be replaced in cases of leakage; - Procedures for storage, handling of hazardous wastes and raw materials (e.g. batteries, chemicals, fuels) shall be prepared; and - Implementation of such procedures shall be adequately enforced and monitored; - Fuel storage tanks/drums shall be leak-proof and checked daily. The tanks/drums shall be installed above ground in a bunded area and shall be replaced in cases of leakage - Workers shall be trained on the correct transfer and handling of fuels and oil.	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
				• Ensure all vehicles are in proper working condition to ensure there is no potential for leaks of motor oil, hydraulic fluid and other hazardous materials. • In case of suspected or confirmed soil contamination, ensure identification of the root cause of the uncontrolled release and correction to avoid further releases & associated adverse impacts. • Ensure availability of spill containment and clean up kits on site.	
15		Change in land use pattern from agro-forestry to industrial use.	MEDIUM	See A17-18	LOW
16		Generation of non-hazardous and hazardous wastes	MEDIUM	• Develop and Implement a site-specific Waste Management Plan (WMP) that addresses issues linked to waste minimization, generation, transport, disposal, and monitoring. • Establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling and finally disposal of wastes. • Ensure the WMP address all solid and liquid waste likely to be generated during the implementation of the project • Implement feasible waste prevention, reduction, reuse, recovery and recycling measures. • Identify and implement pollution prevention opportunities such as use of material substitution for less hazardous alternatives, recycling and waste minimization. • Minimize hazardous waste generation by segregating hazardous from nonhazardous wastes. • Create waste collection areas with clearly marked facilities such as colour code bins and provide equipment for handling waste. • Ensure that hazardous wastes are stored in properly labelled closed containers placed away from direct sunlight, wind and rain and provide secondary containment with 110% of storage containers. • Ensure hazardous materials and waste storage areas are formally designated and access restricted to authorized persons. • Ensure proper disposal/treatment of waste by government	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
				approved waste vendor.	
17		Social Impact Job creation via direct engagement by NSPDL and indirect employment through economic vendor activities such as food selling.	POSITIVE	See A12 and B5	HIGHLY POSITIVE
18		Stimulation of local socioeconomic activities arising from employment of locals during construction.	POSITIVE		HIGHLY POSITIVE
19		Improved livelihood and poverty reduction.	POSITIVE		HIGHLY POSITIVE
20		**Impact on Community Infrastructure** Increase demand on existing health and sanitation infrastructure due to influx of temporary workers and "camp followers".	MEDIUM	• Promote access to community services by supporting infrastructural development in host communities.	LOW
21		**Impact on Culture** Increased social vices/crimes and dilution of indigenous culture, norms and traditions in nearby communities due to influx of migrant workers and business opportunists.	MEDIUM	• See A10	LOW
22		**Impact on Community Health, Safety & Security** Risk of communicable & vector-borne diseases such as STIs including HIV/AIDS, malaria from influx of temporary construction workers and camp followers and stagnation of waste water.	HIGH	See B7	LOW
23		Threat to community safety and security associated with presence of construction workers.	MEDIUM	See A10	LOW
24		**Impact on OHS** Respiratory and eye related problems for workers due to exposure to dusts including cement dust	MEDIUM	• See A6 • Provide and enforce usage of appropriate PPE.	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
		and exhaust emission.			
25		Risk of worker exposure to occupational health and safety hazards	MEDIUM	See A 22 - 24	LOW
26		Risks of occupational accidents and injuries to workers from use of heavy equipment and cranes, falling objects, slips, trips and falls.	MEDIUM		LOW
27	Erection of towers and installation of overhead HV transmission power lines	Risks of fall from working at height and other related occupational accidents and injuries to workers.	MEDIUM	• Develop and implement project specific OHS Plan. (See A22-24). Specifically: • Train workers on proper use of scaffolds and ladders. • Promote usage of fall prevention and protection devices, including safety belt, full body harnesses, shock absorbing lanyards or self-retracting inertia and other fall arrest devices attached to fixed anchor point or horizontal life-lines to protect workers. • Provide rescue and/or recovery plans, and equipment to respond to workers after an arrested fall.	LOW
28		**Impact on Soil and Land** Construction site waste generation.	MEDIUM	• See B16	LOW
29	Pre-Commissioning Testing of facilities	**Impact on Infrastructure and OHS**	MEDIUM	• Develop and implement project specific OHS Plan. (See A22-24). Specifically: - Implement Lock-Out / Tag-Out (LOTO) system during any electrical work. - Create awareness of safety measures for workers to observe when working in areas of high tension potential. - Restrict untrained/unauthorized workers from all areas of high tension potential to prevent electrocution. - Establish “No Approach” zones around or under high voltage power lines in conformance with TCN requirements. - Mark all energized electrical devices and lines with warning signs.	LOW
		Risk of electrocution to workers.	HIGH		
30	Demobilization of personnel, materials and	**Impact on Soil and Land** Generation of waste	MEDIUM	See B16	LOW
31		Soil contamination from indiscriminate disposal	MEDIUM		LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
	equipment (Site clean-up)	of wastes			
32		**Impact on Community & Occupational Health & Safety** Traffic congestion and increased risk of RTA and Injuries.	MEDIUM	See A8	LOW
33		Respiratory and eye related problems from exposure to dust and gaseous emission.	MEDIUM	• See A6 • Provide and enforce usage of appropriate PPE.	LOW
34		Risks of occupational accidents and injuries.	MEDIUM	See A24	LOW
35	Capacity Building and Training	**Social Impact** Acquisition of new skills and development of human capacity especially by locals employed to work during construction.	POSITIVE	See A12	HIGHLY POSITIVE
C	*Operation Phase*				
1	Operation of PV panels and other associated components	**Impact on Air and Climate** Reduction/displacement of electricity generation in fossil-fuel-fired power plants by electricity from the solar energy facility will reduce the overall emissions of combustion-related pollutants.	POSITIVE	• Ensure prompt replacement of damaged PV panels and other equipment to ensure peak electricity generation.	HIGHLY POSITIVE
2		Avoidance of fossil fuel utilization and reduced GHGs and other pollutant gas emissions.	POSITIVE		HIGHY POSITIVE
3		Promotion of clean energy as an alternative energy source and the establishment of cleaner development mechanism (CDM).	POSITIVE		HIGHY POSITIVE
4		Generation of renewable electricity to boost national power supply.	POSITIVE		HIGHY POSITIVE
5		**Social Impact** Creation of employment and business opportunities	POSITIVE	• Ensure maintenance jobs are targeted to the local people. • Ensure technology transfer by training indigenous people on solar plant management, operation and maintenance	HIGHY POSITIVE
6		Technology transfer and training of project staff on solar power plant management, operation and maintenance.	POSITIVE		HIGHY POSITIVE

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
7		Increased revenue generation to government through permits and taxes	POSITIVE		HIGHY POSITIVE
8		Savings on cost of diesel for pumping & distributing water to citizens by the Jigawa State government ministry of water resources.	POSITIVE		HIGHY POSITIVE
9		Creation of tourist attraction and recreational resources	POSITIVE	• Earnest the potential for the development of tourism by allowing tourists to visit solar plant.	HIGHY POSITIVE
10		Visual intrusion and disruption to aesthetics especially due to reflective surfaces of PV panels.	MEDIUM	• Ensure selection of solar panel backs that are colour-treated to minimize visual contrast with natural landscape setting. • Ensure coatings and painting on selected PV panels and associated infrastructures have little or no reflectivity. • Retain natural vegetation wherever possible within the solar plant.	LOW
11		**Impact on Community and Occupational Health & Safety** Potential for fire outbreak due to failure of electrical installations	MEDIUM	• Ensure solar plant is designed and constructed in full compliance with Nigeria's building codes, Fire Service regulations, other applicable emergency and legal/insurance requirements, and in accordance with an internationally accepted life and fire safety (L&FS) standard. • Use fire resistant materials. • Install appropriate fire safety & protection system & equipment. • Train workers on fire prevention techniques and the use of different fire extinguishing agents and equipment • Ensure routine inspection and prompt repair of any malfunctioning electrical installations. • Develop and implement Emergency Response and Contingency Plan to respond to on-site emergency issues	LOW
12		Risk of electrocution to workers	HIGH	See B29	LOW
13	Transmission of power	Risk of electrocution to community members and trespassers from direct and indirect contact with power lines especially from falling power lines.	HIGH	See B29. Use of proper signage (in English and local languages) & engineering barriers(e.g. fencing) to limit access to electricity energized equipment and conductors.	LOW
14		Risk of electrocution to workers from exposure to live power lines	HIGH	See B29	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
15		**Social Impact** Supply of renewable electricity to boost national power supply.	POSITIVE	See C4	HIGHY POSITIVE
16		Increase power transmission to homes and industries.	POSITIVE	See C4	HIGHY POSITIVE
17	Routine maintenance and servicing	Impact on Soil and Land Generation of industrial/ hazardous wastes (insulating oils e.g. polychlorinated biphenyls (PCBs), liquid petroleum fuels, waste water, cleaning agents and solvents, damaged panels, transformers, batteries, herbicides for weed control, etc.) during routine maintenance.	MEDIUM	See B16	LOW
18		Soil contamination from leachates of hazardous wastes.	MEDIUM	See B16	LOW
19		**Impact on OHS** Risk of worker exposure to hazardous chemicals.	MEDIUM	• Develop and implement project specific OHS Plan. (See A22-24). Specifically: • Communicate chemical hazards to workers through labelling and marking according to recognized standards. • Train workers on the use of the available information (such as MSDSs) and safe work practices. • Encourage workers to maintain good personal hygiene. • Use appropriate PPE	LOW
20		Risks of occupational accidents and injuries to workers from falls from heights, towers and use of machineries.	MEDIUM	See B27	LOW
21		Risk of electrocution to workers from exposure to live power lines.	MEDIUM	See B29	LOW
D	*Decommissioning Phase*				
1	Removal of PV panels and equipment, demolition of structures and	**Impact on Air** Air quality deterioration from the release of dust during demolition activities and exhaust emissions from vehicular equipment.	MEDIUM	See B1	LOW
2		**Impact on Soil and Land**	MEDIUM	See B16	LOW

S/N	Project Activities	Significant Associated and Potential Impacts	Impact Rating Before Enhancement / Mitigation	Enhancement/Mitigation Measures	Residual Impact Rating
	evacuation	Generation of industrial and hazardous waste including scrap metals, PV panels, inverters, batteries etc.			
3		Soil contamination from indiscriminate dumping of wastes.	MEDIUM	See B16	LOW
4		**Impact on Community/Worker's Health & Safety** Traffic Congestion and increased risk of RTA and Injuries (Traffic Safety).	MEDIUM	See A8	LOW
5		Risks of occupational accidents and injuries to workers.	MEDIUM	See A24	LOW
6	Site remediation including leveling, filling and re-vegetation	Soil stabilization and regeneration	POSITIVE	• Develop and implement a site reclamation plan to ensure that the site is rehabilitated and restored to a stable state. • Re-contour/grade site to blend with natural topography • Re-vegetate all exposed soil surfaces with indigenous plant species. • Install erosion control structures to prevent erosion and run-offs in order to allow planted vegetation to grow to a self-sustaining state	HIGHLY POSITIVE
7		Increase in land availability for agriculture and other purposes	POSITIVE		HIGHLY POSITIVE
8		Restoration of flora and fauna habitat	POSITIVE		HIGHLY POSITIVE
9		**Social Impact** Loss of employment	MEDIUM	• Carry out an analysis of alternatives to retrenchment e.g. employee capacity building programs; long-term maintenance works etc. prior to implementing any collective dismissals after construction. • Develop and implement a retrenchment plan to reduce the adverse impacts of retrenchment on workers. • Ensure compliance with all legal and contractual agreement with public authorities, workers and their organization. • Ensure all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner. • Provide a grievance mechanism for workers to raise workplace concerns.	LOW

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANGEMENT PLAN

7.1 Introduction

This Chapter discusses the Environmental and Social Management Plan (ESMP) for the proposed 80 MW_{AC} solar PV project. An ESMP is a management tool used to ensure that undue or reasonably avoidable adverse impacts of proposed project are prevented and that benefits of the project are enhanced. It helps to ensure that the management actions (mitigation and enhancement measures) arising from the ESIA process are clearly defined and implemented through all the phases of the project lifecycle. It thus outlines the mitigation, monitoring and institutional measures to be taken during project implementation and operation to control adverse environmental and social impacts. It in addition, includes the actions needed to implement these measures.

In specific terms, the objectives of the ESMP are to:

- Ensure compliance with national and international environmental standards and legislation;
- Ensure adoption and application of best practice environmental management principles to project's life cycle to ensure overall environmental sustainability;
- Ensure that mitigation measures proposed for all significant negative associated and potential impacts of proposed project are implemented;
- Monitor the effectiveness of proposed mitigation measures;
- Ensure that there is sufficient allocation of resources to effectively carry out the proposed mitigation measures;
- Respond to unforeseen events; and
- Provide feedback for continual improvement in environmental performance.

This ESMP has been developed in accordance with the requirements of FMEnv, World Bank/IFC, Equator Principles and will be implemented using the Environmental and Social Management System (ESMS) approach, which draws on the elements of the established business management process of "plan, do, check and act". The ESMS approach is similar to the ISO 14001 EMS depicted in Figure 7.1.

The ESMS provides a systematic framework and approach to managing the environmental and social impacts of the proposed project in a structured way on an ongoing basis. It will therefore ensure the effective management of the day to day environmental and social impacts arising during the preconstruction, construction, operation and decommissioning phases of the project. It will in addition assure environmental and social performance improvement on a continuous basis.

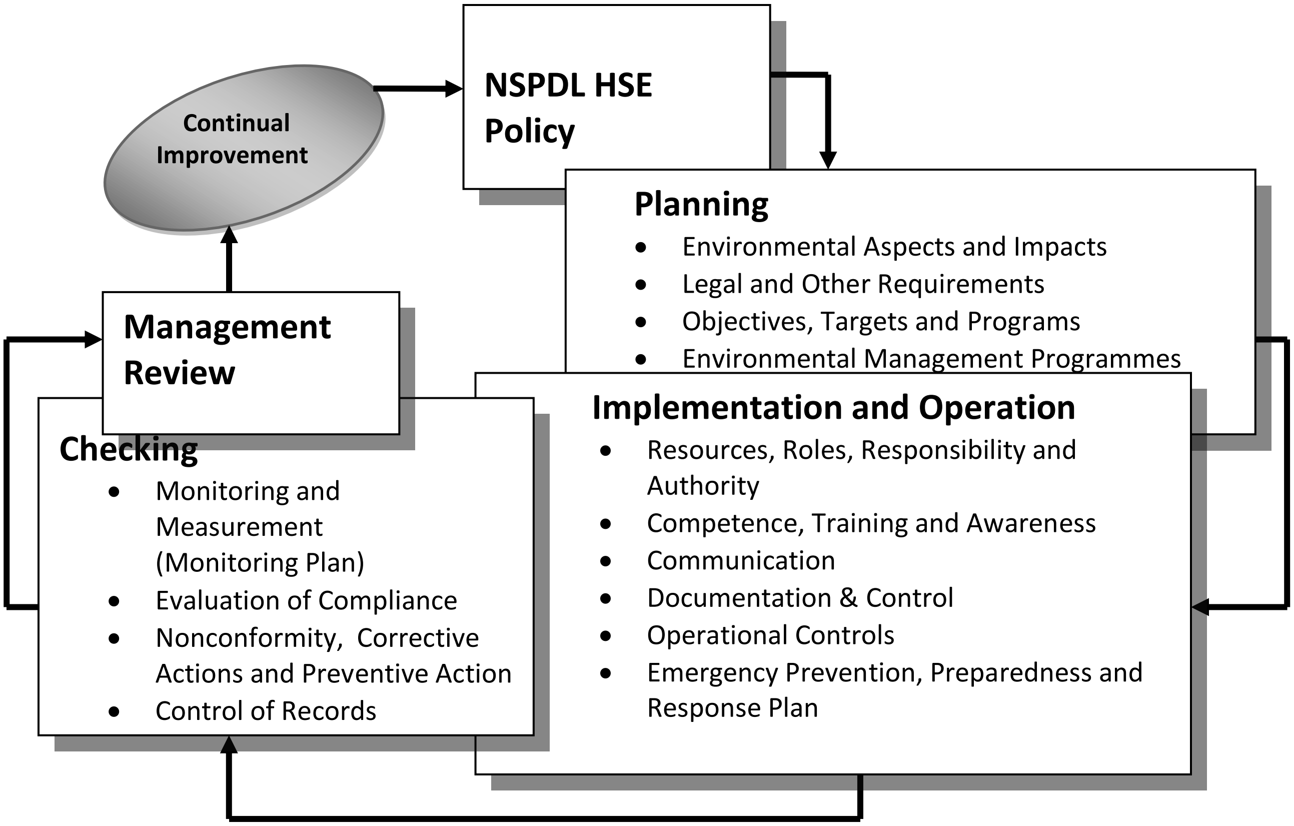

Figure 7.1: ISO 14001 Approach for Developing an Environmental Management System.

The key elements that are necessary to meet the requirements of IFC Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts in managing the environmental and social impacts of the proposed solar PV project and achieve the desired economic, environmental and social outcomes include the following:

- Policy
- Significant associated and potential environmental and social impacts of the proposed project
- Environmental and Social Management Programs
- Organizational Capacity and Competency
- Emergency Preparedness and Response
- Stakeholder Engagement and
- Monitoring and Review

These elements are incorporated in the ESMS and are discussed in the following sections.

7.2 NSPDL's HSE Policy and Commitment

NSPDL has established an integrated project specific policy on Health, Safety and Environment. This policy demonstrates the company's commitment towards ensuring the health and safety of employees that will be involved in the Jigawa Solar PV Project and protection of the environment during the project life cycle. The policy reflects the organization's mission, vision, core values and beliefs.

To achieve this commitment, NSPDL shall inter - alia:

- Identify and evaluate all environmental and social impacts of the solar project and adopt a mitigation hierarchy to avoid, minimize and compensate/offset significant impacts to workers, communities and environment.
- Comply with applicable national and international laws, regulations, codes of practices and other requirements to which the organization subscribes that relates to its environmental aspects.
- Establish, implement and maintain an effective HSE-Management System that will assure continued improvement of the health and safety of its employees and pollution prevention.
- Maintain and continually improve HSE performance of the project and prevent environmental pollution.
- Set and continually evaluate its HSE objectives, targets and performance.
- Protect the environment by reducing pollution from project activities, promote sustainable use of resources and reduce GHG emissions.
- Avoid or minimize human displacement by the solar PV project through proactive exploration of alternative project designs and options.
- Protect and conserve biodiversity and promote sustainable management of all living natural resources through the adoption of practices that integrate conservation needs and development priorities into project activities throughout its life cycle.
- Promote good environmental and waste management practices including the adaptation of 4R's of Reduce, Re-use, Recycle and Recover.
- Provide a safe place of work, safe equipment and systems of work.
- Avoid negative impacts on the health and safety of workers and the Affected Community throughout the project life cycle.
- Train employees to ensure all staff understand and accept their responsibilities to promote and maintain a safe and healthy workplace and protect the environment.
- Ensure EPC and O&M contractors who work on NSPDL solar power project have suitable HSE policies and approved HSE programs consistent with this policy.
- Communicate its HSE commitment and performance to employees, contractors, suppliers and others directly involved in the project.

The Managing Director shall ensure strict adherence to this policy and is ultimately responsible for its execution and communication with regulators and other stakeholders.

The policy will be reviewed periodically and revised to reflect changing organizational activities, legislation and information.

7.3 Associated and Potential Environmental and Social Impacts

The significant associated and potential environmental and social impacts for which management actions are required have been identified in Chapter 5 of this report and summarized in Table 5.9.

7.4 Environmental and Social Management Program

As stated earlier, the ESMP describes the mitigation and performance improvement measures and actions that address the identified environmental and social impacts of the proposed project. The measures and actions to avoid, minimize, compensate for or offset potential negative environmental and social impacts and enhance positive impacts of the proposed project are described in Chapter 6 of the Report and presented in Table 6.1. The performance measures to enhance the desired environmental and social outcome are discussed under monitoring in section 7.6.

The ESMP incorporates other thematic plans that will be prepared by NSPDL and EPC/O&M contractors to address specific potential environmental and social impacts. NSPDL shall develop a RALRP while the EPC/O&M Contractors will be required as part of contractual requirements to develop site-specific ESMPs detailing how the management actions contained in this ESMP will be implemented. The contractors will also be required to develop environmental and social management programs as it relate to their construction and operational activities. Such management programs shall include the following:

- Waste Management Plan
- Spill Prevention and Emergency Response Plan
- Traffic Management Plan
- Erosion Control Plan
- Integrated Vegetation Management Plan
- Occupational Health and Safety Plan
- Security Plan
- Labour and Employment Plan

These plans will be consistent with NSPDL's HSE policy, objectives and targets.

7.5 Implementation and Operation

7.5.1 Environmental and Social Management Organization & Institutional Arrangement

The successful implementation of the management program will depend on the commitment and capacity of the EPC and O&M contractors and other third parties (institutions) to implement the program effectively. Thus, the roles and responsibilities of persons and institutions that will be involved in the implementation, monitoring and review of the ESMP are discussed below:

7.5.1.1 Environmental and Social Management Organization

The selected EPC and O&M contractors shall provide adequate human and financial resources on an ongoing basis to achieve effective implementation of the ESMP and assure continuous improvement of environmental performance. Personnel within each establishment (including management representatives) shall be designated and assigned clear lines of responsibility and authority for environmental and social issues. The environmental and social management personnel will comprise of the following; NSPDL

Project Manager (PM) and HSE Manager/Consultant as well as the EPC/O&M contractor's PM, HSE Manager, HSE Officers, CLO and subcontractors.

The organizational structure showing authorities and communication structure for the environmental and social management of the proposed project is presented in Figure 7.2.

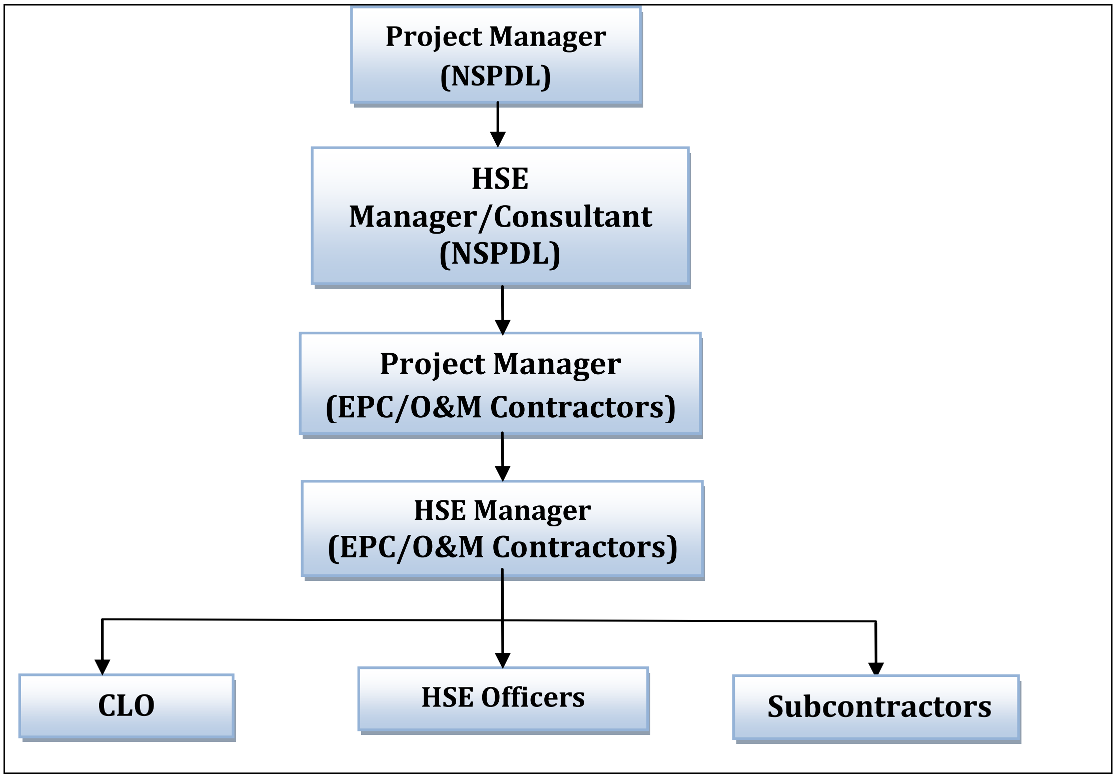

Figure 7.2: Organizational Structure Showing the Environmental and Social Management of the Proposed Project

The roles and responsibilities of the key stakeholders involved in the development, implementation and review of the ESMP are described below:

❖ **NSPDL Project Manager**

The PM shall be responsible for the implementation of the ESMP and ensuring that the environmental and social requirements are satisfied. Other key roles of the PM shall include the following:

- Liaising directly with FMEnv, NESREA, SME and other relevant authorities with respect to the implementation of the ESMP.
- Ensuring the integration of the required environmental and social management measures and obligations in tender documents and contracts.
- Approve environmental and social management programs, procedures and protocols developed by the EPC contractor.
- Making crucial decision on the implementation of the ESMP.

❖ **NSPDL HSE Manager/ Consultant**

The HSE Manager/ Consultant with appropriate training and experience shall be employed by NSPDL for the duration of the construction phase of the project. He/she shall provide feedback to the PM regarding all HSE matters. The HSE manager shall inter-alia:

- Manage the implementation of the ESMP to ensure that the environmental and social management measures are implemented and are effective.
- Periodically review and update the ESMP to ensure it addresses emerging environmental and social issues.
- Communicate all modifications to the ESMP to the relevant stakeholders.
- Assist in the resolution of conflicts that may arise as a result of construction related environmental and social issues.
- Compile and prepare periodic reports for approval of PM and onward submission to relevant authorities, Specifically:
    - Monitor the performance of the EPC Contractor (and Sub-contractors) and ensure compliance with the ESMP;
    - Validate the regular site inspection reports, which are to be prepared by the EPC Contractor;
    - Check the EPC Contractor's record of incidents and non-conformity as well as the corrective and preventive actions taken;
    - Check the EPC Contractor's public complaints register to ensure complaints are recorded and actions are taken appropriately; and
    - Conduct regular audits to ensure that the system for implementing the ESMP is operating effectively.
- Liaise between NSPDL, EPC Contractors, affected communities and relevant authorities on all environmental and social concerns.

❖ **EPC Contractor's Project Manager**

The Contractor shall appoint a Project Manager who shall be responsible for onsite implementation of the ESMP. The EPC Contractor's PM is answerable to the NSPDL PM through the HSE Manager/ Consultant for all HSE issues related to the construction of the project. The Contractor's PM shall:

- Formulate detailed HSE plans for the project.
- Supervise implementation of all the measures in the ESMP and preparation of all required Monitoring Reports.
- Ensure that all subcontractors working under the main contractor comply with the requirements of the ESMP.

❖ **EPC Contractor's HSE Manager**

The Contractor shall appoint a suitably qualified HSE Manager who shall be responsible for the coordination of all HSE activities of the contractor. The Contractor's HSE Manager shall:

- Prepare work plans for HSE Officers in line with the requirements of the ESMP.
- Prepare relevant ESMP documentation and procedures.
- Monitor the efficient implementation of the implementation of the ESMP.
- Organize periodic HSE risk assessment exercises.

- Advise Project Manager on compliance with ESMP and conditions requiring attention.
- Perform regular inspection of site to ensure adherence to management actions of the ESMP.
- Make thorough analysis of statistical data and inspections; delineates problem areas; and makes recommendation for solutions.
- Conduct investigation and take part in the review of incidence of non conformity with ESMP.

❖ **EPC Contractor's HSE Officers**

The Contractor's HSE Officers shall be answerable to the HSE Manager. The HSE Officers shall be deployed to the project site to perform the following functions regarding the implementation of the ESMP:

- Carry out day-to-day HSE activities specified in the HSE Plan and ESMP.
- Provide inputs into the regular HSE report to be prepared by HSE Manager;
- Maintain all HSE records.
- Ensure any changes during construction process that may have a significant environmental and social impact are communicated to the HSE Manager in time and managed accordingly.
- Conduct independent inspections to observe conformance with ESMP requirements and determine the effectiveness of individual elements of the plan.
- Establish contact with Subcontractors with the objective of maintaining good relations, coordination of accident prevention activities and compliance with the established OHS plan.
- Correct unsafe acts and unsafe conditions.
- Inspect safety equipment e.g fire extinguishers, to ensure availability and conformance with ESMP requirements.
- Deliver regular HSE induction/orientation course, HSE awareness course, toolbox talk etc to all employees, including subcontractors in line with the requirement of ESMP.
- Provide on the spot advice and clarifications to construction workers on matters relating to ESMP implementation.
- Assist in carrying out risk assessment and participate in accident investigations.

❖ **Community Liaison Officer (CLO)**

The CLO shall:

- Be the main contact between affected community representatives and the EPC Contractors.
- Assist in resolving all disputes between EPC contractors and the affected communities.

The detailed general environmental management conditions to be implemented by the EPC contractor during civil works are presented in Appendix 7.1.

After the construction of the solar PV facility, the operation of the project shall be transferred to an O&M contractor. NSPDL shall ensure that the legal requirements of the ESMP are transferred to the O&M contractor accordingly and the record of transfer shall be clearly communicated to relevant authorities and other stakeholders. Hence, during operation phase of the project, the roles of the EPC contractor highlighted above shall be transferred to the O&M contractor as applicable.

7.5.1.2 Institutional Arrangement

The roles and responsibilities of the various institutions in the implementation of this ESMP are outlined in the following section and Table 7.1. The proposed institutional arrangement is shown in Figure 7.3.

❖ ***Federal Ministry of Environment (FMEnv)***

For this ESMP, the FMEnv through the EA Department and relevant agencies will play the role of lead environmental regulator, overseeing compliance requirements, granting consent and also monitoring or providing supervisory oversight for the project. Specifically, FMEnv will:

- Receive comments (require revisions where necessary), provide approval and needed clearance for the ESMP and other environmental clearance in collaboration with the SME.
- Review Monitoring Reports from SME.
- Ensure that corrective actions are taken for significant environmental and social impacts.
- Undertake periodic site visits to inspect and verify the nature and extent of impacts and the success or lack of the mitigation measures.

❖ ***Jigawa State Ministry of Environment (JSME)***

The JSME will be the environmental compliance overseer at the state level. In addition to other statutory functions, JSME shall:

- Ensure that all project activities comply with the State environmental laws and requirements.
- Perform regular compliance monitoring and periodic inspection of all the stages of the project.

Table 7.1: Roles and Responsibilities of Relevant Institution

S/N	Category	Roles & Responsibilities
1.	Federal Ministry of Environment	• Lead role - provision of advice on screening, scoping, review of draft ESMP report (in liaison with State Ministry of Environment), receiving comments from stakeholders, public hearing of the project proposals, and convening a technical decision-making panel, environmental and social liability investigations, monitoring and evaluation process and criteria.
2.	TCN	• Coordination of electricity transmission and connection to grid. • Collaboration with EPC/O&M contractors to ensure the implementation of the ESMP especially with regards to the transmission line component of the project. • Supervision of all HSE activities related to the transmission line during construction and operation phase.

3.	Jigawa State Ministry of Environment	• Environmental compliance overseer at the State level • Review of draft ESMP report (in liaison with Federal Ministry of Environment) • Site assessment and monitoring of ESMP implementation.
4.	State Government MDAs (Ministry of Lands, Housing, Urban Development and Regional Planning, etc.,	• Compliance overseer at State Level, on matters of land acquisition and compensation and other resettlement issues, • Other MDAs come in as and when relevant areas or resources under their jurisdiction or management are likely to be affected by or implicated projects. • They participate in the EA processes and in project decision-making that helps prevent or minimize impacts and to mitigate them. These institutions may also be required to issue a consent or approval for an aspect of a project; allow an area to be included in a project; or allow impact to a certain extent or impose restrictions or conditions, monitoring responsibility or supervisory oversight.
5.	JISEPA	• Inspection of project premises in order to ensure strict compliance with sanitation and waste management standards in the state. • Collaboration with other MDAs at the State and Federal level, NGOs and Donor Agencies in environmental protection and management especially in areas of waste recycling etc.
6.	Local Government	• Provision of oversight function across subproject in LGAs for ESMP compliance. • Monitoring of activities related to public health, sanitation, waste management amongst others.
7.	Affected Community	• Promote environmental awareness. • Review environmental and social performance report made available by NSPDL. • Provide comments, advice and/or complaints on issues of nonconformity. • Attend public meetings organized by NSPDL to disseminate information and receive feedback.
8.	CDA	• Ensure community participation by mobilizing, sensitizing community members;
9.	NGOs/CSOs	• Assisting in their respective ways to ensure effective response actions, Conducting scientific researches alongside government groups to evolve and devise sustainable environmental strategies and techniques.
10.	Others/General Public	• Identify issues that could derail the project and support project impacts and mitigation measures, Awareness campaigns.

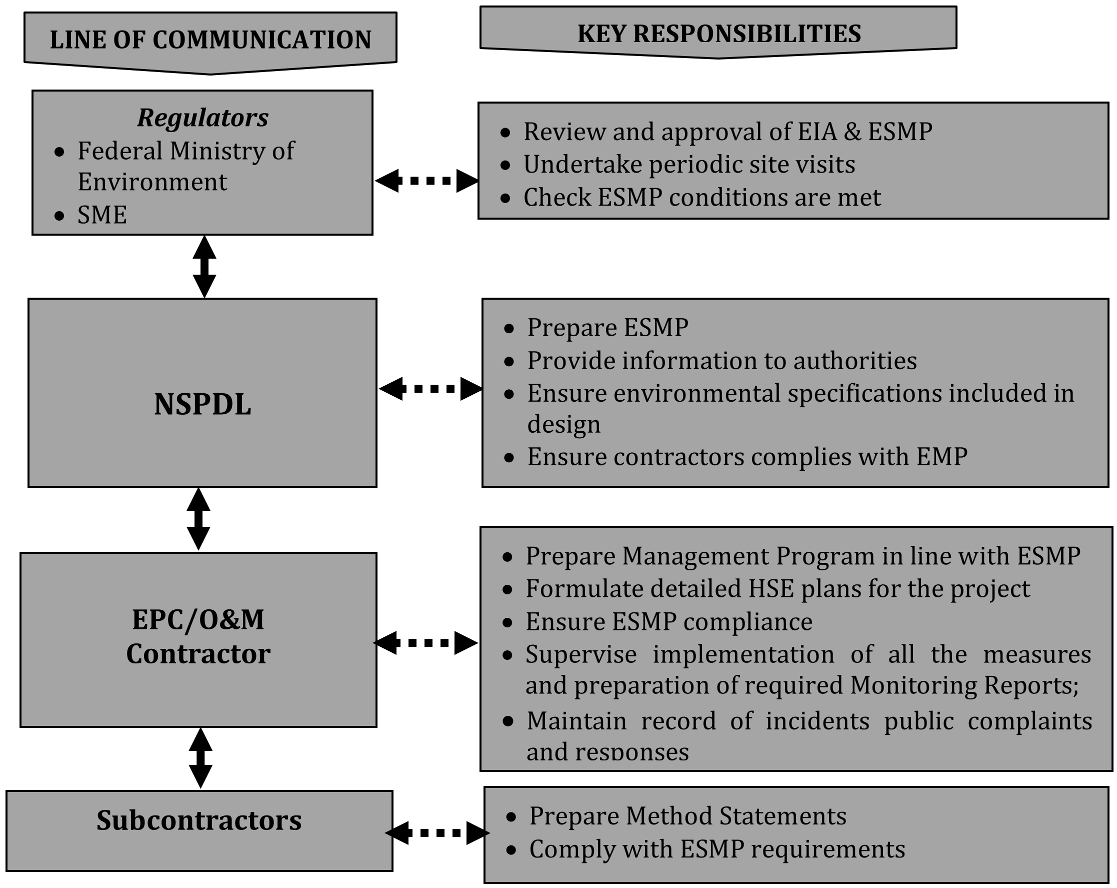

Figure 7.3: The Proposed Institutional Arrangement with Key Roles for the ESMP Implementation

7.5.2 Training, Awareness and Competence

Training is essential for ensuring that the ESMP provisions are implemented efficiently and effectively. NSPDL shall therefore ensure that all persons that have roles to play in the implementation of the ESMP and management system are competent on the basis of appropriate education, training or experience. To this end, NSPDL shall ensure that EPC and O&M contractors identify the training needs for their employees at each relevant function and level, with direct responsibilities for ESMP implementation. Consequently, the EPC and O&M contractors shall be required to develop training plans to include project specific training programs, with respect to the different aspects of the ESMP implementation viz significant potential environmental and social impacts of the project, management and monitoring actions, regulatory requirements and specific roles and responsibilities.

Specifically, the contractors shall be required to undertake general HSE awareness for their project workforce and specific training for those whose work may significantly have impact on the environment. This is to ensure that they are fully aware of the relevant aspects of the ESMP and are able to fulfill their roles and functions.

As a minimum, the contractors shall ensure they provide the following training to their personnel:

I. General Awareness HSE Training
- HSE Induction/Orientation Course for all workers to include (site safety rules, PPE requirements, Emergency Preparedness and Response)
- Daily tool box talk for workers at the start of each day's job.
- Refresher HSE Courses as at when required.

II. Project Specific OHS Training
- Manual Handling Techniques
- Electrical Safety
- Work at Height Training
- First Aid Training (for Site First Aiders)
- Lifting and Rigging
- Safe Driving Techniques (for drivers)

The EPC contractor will be required to forward internal HSE training and procedures to NSPDL Project Manager for approval before commencement of the project.

All training programs shall be:

a. Verified to ensure consistency with NSPDL policy and other applicable regulatory requirements.
b. Documented and kept as records.
c. Evaluated to determine their effectiveness.

Based on the assessment of the institutional capacities of the different agencies that will be involved in the implementation of the ESMP, two broad areas of capacity building have already been identified and recommended for relevant personnel of NSPDL, EPC Contractors and Agencies for effective implementation of the ESMP. The proposed training program, course content and estimated costs are shown in Table 7.2.

Table 7.2: Proposed Training Program for the Implementation of ESMP

Capacity Building Activity	Proposed Topics	Objectives	Target Audience	Duration	Estimated Budget (N)
Module 1: Training on Environmental and Social Management Plan Implementation	• Overview of Environmental Impact Assessment • Overview of Potential Impacts of Project • Environmental Pollution & Control • Environmental and Social Management Plan • Basic Environmental Management • Environmental Performance Monitoring – Monitoring Mitigation Measures in ESMP • Environmental Reporting	To enhance competence in environmental sustainability and regulatory practice	NSPDL representatives, relevant staff of FMEnv (EA Dept), JSME, JISEPA, other relevant MDAs, LGA departments, EPC Contractors, NGOs, CBOs.	5 days	5,000,000
Module 2: Training on Construction HSE	• Introduction to Construction HSE • Overview of Health and Safety Hazards in Construction • Incidents: Causation, Investigation & Reporting	To promote safe & healthy working conditions as well as the health of workers and regulators who	NSPDL representatives, relevant staff of FMEnv (EA Dept), JSME, JISEPA, other	5 days	3,000,000

	• Excavation Safety • Construction Site Inspection • Personal Protective Equipment	may be involved in monitoring during project implementation	relevant MDAs, LGA departments, EPC Contractors, NGOs, CBOs.		
	TOTAL			**10 days**	**8,000,000**

7.5.3 Communication

As a demonstration of its commitment to dealing with project related issues in a positive and proactive manner, NSPDL shall, and ensure that the EPC contractor, implement and maintain procedures for internal and external communications on environmental and social management issues.

7.5.3.1 Internal Communication

Effective internal communication mechanisms for information dissemination between levels and functions within the organizations shall be implemented. The mechanism shall encourage information to flow top-down, bottom-up and across functional lines amongst those responsible for the implementation of the ESMP. Those with specific role within NSPDL for the ESMP include the Project Manager and HSE Manager/Consultant while those of EPC/O&M contractors include the Project Manager, HSE Manager, HSE Officers and CLO. The roles and responsibilities of these personnel and specific lines of communication have been described in Section 7.5.1. The approach for internal communication shall include regular meetings, daily briefings through the use of intranets services, telephone and periodic newsletters as appropriate.

7.5.3.2 External Communication

NSPDL shall also implement proactive, two-way communication with external parties to report on environmental and social performance and progress and to solicit, receive, document and respond to feedback from the public. Audience for external communication shall include the regulators such as FMEnv, JSME etc, affected communities and other stakeholders. Appropriate approach and strategy that fits the interest of each identified external parties shall be adopted.

The NSPDL's PM shall be responsible for external communications on environmental and social concerns of the project through the HSE Manager. Methods of communication may include meetings, periodic reports, press releases etc. Procedure for external communications shall specifically include measures to (i) receive and register external communications such as complaints, advice, and other specific information regarding the environmental and social concerns of the project from the public; (ii) screen and assess the issues raised and determine how to address them; (iii) provide, track, and document responses, if any; and (iv) adjust the management program, as appropriate. NSPDL shall make public available periodic reports on the environmental and social sustainability of the project.

For effective external communication, a project specific Stakeholder's Engagement Plan (SEP) and Grievance Redress Mechanism (GRM) have been designed for the project and presented in the following section:

7.5.3.2.1 Stakeholders Engagement

Stakeholder engagement is an integral part of the ESIA process. The stakeholder engagement process is extensively discussed in Chapter Four of this Report. Affected communities and relevant stakeholders have been identified for informed and meaningful consultation from the early stages of the ESIA process to ensure that the interests, concerns and inputs of affected communities and stakeholders are integrated into the overall project plan thus mainstreaming bottom up approach in the ESIA study. The approach to ensure that stakeholder engagement continues throughout the ESIA process and project life cycle to foster strategic partnerships and collaboration among NSPDL, EPC/O&M contractors, affected communities and other stakeholders has also been outlined.

7.5.3.2.2 Grievance Redress Mechanism

Grievance Mechanism creates a platform and procedures for effective handling of complaints and grievances that is aimed at avoiding lengthy litigation which may mar or delay project objectives and implementation. It is envisaged that under this Solar PV project, grievances may result due to one or a mix of the following factors:

- Failure to identify all affected land owners and categories of affected persons and communities.
- Non-payment of compensation.
- Inadequate compensation or valuation of assets.
- Delay in disbursement of entitlement.
- Dispute about ownership of land or asset
- Non-participation or engagement of affected persons and communities in compensation negotiation.
- Implementation of project before or without resolving resettlement matters

❖ **Objective of the GRM**

The objectives of the grievance redress mechanism are to:

- Provide an effective avenue for affected persons to express their concerns and resolve disputes that are caused by the project.
- Promote a mutually constructive relationship among affected persons/community, NSPDL and EPC/O&M contractors
- Prevent and address community concerns.
- Promote larger processes that create positive social change.
- Identify early and resolve issues that would lead to judicial proceedings.

❖ **Existing Grievance Redress System in the Locality**

All the concerned villages within the project area have common cultural procedures that govern the way civil cases and grievances including land disputes are resolved. Ward Heads adjudicate on cultural and civil matters that are within their ward purviews. This includes hearing and settling of disputes and non-criminal cases. Issues that are not satisfactorily resolved at the ward level are taken to the Barden Kude (Village Head). In the event that any matter is beyond the Barden Kude, or parties disagree with the judgement of

the Barden Kude, the matter goes to the Hakimi (District Head). It is only when a case is not resolved by the District Head that it goes to the Emir and his cabinet counsellors.
The stated local grievance redress does not in any way impede the right of dissatisfied parties in any case from seeking for redress through judicial means.

❖ **Composition of Grievance Redress Committee (GRC) under this Project**

The essence of a special GRC for this project is to install a functional and effective GRM which shall be a hybrid of the traditional GRM system and new methods that represent result oriented best practices. A functional GRC shall be constituted by NSPDL in collaboration with the Dutse local government and the local community. NSPDL will have the responsibility of spearheading the constitution of this committee whose duty is to monitor and review the progress of implementation of the compensation of the affected people and to carry out post implementation social audits.
The composition of the committee will include the following:

i. All the Village Heads (Barden Kude) from the 5 affected villages;
ii. A representative of the Hakimi (District Head);
iii. 2 representatives each from project affected persons in each of the 5 villages.

As a result of the co-option of the village heads into the GRC, the Village Heads shall not be involved in the payment of compensation nor serve as third party to receiving compensation benefits for or on behalf of affected persons. This is a measure to safeguarding their integrity and respect from affected persons thereby building confidence in the GRC.
The main functions of the Committee are:

- Publicize within the list of affected persons and the functioning of the grievance redressed procedure established;
- Verify grievances and their merits;
- Recommend solutions to such grievances to NSPDL and EPC/O&M contractors;
- Communicate the decisions to the Claimants;
- Ensure that all notices, forms, and other documentation required by Claimants are made available in Local language understood by the people;
- Ensure documentation of all received complaints and the progress of remediation; and
- Entrench a feedback system (making sure that affected persons are informed about the outcome of investigations and actions taken on each case.

❖ **Grievance Redress Process**

The structure or steps of the grievance mechanism shall comprise of:

- Locate, receive, register and acknowledge complaint
- Screen and establish the foundation of the grievance
- Implement, Monitor and Evaluate a redress action
- Entrench a feedback system
- Advise for a judicial proceedings as last resort if necessary
- Document the experience for future reference

- ***Procedure to Locate, Receive, Register and Acknowledge complaints***

NSPDL shall in consultation with the GRC choose a convenient location where the GRC shall use as secretariat. The venue may be the palace of one of the Village Heads, but must be a venue central, accessible and agreeable to affected persons (via their representatives in the GRC). The GRC will establish a register/complaint log book for all complaints at the project level. The log book will constitute of: 1) the complainant's name, 2) date of complaint, 3) nature of complaint, 4) follow-up action and schedule. NSPDL shall communicate to affected persons prior to compensation implementation about the functions of the GRC, and the process to accessing redress.

It must be noted that proper and honest response to grievances, an apology, adequate compensation, and modification of the conduct that caused grievances are fair remedies for grievance redress. Therefore, the GRC should be trained on the diplomacy of handling aggrieved persons while verifying/screening the merit or otherwise of his/her complaints.

- ***Procedure to Screen and Establish the Merit of Grievance***

The GRC will upon receipt and registration of grievance proceed to investigate the cause/merit of the complaints. This should be undertaken within one (1) week of receiving complaints. Depending on the nature and complexity of the matter in question, the GRC may invite the parties involved in the process of investigation and redress.

- ***Procedure to Implement, Monitor and Evaluate a Redress Action***

Once the cause of the grievance and eligibility of the affected person is established, the GRC shall recommend to NSPDL and EPC/O&M contractors the remedial package or line of action to address the grievance in line with established entitlement/valuation matrix. NSPDL shall spell out in writing to the aggrieved persons and copied to the GRC within two weeks of resolution of grievance, of its commitment and when to pay the compensation. The GRC will issue a grievance resolution form to be completed and endorsed by the complainant confirming resolution of the grievance. It is recommended that implementation of the redress action plan be witnessed and monitored by the GRC and/or a third party. If established that project affected person (PAP) was ineligible for the claim he/she presented, the GRC will persuade the affected persons to drop the complaint.

- ***Alternative Action for Dissatisfied Aggrieved Persons***

In the event that the aggrieved person is dissatisfied with the resolution/decision of the GRC, he/she can bring the matter up to the District Head for hearing and action, but where the matter appears unresolved or unsatisfactory to the complainant, court of law will be a last resort to seek redress.

- ***Financing of the Grievance Redress Mechanism and Cost of Remediation***

NSPDL shall be responsible for the funding of logistics for the GRC as well as the eventual compensation or resettlement remediation that aggrieved party may be entitled to.

The implementation plan for grievance redress process for the proposed project is presented in Table 7.3.

Table 7.3: Implementation Plan for Grievance Redress Process

#	Process	Description	Completion Time frame	Responsible Agency/Person
1	Receipt of complaint	Document date of receipt, name of complainant, village, nature of complaint, inform NSPDL/EPC/ O&M	1day	Secretary to GRC at project level
2	Acknowledgement of grievance	By letter, email, phone	1-3 days	Secretary to GRC at project level
3	Screen and Establish the Merit of the Grievance	Visit the site; listen to the complainant/community; assess the merit	7-14 days	GRC and the aggrieved affected person or his/her representative
4	Implement and monitor a redress action	Where complaint is justified, carry out compensation redress	21-30 days	NSPDL/EPC/O&M contractors.
5	Extra intervention for a dissatisfied scenario	Review the redress steps and conclusions, provide intervention solution	2-4 weeks of receiving status report	District head
6	Judicial adjudication	Take complaint to court of law	No fixed time	Complainant
7	Funding of grievance process	GRC logistics and training, redress compensation	No fixed time	NSPDL/EPC/O&M contractors.

7.5.4 Documentation, Record Keeping and Control

Documents, particularly records provide evidence of the ongoing mitigation/ monitoring activities and effectiveness of the ESMP. They are required to track performance and other data necessary to achieve and demonstrate compliance with the ESMP and applicable regulatory requirements. Documents and records to be kept will include amongst others:

- NSPDL HSE Policy;
- EPC Contractor HSE Policy;
- EPC Contractor HSE Manuals;
- ESMP Implementation activity specification;
- Emergency response and preparedness procedures;
- Site instructions;
- Complaint records;
- Training records;
- Inspection, maintenance and equipment calibration records;
- Monitoring data and audit results;
- Pertinent contractor and supplier records;
- Identified problems and corrective actions taken;
- Incident reports; and
- Significant communications with regulators.

The effective control of these documents is essential to the successful implementation of this ESMP. Procedures for the identification, collection, indexing, filing, storage, maintenance, retrieval and retention of documents will therefore be established, implemented and maintained. Responsibilities shall be assigned to relevant personnel for ensuring that the ESMP documentation system is maintained and that document control is ensured.

7.5.5 Operational Controls

An important step in successfully managing HSE risks is the process of gaining operational control over identified significant potential OHS risks and environmental impacts. Operational control can be achieved by a variety of effective methods such as safe operating procedures, work instructions, physical controls, preventative maintenance programs, training and engineering specifications. One of the most important and effective method is documented operating procedures. Documented procedures ensure that the necessary steps and activities for controlling risks are completed correctly, at the right time, by the right people, and the same way every time.

To meet its objectives, targets and requirements of HSE policy as well as legal requirements, EPC/O&M shall:

- Establish and implement operational controls for all identified significant OHS risk and environmental impacts and integrate the procedures into the overall HSE-Management System.
- Ensure procedures include assignment of responsibility for all procedure requirements. Where possible responsibility shall be assigned to the individual(s) that have authority and responsibility for the operation, activity or risk to be controlled.
- Ensure where training is used as an operational control, it must conform to the requirements of approved Training Plan.

Operational control procedures shall be reviewed, revised and updated on a periodic basis by the EPC/O&M contractors to evaluate their ongoing suitability and effectiveness and necessary changes will be implemented.

7.5.6 Emergency Preparedness and Response Plan

Emergency Preparedness and Response Plan is essential to address unplanned situations that may result in risks to human health, properties or the environment, either within the solar plant or in the nearby local communities. EPC/O&M contractors shall prepare plans and procedures for preventing and mitigating unplanned potentially adverse environmental and social events that may occur during project implementation and operation. Specifically, EPC/O&M shall:

- Identify areas where accidents and emergency situations may occur and individuals that may be affected. Such emergencies include fire emergency (during operation phase of the plant) and hazardous material spill during construction and operation phases of the project.

- Provide and install relevant emergency equipment such as fire fighting/extinguishing equipment and detection system, including alarm bells and visual alarms for communication to alert workers to an emergency.
- Ensure regular servicing and testing of emergency equipment.
- Provide first aid attendants for the solar power project as well as suitable medical equipment.
- Liaise or collaborate with the local communities that may be affected by the project and relevant local agencies in preparation to respond effectively to emergency situations.
- Provide relevant local authorities, emergency services, affected communities and other stake holders with information on the nature and extent of environmental and human health effects that may result from the project activities.

The project-specific emergency plan shall address amongst others the following aspects of emergency preparedness and response:

- Emergency procedures
- Emergency contacts and communication
- Evacuation routes and meeting points
- Roles and responsibilities
- Education and Training
- Emergency Drills

The Emergency Preparedness and Response Plan shall be reviewed, revised and updated annually to reflect changing conditions in the plan.

7.6 Checking and Corrective Actions

7.6.1 Monitoring

As part of the ESMP, a project specific monitoring plan has been designed. This plan establishes environmental and social action plans with well defined desired outcomes and actions to address all significant impacts identified for the proposed project. The plan also include measuring elements such as parameters to be measured, methods of measurement, location of measurement, performance indicators (targets or acceptance criteria) that can be tracked over defined time periods, and with estimates of the resources and responsibilities for monitoring.

Recognizing the dynamic nature of the project, the monitoring plan is designed to be responsive to changes in circumstances, non compliance issues, unforeseen events, and the outcome of reviews. The environmental monitoring activities shall be based on direct/indirect indicators of emissions, effluents, and resource use applicable to the project. Monitoring frequency incorporated shall be sufficient to provide representative data for the parameters being monitored. Monitoring data shall be analyzed, documented and reviewed at regular intervals and compared with the operating standards for necessary corrective actions.

For effective monitoring, the following measures shall be taken:

- Monitoring shall be conducted by trained HSE Officers and other competent professionals;
- Measuring equipment will be accurately calibrated;
- Quality control of sampling undertaken will be ensured;
- Accredited laboratories will be used;
- Certified methods of testing will be employed and where legal specifications exist for testing and sampling methods, these will be taken into account.

Monitoring results shall be documented with preventive/corrective actions to be implemented. The monitoring plan comprises of both internal monitoring to which shall be undertaken by NSPDL and/or EPC Contractor as well as external monitoring by regulators and other relevant third parties. The monitoring plan is incorporated in the ESMP and presented in Table 7.4

7.6.1.1 Internal Monitoring

Internal monitoring shall be carried out at two levels. The first level of monitoring shall be carried out by the EPC Contractor on an ongoing basis as specified in the monitoring plan. The second level of monitoring shall be carried out by NSPDL. NSPDL shall require supervision and monitoring of its own in order to ensure that the mitigation measures and actions specified in the monitoring plan and as bound by the contract is satisfactorily implemented. This shall be the main duties of the HSE Manager as described in Section 7.5.1.1. Monitoring by the HSE Manager shall be carried out by regular site visits and inspection of EPC contractor's regular monitoring reports.

7.6.1.2 External Monitoring

External monitoring and supervision will be done by FMEnv, JSME, other relevant MDAs, financial institutions and affected communities as may be required. These institutions will check reports received periodically from the NSPDL and carry out inspections and/or audits on their own. Using the monitoring indicators specified in the monitoring plan, each party will seek to measure the project's progress, in a manner that highlights the various objectives in line with national and international environmental and social requirements.

7.6.2 Reporting Procedures

Reporting is essential for conveying information from the monitoring activities. The following reporting procedures have been developed in order to ensure that NSPDL is able to receive feedback from the implementation of the ESMP on an ongoing basis and to take rapid corrective actions if there are issues of non-conformance:

- Monthly Progress and Monitoring Report: to be prepared by the EPC Contractor's HSE manager, providing relevant information on all monitoring activities, and on any specific events, as the case may be. These reports are to be made available to NSPDL and FMEnv/JSME at their request.

- Quarterly Reports: to be prepared by the EPC Contractor, summarizing all observations of the period. Reports will also be made available to NSPDL and FMEnv/JSME accordingly.

- Quarterly Report by NSPDL: based on the EPC Contractor's reports and on own activities. The report shall be made available to FMEnv/JSME and financial institutions upon request. The quarterly monitoring report will contain the following aspects of the ESMP implementation:
    a. Brief introduction to activities
    b. Objectives and scope of monitoring
    c. Monitoring parameters
    d. Field observations and analysis
    e. Percentage of safeguard compliance
    f. Non-compliance issues, gaps and weaknesses
    g. Recommendations for corrective measures
    h. Data, analysis results and pictures

- Additional Reports according to specific conditions. Most importantly, separate reports will have to be prepared in the case of incidents irrespective of whether or not these give rise to “accidents” involving actual injury, fatality, serious environmental impact or other serious damage. The procedure for investigating and reporting these incidents shall be included in the OHS Plan for the project.

7.6.3 Auditing

An audit is an environmental management tool employed to analyze the results obtained from monitoring activities and to assess whether objectives and targets have been met and whether there are variances from the ESMP and legal requirements. Audit for the proposed project shall be carried out at two levels, namely internal and external audit.

- **Internal Audit:** This shall be undertaken by NSPDL (O&M contractor during operation phase) to ensure there is absolute compliance with its HSE Policy, all the requirements of this EIA/ESMP, all applicable national laws, relevant international policies, guidelines and conventions. The procedure for conducting ESMP audits shall be developed by the NSPDL HSE Manager to include processes for scheduling and reporting, as well as the timing and frequency of the audits. This procedure shall also address responsibilities and required resources. The HSE Manager shall be responsible for scheduling and ensuring execution of the audit, as well as for the verification of the implementation of corrective action.

- **External Audit:** This shall be undertaken by the O&M contractor. The frequency of external audit shall be determined by regulators and may likely be carried out every three years once the solar plant commences operation in fulfilment of the law.

NSPDL/O&M contractor shall ensure competent personnel are engaged to carry out audits. An independent HSE consultant may be engaged to undertake the audits. In addition, the audit programme shall be documented and issues identified reported and corrected. NSPDL shall also design and implement a follow-up system in order to ensure the shortcomings identified have been corrected.

7.6.4 Nonconformity, Corrective Action and Preventive Action

It is expected that efficient monitoring, auditing and other measurement activities designed as part of the ESMP will identify some deficiencies.

To deal with issues of non-conformity, NSPDL/O&M contractor shall establish a process to ensure that:

- All nonconformities issues are identified and investigated;
- Root causes are identified;
- Corrective and preventive actions are identified and implemented; and,
- Actions are tracked and their effectiveness is verified.

During construction, issues relating to nonconformities and other system deficiencies shall be analyzed to detect patterns or trends. Identifying trends allows anticipation and prevention of future problems. NSPDL shall focus on correcting existing problems and preventing future problems or reoccurrence as preventing problems is generally more environmentally, socially and economically sound than fixing them after they occur (or after they reoccur). The NSPDL HSE Manager shall record and document the results of corrective and preventive actions taken and shall monitor the effectiveness of corrective and preventive actions taken. The HSE Manager shall present report of non-conformity, corrective action and preventative action to the NSPDL PM. Depending on severity of the problem and potential environmental and social impact, the PM may report any non-conformity issue, corrective and preventative action to the top management for discussion during management review meetings. During operation, all issues relating to nonconformities and other system deficiencies shall be subject to O&M contractor's management system.

7.7 Management Review and Revision of ESMP

This ESMP is designed to be a dynamic and flexible plan that shall be subject to periodic review by top management to improve overall environmental and social performance of the project. Reports shall be compiled by NSPDL HSE Manager/Consultant with inputs from EPC contractor's HSE manager. Such reports shall be submitted to the NSPDL PM for review and approval. The following are major sources of the information to be documented for management review:

- Outcome of audits including issues of non conformity, corrective and preventive actions.
- Outcome of monitoring activities.
- Suggestions from independent consultants.
- Suggestions from project implementation team.
- Suggestions from EPC contractor and subcontractors.
- Major complaints from affected communities and other stakeholders.

Following approval, PM shall present the report to the top management. All issues discussed, decisions reached, action items, timing and delegated responsibilities shall be documented. In addition, responsibility for follow-up on all action items arising from management review shall be delegated to ensure prompt implementation. EPC contractor is also expected to carry out review and revision of in line with its management system. During operation, management review and revision of management system shall be the responsibility of the O&M contractor.

Table 7.4: Environmental and Social Management Plan

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility: Implementation	Responsibility: Supervision	Monitoring Cost (N)
A	***PRE-CONSTRUCTION PHASE*: LAND ACQUISITION**										
1	**Impact on Land Owners/Users** Loss/depletion of farm land	Satisfactory compensation implementation Social justice and sustainability	• Develop and implement a Resettlement Action and Livelihood Restoration Plan to compensate affected persons and/or communities. • Avoid forced eviction of farmers from their farmlands. • Ensure all issues relating to compensation are handled in a transparent, consistent and equitable manner. • Ensure adequate engagement with affected persons and communities throughout the process of land acquisition. • Ensure disclosure of relevant information and participation of affected communities and persons continue through implementation, monitoring and evaluation of compensation payments. • Ensure affected land owners are adequately compensated for loss of land and economic crops at full replacement cost. • Provide alternative income earning opportunities such as credit facilities, training or employment opportunities to assist affected persons. • Provide opportunities to affected persons and communities to derive appropriate development benefits such as employment, from the project. • Establish a grievance mechanism to receive and address specific concerns about compensation.	Developed RALRP Evidence of stakeholders Engagement. Grievances and conflicts. Alternative livelihood. New skills acquired No of employed locals	• Increase in direct and indirect jobs. • No of people trained. • No of benefitting locals. • No of complaints received • No of grievances received/ resolved	• Visual Observation • Survey • Participation records/ minute of meetings	Host communities	Quarterly	NSPDL	FMEnv Jigawa State Ministry of Lands Invest Jigawa Dutse LGA	700,000
2	Loss of land based livelihood.										
3	Loss of economic trees including medicinal herbs.										
4	Grievance and conflicts over land resettlement & compensation.										
5	Exacerbated poverty condition due to loss of access to land (means of livelihood).										
6	**MOBILIZATION OF PERSONNEL, MATERIALS AND EQUIPMENT TO SITE**										
	Impact on Air Quality & Noise Level Deterioration of local air quality due to the release of fugitive dusts and gaseous pollutant emissions from heavy duty vehicles.	To minimize fugitive dust and exhaust emissions	• Implement dust suppression techniques such as, use of (i) water suppression for control of loose soil materials on unpaved surfaces and (ii) covered trucks for transporting loose materials that may generate dust. • Ensure emissions from road and off-road vehicles comply with specified national standards. • Conduct regular visual inspection of dust	Gaseous pollutants such as SO_2, NO_2, CO_2, CO, VOCs, H_2S, TSP. Vehicular emission	FMEnv air pollutants permissible limit	In-situ Air Quality Measurement	Access Road Air quality sampling points (See Chapter 4)	Daily	EPC Contractor	FMEnv JSME JISEPA	1,000,000 for monitoring activities during pre-Construction phase. 1,000,000

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			pollution and ensure appropriate intervention if dust levels are high • Pave access roads with gravel to minimize release of dust. • Implement routine preventative maintenance including tune-ups on all heavy equipment to meet the manufacturer's specification in order to ensure efficient combustion and minimal emissions. • Ensure speed limits are reduced and enforced especially on unpaved roads to minimize airborne fugitive dusts. • Train drivers/ workers on proper operation of vehicles and equipment to include fuel efficiency and anti-idling techniques. • Limit soil disturbance activities and travel on unpaved roads during periods of high wind. • Reroute access roads away from immediate outskirt of communities as much as possible.	• Evidence of dust control measures • Vehicle maintenance records • Vehicular speed limit • Drivers' training records							for Air Quality In-Situ Equipment
7	Noise disturbances from equipment and truck traffic.	To reduce potential noise impacts on affected communities, workers and wildlife	• Restrict all haulage and noise generating activities to working hours during the day when noise is better tolerated. • Select and use (where feasible) vehicles and equipment with lower sound power levels. • Install suitable mufflers on engine exhausts & compressor. • Ensure the maintenance of all equipment in accordance to manufacturer's specifications. • Ensure vehicle travelling within and around project area are operated in accordance with speed limits to reduce noise levels. • Develop a mechanism to record and respond to noise complaints. • Provide and enforce the usage of hearing protection devices (ear plugs/muffs) for workers exposed to noise levels >90 dB(A) for a duration of more than 8 hours per day. • Institute a Hearing Protection Program for workers in work areas with noise in excess of 85 dB(A).	• No of Complaints from affected communities • Working hours • Vehicle / equipment maintenance records • No of workers trained • Usage of ear plugs/ muffs	• Noise Levels (Not to exceed 90dB(A) for 8 hours working period	• In-Situ Measurement of noise level	Along access Roads Noise level sampling points (See Chapter 4)	Daily	EPC Contractor	FMEnv JSME JISEPA	600,000 for Noise Level In-Situ Equipment
	Impacts on Affected Communities (Pedestrians,		• Ensure regular maintenance of vehicles and use of manufacturer approved parts to	• Vehicles maintenance	No of speed limit violations.	• Visual Observation	Along access roads	Montly	EPC Contractor	FRSC Police	500,000 for monitoring

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
	Motorcyclists – Community Health, Safety & Security)		minimize potentially serious accidents such as those caused by equipment malfunction or premature failure.	records.							activities during pre-construction
8	Traffic Congestion & increased risk of RTA and Injuries (Traffic Safety).	To minimize potential impacts of traffic congestion and risk of RTAs	• Engage drivers with appropriate class of driving license and at least three years of driving experience. • Train drivers on defensive driving techniques, haulage safety and pedestrian safety. • Develop and implement a Traffic Management Plan (TMP) and safe traffic control measures shall include: - Establishment and strict enforcement of speed limits; - Employment of appropriate road safety signage and on-site trained flag-men with high-visibility vests to direct traffic and warn of dangerous conditions; and - Minimization of movement at peak hours of the day. • Ensure coordination with emergency agencies to ensure that appropriate first aid is provided in the event of accidents. • Where possible, use locally sourced materials to minimize transport distances.	• Drivers' license. • TMP submitted. • Records of Drivers' Training • Speed control measures	No of signal violations. No of congestion occurrences & queue lengths	• Interview	Project site				
9	Risk of injuries to pedestrians and motorcyclists from collision with moving heavy duty vehicles (Pedestrian Safety).										
10	Introduction of negative values and alien culture by the influx of migrant personnel.	To avoid or minimize social vices and crimes and protect community culture	• Develop an induction program including a code of conduct for all workers. The code of conduct will address the following aspect: - Respect for local residents; - No hunting or unauthorized taking of products or livestocks; - Zero tolerance of illegal activities such as prostitution, illegal sale or purchase alcohol, purchase or consumption of drugs, illegal gambling or fighting; - Description of disciplinary measures for infringement of the code of conduct and/or company rules. • Ensure a copy of the code of conduct is presented to all workers and signed by each worker. • Improve awareness of and sensitivity of workers to local cultures, traditions and	• Developed induction program. • No of workers trained. • No of workers who has and signed a copy of the code of conduct document. • Level of awareness of workers to local	Community perception and level of satisfaction. Increase or decrease in social vices	Interview	Affected communities	Quarterly	NSPDL	Dutse LGA	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			lifestyles. • Ensure affected communities are assisted and have a voice in appropriation of mitigation measures. • Develop and implement a grievance procedure and raise awareness of grievance procedures amongst affected communities. • Provide a grievance register and grievance officer. • Promote the establishment of local vigilante groups at community level in consultation with the Police authorities.	cultures and traditions. • Awareness of grievance procedures in affected communities. • Presence of security personnel							
11	Security challenges due to storage of materials and equipment on site.	To ensure the security of lives and properties	• Deploy competent security personnel to secure project site. • Disclose on-site security arrangements to the public especially members of nearby communities.	No of security personnel Report on theft	Community perception and level of satisfaction. No of security breaches	• Records • Interview	Project site Affected communities	Quarterly	NSPDL EPC Contractor	Police	--
12	Employment of local labour.	To enhance positive impacts of job creation and improve standard of living in the affected communities	• Develop and implement a Labour and Employment Plan (LEMP) in line with international employment guidelines and IFC Performance standard 2: Labour and Working Condistions. The Plan should detail percentages and numbers of workforce to be sourced from the local areas and various demographics. • Notify community's representatives and Dutse LGA of the specific jobs and skills required for the project prior to commencement of recruitment. • Initiate training and skills development programs prior to the commencement of construction to ensure members of local workforce are up-skilled and can be employed on the project or other industrial developments in the area. • Ensure construction jobs are targeted to the local people. • Train members of nearby communities to enable them find employment opportunities within the proposed solar project and other industrial developments in the area. • Promote the fair treatment, non-	• Developed LEMP. • No of employed locals • Evidence of job notification in affected communities and Dutse LGA. • No of locals trained.	National Labour Laws. Proportion of community members with improved income. No of employed persons.	Interview Records	Site office Affected communities	Periodic	EPC Contractor	Federal Ministy of Labour (FML) Dutse LGA	300,000

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			discrimination, and equal opportunity of workers. • Protect workers, including vulnerable categories of workers such as women and migrant workers. • Promote safe, healthy working conditions & the health of workers. • Provide a grievance mechanism for workers to freely raise workplace concerns. • Prohibit employment of minors. • Avoid the use of forced labor.								
13	Respiratory and eye related problems from exposure to fugitive dusts and gaseous emissions.	To minimize fugitive dust and exhaust emissions	• See A6 • Provide and enforce usage of appropriate PPE.	• Gaseous pollutants such as SO_2, NO_2, CO_2, CO, VOCs, H_2S, TSP	FMEnv air pollutants permissible limit	• In situ • Complaint records	Affected communities Project site Access roads	Periodic	EPC Contractor	FMEnv JSME	--
14	Risks of accidents and struck-by injuries from the movement of vehicles.	To promote safe and healthy working conditions as well as protect the health of workers	• Plan and segregate the location of vehicles traffic, machine operation and walking areas. • Control vehicle traffic through the use of one-way traffic routes. • Establish speed limits and use on-site trained flagmen with high visibility vests or outer clothing covering to direct traffic. • Ensure mobile equipment is outfitted with audible reverse alarms. • Provide & enforce usage of appropriate PPE.	• Speed limits • Presence of flagmen • Audio reverse alarms on vehicles • Usage of PPE	No of speed limit and signal violations.	Visual observation HSE Records	Access roads and project site	Weekly	EPC Contractor	FML	--
	SITE PREPARATION AND CLEARING										
15	**Impact on Air Quality & Noise Level** Deterioration of local air quality due to release of fugitive dusts & gaseous pollutant emissions from land clearing activities & heavy duty vehicles.	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	--
16	Noise disturbances from operation of machineries and motorized equipment.	• See A7	• See A7	See A7	See A7	See A7	See A7	See A7	See A7	See A7	--
17	**Impacts on Ecology and Biodiversity**	To Protect and conserve	• Avoid the removal of natural vegetation and	Clearly defined	Available number and	Biodiversity survey	Project site and	Periodic	EPC Contractor	FMEnv JSME	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
	Loss of vegetation/ habitat and natural carbon sequestration from vegetation clearing	biodiversity and promote sustainable management of all living natural resources.	trees to the extent possible, especially species of *Acacia senegal* and *Phoenix dactylifera* which mostly occur in isolation. • Restrict removal of natural vegetation to construction site only. • Clearly define work areas to avoid unnecessary disturbance of areas outside development footprint. • Retain all short (<18 cm) native vegetation to the maximum extent possible. • Retain native root structure to facilitate recovery of vegetation cover, retain soil stability and minimize erosion. • Compensate for economic trees at full replacement cost. • Revegetate temporary disturbed areas with native species immediately following the completion of construction activities to ensure all temporary use areas are restored. • Develop and implement a project specific Integrated Vegetation Management Plan (IVMP) to revegetate part of the solar array area. • To the extent possible schedule vegetation clearing to occur outside of bird breeding season. • Implement soil conservation measures such as stockpiling topsoil or gravel for the remediation of disturbed areas. • Avoid the use of herbicides on site.	boundaries of protected areas	diversity of plant species within baseline conditions		adjoining areas				
18	Loss of ecosystem provisioning services such as fuel wood & economic trees										
19	Predisposition to soil erosion due to the removal of vegetal cover and exposure of soil surfaces to rain and wind.	To prevent soil erosion		Evidence of revegetation Developed IVMP							
20	**Social Impact** Employment of labour	See A12	See A12	See A12	See A12	See A12	See A12	See A12	See A12	See A12	--
21	**Impacts on Occupational Health and Safety** Respiratory and eye related problems for workers due to exposure to fugitive dusts and gaseous emissions.	To promote safe and healthy working conditions as well as the health of workers	• See A6 Provide and enforce usage of appropriate PPE.	See A6	See A6	See A6	See A6	See A6	See A6	See A6	--
22	Risks of worker exposure to noise emanating from machineries and associated safety concerns		• Develop and implement project specific OHS Plan. The OHSP will inter-alia entail: - Provision of health and safety orientation training and hazard specific training;	- OHS Plan developed - Compliance	Increase/ decrease in Lost Time Injuries (LTI).	Visual observation Interview.	Project site	Monthly	EPC Contractor	FML	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
	from poor communication		- OHS responsibilities; - Site health and safety rules and instructions; - Safe work practices; - Incident/Accident reporting; - Emergency contingency plan; - Provision and enforcement of use of PPE. - Implementation of explicit plans regarding initial response, triage, communication and transportation of casualties in the event of medical emergencies; - Prohibition of drug & alcohol use by workers while on the job; - Provision and training of first aiders at site.	with OHS Plan. - No of workers trained • No of accidents & injuries	First Aid care. No of near misses. % of workers trained.	HSE Records					
23	Risks of worker exposure to poisonous plants & dangerous animals e.g. snakes										
24	Risks of accidents and struck-by injuries from the movement heavy duty vehicles										
B	***CONSTRUCTION PHASE:* CONSTRUCTION/ IMPROVEMENT OF INTERNAL AND EXTERNAL ACCESS ROADS**										
1	**Impact on Air Quality & Noise Level** Deterioration of local air quality due to the release of dust from exposed soil surfaces and exhaust emissions from equipment and vehicles.	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	FMEnv JSME JISEPA	1,000,000 for monitoring activities during construction phase
2	Noise and vibration disturbances in the adjoining settlements from the operation of heavy duty equipment during road construction.	See A7	See A7	See A7	See A7	See A7	See A7	See A7	See A7	See A7	--
3	**Impact on Soil** Soil erosion due to compaction and exposure of soil surfaces to rain and wind during road grading and levelling.	To avoid or reduce soil predisposition to erosion	• Avoid vegetation and trees removal to the extent possible. • Restrict vegetation removal to construction site only in order to minimize the footprint of disturbed areas. • Protect all vegetation not required to be removed against damage. • Re-vegetate all bare and exposed soils with native vegetation immediately after construction to prevent erosion. • Use erosion protection structures such as sediment traps, riprap, gabions, etc. wherever possible to capture run-off sediments. • Use gravel to cover unpaved access road surface for added protection against erosion	Clearly defined boundaries of protected areas Evidence of re-vegetation Evidence of erosion protection structures	Available number and diversity of plant species within baseline conditions	Visual observation	Project site and Access roads	Quarterly	EPC Contractor	FMEnv JSME	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			and run-off. • Schedule ground-disturbing activities to avoid heavy rainfall and high wind periods to the extent that is practical. • Design channels and ditches for post construction flow.								
4	**Social Impact** Opening up of access roads to adjoining settlements and remote areas to enhance easy movement of people and their farm produce.	To ensure sustainability of access roads	• Improve access road by paving the surface to assure their durability. • Ensure continuous maintenance of access road.	Evidence of improvement works on access road	Paved access roads	Visual observation	Access road surface	Annually	NSPDL EPC Contractor	FMEnv JSME	--
5	Job creation and increased business	See A14	• Ensure local and regional procurement targets are included in the project's LEMP • Include requirements for local employment in the contract establish with EPC/O&M Contractors and require that the contractor recruits in accordance with the NSPDL's recruitment policy and request for proposal (RFP) documents. • Also see A12	See A12	See A12	See A12	See A12	See A12	See A12	FML Invest Jigawa Dutse LGA	300,000
6	**Impact on Community Health and Safety** Increased traffic and attendant risk of RTA and Injuries (Traffic Safety).	See A8	• See A8	See A8	See A8	See A8	See A8	See A8	See A8	See A8	--
7	Risk of communicable diseases such as STDs including HIV/AIDS from influx of temporary construction workers.	To avoid negative impacts on the health and safety of workers & Affected Community	• Institution of HIV prevention program to include peer education, condom distribution & Voluntary Counseling and Testing (VCT). • Undertaking health awareness and education initiatives on STIs amongst workers and in affected communities.	Level of Awareness and Education No of new STI cases	Level of awareness and knowledge of preventive measures. % of STI cases among workforce and communities	Visual observation Records Interview	Project site Affected communities Health care centres Site clinic	Quarterly	NSPDL EPC Contractor	FMoH JSMoH Dutse LGA	500,000
8	**Impact on OHS**	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	**Supervision**	
	Respiratory and eye related problems for workers due to exposure to dusts and gaseous emissions.										
9	Risk of worker exposure to occupational health and safety hazards	See A22-24	See A22-24	See A22-24	See A22-24	See A22-24	See A22-24	See A22-24	See A22-24	See A22-24	--
10	Risks of occupational accidents and injuries to workers.										
11	**CIVIL WORKS**										
	Impact on Air Quality & Noise Level Deterioration of local air quality due to the release of dust from earthwork activities and exhaust emissions from operating vehicles and equipment.	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	
12	Noise generation from operation of earth moving and excavation equipment, concrete mixers, cranes and heavy duty vehicles.	See A7	See A7	See A7	See A7	See A7	See A7	See A7	See A7	See A7	--
13	**Impact on Soil** Soil erosion due to compaction, soil horizon mixing and exposure of soil surfaces to rain and wind during earth moving and excavation activities.	To avoid or reduce soil predisposition to erosion	• Schedule ground-disturbing activities to avoid heavy rainfall and high wind periods to the extent that is practical. • Implement soil conservation measures such as stockpiling topsoil or gravel for the remediation of disturbed areas. • Design channels and ditches for post construction flow.	Evidence of erosion control measures	Soil erosion	Visual observation	Project site	Monthly	EPC Contractor	FMEnv JSME JISEPA	--
14	Soil contamination from accidental leakage/spillage of fuel, oil/lubricants from equipment and vehicles.	To prevent or minimize soil contamination	• Ensure that refueling, maintenance as well as storage of diesel and oil conform to best practices to ensure there are no spillages or leakages. Specifically; - Fuel storage tanks shall be leak-proof and checked daily. The tanks shall be installed in a bunded area and shall be replaced in cases of leakage; - Procedures for storage, handling of hazardous wastes and raw materials (e.g.	Soil quality parameters (especially hydrocarbon contaminants) Compliance with fuel storage procedures	FMEnv soil pollutants permissible limit	In situ/ Laboratory analysis Visual observation	Project site	Monthly	EPC Contractor	FMEnv JSME JISEPA	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			batteries, chemicals, fuels) shall be prepared; and - Implementation of such procedures shall be adequately enforced and monitored; - Fuel storage tanks/drums shall be leak-proof and checked daily. The tanks/drums shall be installed above ground in a bunded area and shall be replaced in cases of leakage. - Workers shall be trained on the correct transfer and handling of fuels and oil. • Ensure all vehicles are in proper working condition to ensure there is no potential for leaks of motor oil, hydraulic fluid and other hazardous materials. • In case of suspected or confirmed soil contamination, ensure identification of the root cause of the uncontrolled release and correction to avoid further releases & associated adverse impacts.	Evidence of leakages							
15	Change in land use pattern from agro-forestry to industrial use.	See A17-18	See A17-18	See A17-18	See A17-18	See A17-18	See A17-18	See A17-18	See A17-18	See A17-18	--
16	Generation of non-hazardous and hazardous wastes	To avoid the potential impacts of non-hazardous and hazardous wastes to human health and the environment	• Develop and Implement a site-specific Waste Management Plan (WMP) that addresses issues linked to waste minimization, generation, transport, disposal, and monitoring. • Establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes. • Ensure the WMP address all solid and liquid waste likely to be generated during the implementation of the project • Implement feasible waste prevention, reduction, reuse, recovery and recycling measures. • Identify and implement pollution prevention opportunities such as use of material substitution for less hazardous alternatives, recycling and waste minimization. • Minimize hazardous waste generation by segregating hazardous from nonhazardous wastes.	• Prepared WMP • Compliance with WMP	Requirements of WMP	• Visual Observation • Waste Tracking Report • Visual Observation/ • Records Interview	Project site	Monthly	EPC Contractor	FMEnv JSME JISEPA	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			• Create waste collection areas with clearly marked facilities such as colour code bins and provide equipment for handling waste. • Ensure that hazardous wastes are stored in properly labelled closed containers placed away from direct sunlight, wind and rain and provide secondary containment with 110% of storage containers. • Ensure that hazardous wastes are stored in properly labelled closed containers placed away from direct sunlight, wind and rain and provide secondary containment to the extent feasible. • Ensure hazardous materials and waste storage areas are formally designated and access restricted to authorized persons. • Ensure proper disposal/treatment of waste by government approved waste vendor.								
17	**Social Impact** Job creation via direct engagement by NSPDL and indirect employment through economic vendor activities such as food selling.	To boost local socioeconomic status of the state and especially in affected communities	See A12 & B5	See A12 & B5	See A12 & B5	See A12 & B5	See A12 & B5	See A12 & B5	See A12 & B5	See A12 & B5	--
18	Stimulation of local socioeconomic activities arising from employment of locals during construction.										
19	Improved livelihood and poverty reduction.										
20	**Impact on Community Infrastructure** Increase demand on existing health and sanitation infrastructure due to influx of temporary workers and camp followers.	To prevent outbreak of sanitation related illnesses.	• Promote access to community services by supporting infrastructural development in host communities.	No of new amenities provided	Infrastructure improvement in affected communities	Visual inspection Records Interview	Affected communities	Periodic	NSPDL	Dutse LGA	--
21	**Impact on Culture** Increased social vices/crimes and dilution	See A10	See A10	See A10	See A10	See A10	See A10	See A10	See A10	See A10	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
	of indigenous culture, norms and traditions in nearby communities due to influx of migrant workers and business opportunists.										
22	**Impact on Community Health, Safety & Security** Risk of communicable & vector-borne diseases such as STDs including HIV/AIDS, malaria from influx of workers and camp followers and stagnation of waste water.	See B7	See B7	See B7	See B7	See B7	See B7	See B7	See B7	See B7	--
23	Threat to community safety and security associated with presence of construction workers.	See A10	See A10	See A10	See A10	See A10	See A10	See A10	See A10	See A10	--
24	**Impact on OHS** Respiratory and eye related problems for workers due to exposure to dusts including cement dust and exhaust emission.	See A16	See A16	See A16	See A16	See A16	See A16	See A16	See A16	See A16	--
25	Risk of worker exposure to occupational health and safety hazards	See A 22-24	See A 22-24	See A 22-24	See A 22-24	See A 22-24	See A 22-24	See A 22-24	See A 22-24	See A 22-24	--
26	Risks of occupational accidents and injuries to workers from use of heavy equipment & cranes, falling objects, slips trips.										
	ERECTION OF TOWERS AND INSTALLATION OF OVERHEAD HV TRANSMISSION POWER LINES										
27	Risks of fall from working at height and other related occupational accidents and injuries to workers.	To promote safe and healthy working conditions as well as the health of workers	• Develop and implement project specific OHS Plan. (See A22-24). Specifically: - Training of workers on proper use of scaffolds and ladders. - Usage of fall prevention and protection devices, including safety belt, full body harnesses, shock absorbing lanyards or self-retracting inertia and other fall arrest devices attached to fixed anchor point or horizontal	• See A22-24 • No of workers trained • Availability of fall prevention and	See A22-24	Visual observation Interview	Project site & Along RoW	Monthly	EPC Contractor	FML TCN	300,000

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			life-lines to protect workers. - Provision of rescue and/or recovery plans, and equipment to respond to workers after an arrested fall.	protection devices							
28	**Impact on Soil and Land** Construction site waste generation.	See B16	• See B16	See B16	See B16	See B16	See B16	See B16	See B16	See B16	--
	PRE-COMMISSIONING TESTING OF FACILITIES										
29	**Impact on and OHS** Risk of electrocution to workers.	To promote safe and healthy working conditions as well as the health of workers	• Develop and implement project specific OHS Plan. (See A22-24) • Implement Lock-Out / Tag-Out (LOTO) system during any electrical work. • Create awareness of safety measures for workers to observe when working in areas of high tension potential. • Restrict untrained/unauthorized workers from all areas of high tension potential to prevent electrocution. • Establish "No Approach" zones around or under high voltage power lines in conformance with TCN requirements. • Mark all energized electrical devices and lines with warning signs.	• Compliance with site specific OHS Plan. (See A22-24) • Visible warning signs and site restrictions	See A 22-24	Visual observation	Project site	Monthly	EPC Contractor	FML	--
	Demobilization of personnel, materials and equipment (Site clean-up)										
30	**Impact on Soil and Land** Generation of waste	See B16	See B16	See B16	See B16	See B16	See B16	See B16	See B16	See B16	--
31	Soil contamination from indiscriminate disposal of wastes										
32	Impact on Community & Occupational Health & Safety Traffic congestion and increased risk of RTA and Injuries.	See A8	See A9	See A9	See A9	See A9	See A9	See A9	See A9	See A9	--
33	Respiratory and eye related problems from exposure to dust and gaseous emission.	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	See A6	--
34	Risks of occupational accidents and injuries.	See A24	See A24	See A24	See A24	See A24	See A24	See A24	See A24	See A24	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility: Implementation	Responsibility: Supervision	Monitoring Cost (N)
	CAPACITY BUILDING AND TRAINING										
35	**Social Impact** Acquisition of new skills and development of human capacity especially by locals employed to work during construction.	See A12	See A12	See A12	See A12	See A12	See A12	See A12	See A12	See A12	--
C	***OPERATION PHASE:* OPERATION OF PV PANELS AND OTHER ASSOCIATED COMPONENTS**										
1	**Impact on Air and Climate** Reduction/displacement of electricity generation in fossil-fuel-fired power plants by electricity from the solar energy facility will reduce the overall emissions of combustion-related pollutants.	To enhance sustainability of project objectives and benefits	• Ensure prompt replacement of damaged PV panels and other equipment to ensure peak electricity generation.	Generation of 80 MW_{AC} electricity	Continuous generation and supply of peak (80 MW_{AC}) electricity to national grid	Maintenance records Interview	Project site/ site office Dutse substation	Annually	O&M Contractor	--	--
2	Avoidance of fossil fuel utilization and reduced GHGs and other pollutant gas emissions.										
3	Promotion of clean energy as an alternative energy source and the establishment of cleaner development mechanism (CDM).										
4	Generation of renewable electricity to boost national power supply.										
5	**Social Impact** Creation of employment and business opportunities	To enhance positive impacts of job creation and improve standard of living in the Jigawa State and Nigeria	• Ensure maintenance jobs are targeted to the local people. • Ensure technology transfer by training indigenous people on solar plant management, operation and maintenance • Also see A12	No of employed locals. No of locals trained.	Applicable National Labour Regulations and Laws.	Interview Records	Site office	Periodic	O&M Contractor	FML	300,000
6	Technology transfer and training of project staff on solar power plant management, operation and maintenance.										
7	Increased revenue generation to government through permits and taxes										

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
8	Savings on cost of diesel for pumping & distributing water to citizens by the Jigawa State government ministry of water resources.										
9	Creation of tourist attraction and recreational resources	To enhance project economic benefits and to boost regional socioeconomic status	• Earnest the potential for the development of tourism by allowing tourists to visit solar plant.		No of tourists	Records	Solar Plant	Annually	O&M Contractor	--	--
10	Visual intrusion and disruption to aesthetics especially due to reflective surfaces of PV panels.		• Ensure selection of solar panel backs that are colour-treated to minimize visual contrast with natural landscape setting. • Ensure coatings and painting on selected PV panels and associated infrastructures have little or no reflectivity. • Retain natural vegetation wherever possible within the solar plant.	No of complaints	PV technology conforming with international standards	Records Interview	Solar Plant	Annually	O&M Contractor	Dutse LGA	100,000
11	**Impact on Community Infrastructure and OHS** Potential for fire outbreak due to failure of electrical installations	To prevent fire outbreak	• Ensure solar plant is designed and constructed in full compliance with Nigeria's building codes, Fire Service regulations, other applicable emergency and legal/insurance requirements, and in accordance with an internationally accepted life and fire safety (L&FS) standard. • Use fire resistant materials. • Install appropriate fire safety & protection system & equipment. • Train workers on fire prevention techniques and the use of different fire extinguishing agents and equipment • Ensure routine inspection and prompt repair of any malfunctioning electrical installations. • Develop and implement Emergency Response and Contingency Plan to respond to on-site emergency issues	Evidence of fire safety and protection equipment No of workers trained Developed Emergency Plans	No of fire incidences	Visual inspection Interview	Solar Plant	Annually	O&M Contractor	Fire Service	300,000
12	Risk of electrocution to workers	See B29	See B29	See B29	See B29	See B29	See B29	Annually	O&M Contractor	FML	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
	TRANSMISSION OF POWER										
13	Risk of electrocution to community members and trespassers from direct and indirect contact with power lines especially from falling power lines.	See B29	See B29	See B29	See B29	See B29	See B29	Annually	TCN	See B32	--
14	Risk of electrocution to workers from exposure to live power lines	See B29	See B29	See B29	See B29	See B29	See B29	Annually	TCN	See B32	--
15	**Social Impact** Supply of renewable electricity to boost national power supply.	See C4	See C4	See C4	See C4	See C4	See C4	See C4	TCN	See C4	--
16	Increase power transmission to homes and industries.										
	ROUTINE MAINTENANCE AND SERVICING										
17	**Impact on Soil and Land** Generation of industrial/ hazardous wastes (insulating oils e.g. polychlorinated biphenyls (PCBs), liquid petroleum fuels, waste water, cleaning agents and solvents, damaged panels, transformers, batteries, herbicides for weed control, etc.) during routine maintenance.	See B16	• See B16	See B16	See B16	See B16	See B16	Periodic	O&M Contractor	FMEnv NESREA JSME	500,000
18	Soil contamination form leachates of hazardous wastes.	See B16	See B16	See B16	See B16	See B16	See B16	Periodic	O&M Contractor	See B16	--
19	**Impact on OHS** Risk of worker exposure to hazardous chemicals.	See B28	• Develop and implement project specific OHS Plan. (See A22-24). Specifically: - Communicate chemical hazards to workers through labelling and marking according to recognized standards. - Train workers on the use of the available information (such as MSDSs) and safe work practices. - Encourage workers to maintain good	• Compliance with OHS Plan (See A22-24) • Evidence of appropriate labelling and markings	O&M contractor's site specific OHS Plan	Visual observation Interview	Solar Plant	Annually	O&M Contractor	FML	--

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
			personal hygiene. - Use appropriate PPE	• No of workers trained							
20	Risks of occupational accidents and injuries to workers from falls from heights, towers and use of machineries.	See B27	See B27	See B27	See B27	See B27	See B27	Annually	O&M Contractor	FML	--
21	Risk of electrocution to workers from exposure to live power lines.	See B29	See B29	See B29	See B29	See B29	See B29	Annually	O&M Contractor	FML	--
D	***DECOMMISSIONING PHASE:* REMOVAL OF PV PANELS AND EQUIPMENT, DEMOLITION OF STRUCTURES AND EVACUATION**										
1	**Impact on Air Quality** Air quality deterioration from the release of dust during demolition activities and exhaust emissions from vehicular equipment.	See B1	See B1	See B1	See B1	See B1	See B1	Weekly	O&M Contractor	FMEnv JSME JISEPA	500,000
2	**Impact on Soil and Land** Generation of industrial and hazardous waste including scrap metals, PV panels, inverters, batteries etc.	See B16	See B16	See B16	See B16	See B16	See B16	Weekly	O&M Contractor	FMEnv JSME JISEPA	--
3	Soil contamination from indiscriminate dumping of wastes.	See B16	See B16	See B16	See B16	See B16	See B16	Monthly	O&M Contractor	FMEnv JSME JISEPA	--
4	**Impact on Community/ Worker's Health & Safety** Traffic Congestion and increased risk of RTA and Injuries (Traffic Safety).	See A8	See A8	See A8	See A8	See A8	See A8	Weekly	O&M Contractor	FRSC	200,000
5	Risks of occupational accidents and injuries to workers.	See A24	See A24	See A24	See A24	See A24	See A24	Weekly	O&M Contractor	FML	--
	SITE REMEDIATION INCLUDING LEVELLING, FILLING AND RE-VEGETATION										
6	Soil stabilization and regeneration	To restore the site to pre-	• Develop and implement a site reclamation plan to ensure that the site is rehabilitated	Developed site	Plant distribution	Visual observation	Solar plant	periodic	O&M Contractor	FMEnv JSME	500,000

S/N	Significant Associated and Potential Impacts	Desired Outcome	Enhancement/Mitigation Measures	Parameters to be Measured	Performance Indicator	Method of Measurement	Sampling Location	Frequency of Monitoring	Responsibility		Monitoring Cost (N)
									Implementation	Supervision	
7	Increase in land availability for agriculture and other purposes	project conditions	and restored to a stable state. • Re-contour/grade site to blend with natural topography • Re-vegetate all exposed soil surfaces with indigenous plant species. • Install erosion control structures to prevent erosion and run-offs in order to allow planted vegetation to grow to a self-sustaining state.	reclamation Plan % vegetal cover Evidence of erosion control structures	and diversity in Adjoining farmlands					JISEPA	
8	Restoration of flora and fauna habitat										
9	**Social Impact** Loss of employment	See B35	• Carry out an analysis of alternatives to retrenchment e.g. employee capacity building programs; long-term maintenance works etc. prior to implementing any collective dismissals after construction. • Develop and implement a retrenchment plan to reduce the adverse impacts of retrenchment on workers. • Ensure compliance with all legal and contractual agreement with public authorities, workers and their organization. • Ensure all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner. • Provide a grievance mechanism for workers to raise workplace concerns.	See B35	See B35	See B35	See B35	See B35	O&M Contractor	FML	300,000
	Monitoring Cost									**8,900,000.00**	

7.8 Cost Estimates

To effectively implement the mitigation and monitoring measures recommended in this ESMP, necessary provision will have to be made. The total estimated cost for the ESMP implementation and monitoring is N43,900,000. The cost of mitigation by the EPC Contractor shall be included in the contract as part of the project implementation cost. Details of cost estimations are given in Table 7.5

Table 7.5: Estimated Budget for the Implementation of ESMP

S/N	Item	Responsibilities	Estimated Cost
1	Mitigation	EPC Contractor	To be included as part of construction cost.
		NSPDL (Land Acquisition related cost)	27,000,000.00
2	Monitoring	FMEnv, JSME, JISEPA, FRSC, Police etc	8,900,000.00
3	Capacity Building	EPC Contractor	8,000,000.00
Grand Total			**43,900,000.00**

7.9 Waste Management

It is the goal of NSPDL to design, construct, and operate the proposed project in a sustainable manner. To this end, effective waste management practices shall be implemented through the entire life cycle of the project. Waste management principles and priorities shall be based on an integrated approach which involves using a combination of techniques and programs to manage wastes and employing the principle of Reduce, Repair, Reuse, Recycle/Recover and Disposal. The priority of the approach shall be on waste reduction while the least favoured principle shall be disposal as depicted in Figure 7.4

All wastes generated from the project shall be categorised as either non-hazardous or hazardous following an assessment of the hazard potentials of the materials. In line with the principle specified above, EPC and O&M contractors shall avoid the generation of hazardous and non-hazardous waste materials to the extent possible. Where waste generation cannot be avoided, they shall reduce the generation of waste, reuse or recycle waste in a manner that is safe for human health and the environment. Where waste cannot be reused or recycled, the contractors shall dispose waste through an approved waste contractor. In the case of hazardous waste, contractors shall adopt GIIP alternatives for its environmentally sound disposal while adhering to the limitations applicable to its transboundary movement.

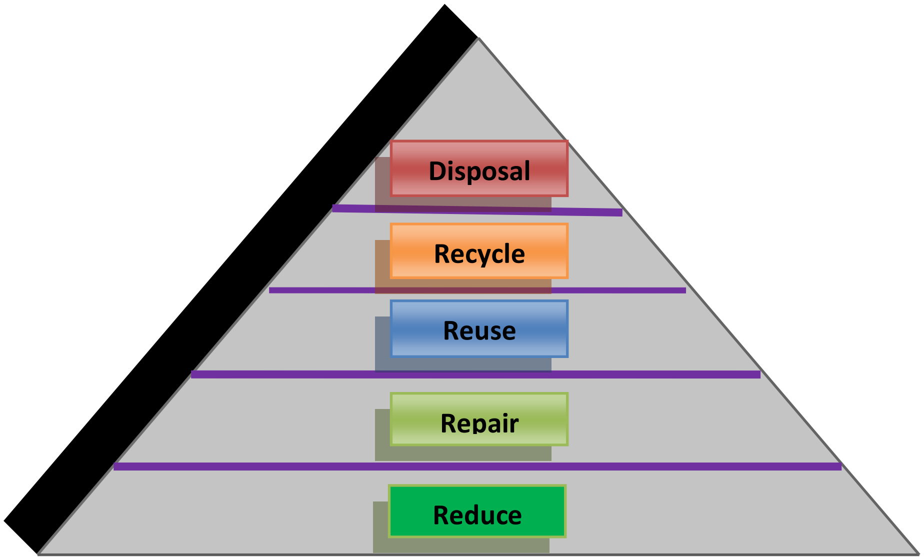

Figure 7.4: Waste Management Hierarchy

■ ***Hazardous Materials Management***

Hazardous materials will inevitably be used as raw material during project implementation and operation. The EPC contractor shall avoid generation of hazardous waste to the extent possible by seeking to substitute highly hazardous materials with less hazardous ones during project design or going into agreement with product manufacturers for recycling opportunities. Where avoidance is not possible, the EPC/O&M contractors shall minimize and control the release of hazardous materials. To achieve this, the production, transportation, handling, storage, and use of hazardous materials for project activities shall be assessed. The contractors shall avoid the use of chemicals and hazardous materials subject to international bans or phase-outs due to their high toxicity to living organisms, environmental persistence, potential for bioaccumulation, or potential for depletion of the ozone layer.

■ **Waste Streams and Management**

Waste in each phase of project life cycle (Preconstruction, Construction, Operation, Decommissioning) have been identified in Chapter 3 of this Report. However, Table 7.5 presents overview of waste stream in all phases of the project and specifies proactive management approach to prevent environmental pollution and degradation.

Hazardous and non hazardous waste disposal shall be conducted by third parties waste contractors that are reputable and legitimate enterprises and licensed by FMEnv, JISEPA and other relevant government regulatory agencies. The EPC/O&M contractors shall obtain chain of custody documentation to the final destination. They shall also ascertain that disposal sites are licensed and being operated to acceptable standards.

Table 7.6: Waste Streams and Management.

S/N	Potential Source	Waste Type	Waste Streams	Management
A	**PRECONSTRUCTION**			
1	Movement of vehicles on unpaved surface and engine exhaust	Emission	COx, SOx, NOx, CO, Dust	Use water suppression to prevent dust emission Maintain vehicles and machineries to reduce emission Maintain low speed to reduce dust and gaseous emission Allow aerial dispersal over a large area.
2	Installation of temporary workers camp and offices and workshops	Non-Hazardous	• Vegetal Waste • Industrial Waste: Metal scraps, packaging waste	Vegetal waste shall be supplied to farmers for use as compost. Woody vegetal shall be supplied to host communities for domestic uses including as fuel wood for cooking. Segregated and stored on site to be collected at least once a week for reuse or recycle through licensed third party facilities.
3	Spills of oil and fuels from vehicles and equipment	Hazardous	Not envisaged	Insignificant
4	Workers' camp	Domestic and Sanitary	• Food remnant, kitchen wastes. Food packaging etc • Domestic Sewage	To be transferred to locals for use as compost and animal feed. Plastic and other packaging to be recycled through licensed recycling third parties. Temporary stored and transferred to licensed carrier for disposal
B	**CONSTRUCTION**			
1	Movement of vehicles on unpaved surface and engine exhaust	Emission	COx, SOx, NOx, CO, Dust	See A1
2	Construction of access roads, civil works on site, installation of equipment, installation of towers for transmission line, electrical works Workers' camp/offices	Non-Hazardous /Industrial	• Waste Packaging and Dunnage such as scrap wood, scrap metal, steel, glass, plastic, paper and cardboard, empty metal containers**,** excess concrete, broken equipment, or components • Domestic-type waste: wastepaper and food scraps, metal cans	Segregated and kept securely in closed containers on site. To be transferred to approved recycling third parties for reuse/recycling. Non-recyclables to be removed by approved JISEPA waste contractor for onward disposal at approved sites. To be transferred to locals for use as compost and animal feed. Plastic and other packaging to be recycled through licensed recycling third parties.
3	Civil works on site, installation of PV panels and other equipment, installation of towers for transmission line, electrical works	Hazardous Waste	**Solid Wastes:** Used nickel-cadmium batteries, damaged panels, chemical containers, WEEE etc **Liquid Waste:** spent lubricating oils, hydraulic fluids, brake fluids, battery electrolyte, and dielectric fluids, chemical cleaning agents, paints, primers, thinners, and corrosion control coatings; sealants and adhesives etc	Avoid waste by engaging experienced experts to install PV panels and equipment to prevent damage. Stored on site in closed containers with secondary containment and transferred to a registered waste contractor with off-site permitted hazardous waste treatment, storage, or disposal facilities

	Civil works	Waste Water	Waste water from equipment washing and concrete production	Discharged to the ground as only very small quantity is envisaged at this stage.
4	Workers' camp	Domestic and Sanitary	• Food remnant, kitchen wastes. Food packaging etc • Domestic Sewage	See A4
C	**OPERATION**			
1	Movement of vehicles on unpaved surface and engine exhaust	Emission	COx, SOx, NOx, CO, Dust	See A1
2	Maintenance of facilities Workers' camp/offices	Non-Hazardous /Industrial	• Packaging waste, scrap metals, plastic, paper and cardboard, empty metal containers, broken equipment, or components • Domestic-type waste: wastepaper and food scraps, metal cans	Segregated and kept securely in closed containers on site. To be transferred to approved recycling third parties for reuse/recycling. Non-recyclables to be removed by approved JISEPA waste contractor for onward disposal at approved sites. To be transferred to locals for use as compost and animal feed. Plastic and other packaging to be recycled through licensed recycling third parties.
3	Maintenance of facilities	Hazardous	Same as B3 but larger quantity may be expected.	See B3
4	Panel washing	Waste water	--	Use gentle detergents that are not toxic to ensure waste water is non-hazardous. Adequate drainage system will be constructed around the site according to the site conditions to prevent water logging. Waste and Storm water will be managed through a combination of open trenches, and ditches and shall be led to drain away to the natural environment via gravity. Paved and concreted areas will be sloped to allow for proper drainage.
D	**DECOMMISSIONING**			
1	Movement of vehicles on unpaved surface and engine exhaust	Emission	COx, SOx, NOx, CO, Dust	See A1
2	Demolition of structures	Non-hazardous	Concrete, scrap metals, woods, plastic,	Segregated and kept securely. To be transferred to approved recycling third parties for reuse/recycling. Non-recyclables to be removed by approved JISEPA waste contractor for onward disposal at approved sites.
3	Removal of PV panels and other equipment	Hazardous	PV Panels, batteries, inverters, transformers, WEEE, spent lubricating oils, hydraulic fluids, brake fluids, battery electrolyte, and dielectric fluids, chemical cleaning agents, paints, primers, thinners, and corrosion control coatings; sealants and adhesives etc	Avoid waste by engaging experienced experts to remove PV panels and equipment to prevent damage/waste. Reuse materials in other solar PV plants. Recycle materials through licensed third parties Waste materials shall be stored on site in closed containers with secondary containment and transferred to a registered waste contractor with off-site permitted hazardous waste treatment, storage, or disposal facilities.

CHAPTER EIGHT

ABANDONMENT, DECOMMISSIONING AND REMEDIATION PLAN

8.1 Introduction

This Chapter presents the framework for the decommissioning of the proposed 80 MW_{AC} solar PV development project. Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle from the project site. The design and planned life span for the proposed solar plant is approximately 20 years. The life span of the plant can be considerably extended well beyond that limit with proper maintenance to sustain the facility. However, the plant shall be decommissioned at the end of its useful life.

NSPDL through the O&M contractor shall develop a comprehensive abandonment, decommissioning and remediation plan that is specific to the project taking into account the most cost-effective and practicable methods, environmental considerations, legal requirements and industry practices at that time. In addition, the plan shall contain an adaptive management component that allows for the incorporation of lessons learned from monitoring data during the operation of the facility. This plan will be submitted to the FMEnv and other relevant regulatory agencies for approval, at least 2 years prior to scheduled abandonment and decommissioning. Decommissioning shall only commence after the approval of the decommissioning plan by the regulatory Agencies.

The plan shall specify all activities that will be undertaken during the decommissioning and abandonment of the project which shall include the following:

- Stakeholders Consultation
- Dismantling and removal of PV panels and other equipment
- Demolition of buildings and structures
- Site remediation/re-establishment of vegetation in order to restore the environment back to pre-project state as practicable possible.
- Assessment of residual impacts, if any.
- Monitoring

An effective WMP shall be developed as part of the decommissioning plan to ensure proper waste management and protection of the environment. The WMP shall adopt the waste hierarchy specified in this Report i.e Reduce, Reuse, Recycle/Recover and disposal. NSPDL through the O&M contractor shall take advantage of the reuse and recycling opportunities identified for majority of the components of the plant while all waste not fit for reuse or recycling shall be evacuated by an approved municipal waste contractor to be disposed off in a government approved dump site. The O&M contractor shall ensure adequate monitoring of waste handling and disposal and shall present waste documentations to FMEnv and/or JISEPA upon request.

8.2 Decommissioning Programme

8.2.1 Stakeholders Consultation

The abandonment, decommissioning and remediation programme shall commence following the approval of the Plan with active engagement with stakeholders including operational staff, affected communities, TCN, as well as other relevant local and national regulatory agencies. Relevant information regarding the plan shall be disclosed to workers to ensure they receive adequate notice of dismissal and severance payments mandated by law and collective agreements in a timely manner. Affected communities shall also be consulted and provided with information regarding how they may be affected by the decommissioning activities. As necessary, regulators particularly the FMEnv shall be carried along throughout the process.

8.2.2 Wind Down of Operation and Plant Shut Down

Prior to the actual decommissioning activities, operational activities at the plant shall be gradually wound down. Majority of the operational staff shall either be disengaged or redeployed to other solar plants. Only relevant staff with key involvement in the decommissioning activities shall be present on site during actual decommissioning. Wind down activities shall culminate in the absolute shut down of electricity generation and plant disconnection from the grid.

8.2.3 Decommissioning of Facilities

The actual decommissioning activities shall comprise of the following:

8.2.3.1 Dismantling and Removal of PV Panels and other Equipment

The major component of the solar plant will include a total of 306,432 solar PV modules and other electrical, mechanical and structural equipment such as mounting structures, inverters, transformers, Switchgear, pylons/poles and 132 kV overhead transmission line. These equipment and materials shall be dismantled and removed from the project site during decommissioning.

PV modules contain materials that can be recovered and reused in either new PV modules or other new products. Materials such as glass, aluminum, as well as a variety of semiconductor materials, are valuable when recovered. NSPDL through the O&M contractor shall consider working with PV CYCLE, an association which organizes the take-back and recycling of PV modules at the end of the project life span. PV CYCLE operates a comprehensive recycling process, which recovers most of the materials within the PV panel for reuse in new products. Alternatively NSPDL may re-use PV panels at other operational sites, depending on the condition of the panels.

All other major mechanical and electrical components will be recycled as specified below:

- PV panels will be removed from the mounting structure made of aluminium frames. The frames shall be recycled

- Electrical equipment (transformers, inverters etc) shall either be re-used on other solar developments/projects or recycled.
- All underground and above ground cable runs shall be removed and recycled.
- Other non-recyclable or reusable materials shall be evacuated and disposed by an approved municipal waste contractor in line with the WMP.

8.2.3.2 Demolition of Buildings and Structures

Depending on local needs, site buildings, such as the guardhouse may not be demolished but can be handed over to the landowners for operational purposes. However, other structures not suitable for local needs shall be demolished including internal access roads. All reusable materials from buildings such as metal scraps, pipes, doors, glass etc shall be preserved for reuse or recycling while rubble shall be evacuated by an approved municipal waste contractor.

8.2.3.3 Envisaged Impacts of Decommissioning Activities

Significant impacts likely to arise during decommissioning phases are those associated with removal of equipment and demolition activities. These impacts have been addressed in the ESMP prepared for the project and they include:

- Air quality deterioration from the release of dust during demolition activities and exhaust emissions from vehicular and other operating equipment
- Generation of industrial and hazardous waste including scrap metals, batteries, spent oils e.t.c
- Soil contamination from wastes
- Traffic congestion and increased risk of RTA and injuries
- Loss of employment for operational staff
- Occupational health and safety related impacts including accidents, injuries and risk of electrocution.

The management actions to avoid or minimize these impacts have been included in the relevant section of the ESMP. However, the Decommissioning Plan which shall be developed shall include details of other likely impacts which may not have been envisaged at this stage based on new legislations, changes in site conditions etc.

8.2.4 Site Remediation/Rrevegetation

The Plan shall be designed to expedite the re-establishment of vegetation required to restore the environment to pre-project conditions as far as practicable. Site remediation shall be completed as soon as practicable following actual decommissioning activities and evacuation of all equipment, rubbles and waste from the site. Site remediation activities shall include the following as appropriate:

- Re-contouring and grading of site to blend with natural topography.
- Planting of native plant species that are dominant within the plant communities in adjacent areas with similar soil conditions to re-establish vegetation. The cover, species composition, and diversity of the re-established plant community shall be

similar to those present on-site prior to project development and in the vicinity of the site. The baseline data of existing ecological biodiversity of the project site contained in Chapter Four of this Report shall be a benchmark for selecting the appropriate plant species for revegetation.

- Installation of erosion protection structures such as sediment traps, riprap, gabions, etc. wherever possible to capture run-off sediments and protect the new vegetation.

8.2.5 Assessment of Residual Impacts

Following decommissioning, the project site shall be assessed for any residual impacts on the various components of the environment especially air, soil and groundwater. Any suspected contaminated resource shall be rehabilitated. Similarly, the residual impacts of the project on the socioeconomic aspect of affected communities shall be assessed with appropriate compensatory measures established and implemented in conjunction with affected communities and regulatory authorities.

8.2.6 Monitoring

To ensure rapid and successful re-establishment of vegetation cover and site restoration, the abandonment, decommissioning and remediation plan shall specify site-specific measurable success criteria with target dates (monitoring data) to allow effective monitoring of the site. These monitoring data shall be used to determine the success of reclamation activities and the need for changes in ongoing management or for additional reclamation measures. Periodic visual inspections for a minimum of 3 years following decommissioning activities shall be required to ensure that there is adequate restoration and minimal environmental degradation. This period shall be extended until satisfactory results are obtained. Vegetation re-establishment efforts shall continue until all success criteria have been met.

CHAPTER NINE

CONCLUSIONS

9.1 Conclusions

The ESIA study for the proposed 80 MW_{AC} solar PV plant near the town of Dutse, Jigawa State has been carried out in line with the EIA Act Cap E12 LFN 2004, EIA Sectoral Guidelines for Power Sector, 2013 as well as other relevant national and international standards including the IFC Performance Standards on Environmental and Social Sustainability and Equator Principles.

The overall goal of ESIA is to identify and assess the potential environmental and social impacts of the proposed project, evaluate alternatives and propose appropriate measures to mitigate the significant adverse effects and enhance potential benefits in order to ensure that the proposed project is environmentally and socially sustainable.

A multidisciplinary approach was employed for the study in order to holistically address all pertinent aspects of the proposed project on the bio-physical and social conditions of the study area. The methodology entailed a comprehensive review of relevant literatures; stakeholders' consultation including a scoping exercise and public consultation; field data gathering and laboratory analysis; potential impact identification and evaluation, identification of effective mitigation measures; and development of a project-specific ESMP including monitoring plan.

The proposed project will be a source of renewable electricity production and thus boost electricity generation in Nigeria and reduce dependency on hydrocarbon and other non-renewable sources. The project is also expected to have highly positive social impacts on the affected communities, people of Jigawa State and Nigeria at large. Specifically, the proposed project will be most beneficial to the local economy as it will promote industrial growth and provide direct and indirect employment opportunities and thereby improve livelihood and enhance poverty reduction especially in affected communities.

However, the project will inevitably have some adverse impacts on the biophysical and social environment particularly during pre-construction, construction and decommissioning phases. The most notable negative social impacts are those related to land acquisition for the project. It is instructive to note that, although there will be acquisition of 200 hectares of land for the proposed project, project implementation will not lead to physical displacement of human settlement. Significant negative environmental impacts include air quality deterioration due to release of fugitive dust and gaseous emissions, loss of vegetation, soil erosion and waste generation.

As identified by this ESIA, all negative environmental impacts are largely localized in spatial extent, short term and occurring within less sensitive environmental areas and can thus be easily managed.

This ESIA has identified a series of measures to enhance potential positive impacts of the proposed project as well as technically and financially feasible measures to address negative impacts largely through the application of appropriate mitigation measures, sound engineering design, good construction practices, effective maintenance and adequate supervision and enforcement during the project life cycle. In addition, a comprehensive ESMP has also been developed using the using ESMS approach to ensure mitigation and enhancement measures proposed for project impacts are implemented through all the phases of the project lifecycle to assure environmental and social performance improvement on a continuous basis.

In consideration of the above therefore, there is no major environmental or social issue to impede the implementation of the proposed development of solar PV project, which is expected to generate and supply additional 80 MW_{AC} of renewable electricity to boost national power supply and specifically provide the Jigawa State and surrounding areas with indigenous carbon free source of electricity to promote economic development. The immense benefits that will be derived from the proposed projects are significantly greater than the short-term environmental effects.

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APPENDIX 1.1

PROJECT PROPOSAL/ TERMS OF REFERENCE

FOR

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE DEVELOPMENT OF PHOTOVOLTAIC (PV) SOLAR PLANTS IN DUTSE LOCAL GOVERNMENT AREA OF JIGAWA STATE

SUBMITTED TO

THE FEDERAL MINISTRY OF ENVIRONMENT

BY

GLOBAL ENVIRONMENTAL HEALTH SOLUTIONS
3rd Floor, Kojo Motors Building, Plot 1209, Kado Road, By VIO,
Mabushi, Abuja, Nigeria.
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FOR

NOVA SCOTIA POWER DEVELOPMENT LIMITED (NSPDL)
No. 15 Buchanan Crescent, Off Aminu Kano Crescent, Wuse II, Abuja, Nigeria

Table of Contents

1.0 INTRODUCTION

This document presents the project proposal and outlines the Terms of Reference (ToR) for conducting the Environmental and Social Impact Assessment (ESIA) for the development of Photovoltaic (PV) solar plants near Dutse Town in Jigawa State. It presents an overview of the project and highlights the objectives, work scope, approach and methodology of the proposed ESIA study. It also outlines the reporting format for the ESIA. The ESIA findings will serve as a tool towards ensuring environmental sustainability of the project.

2.0 BACKGROUND INFORMATION

2.1 Project Background

Nova Scotia Power Development Limited (NSPDL) is planning to build solar PV plants near the town of Dutse in Jigawa State, Nigeria. The proposed site known as Dutse-2 is approximately 204 hectares of land and located within 5km of Dutse town in Jigawa State. The proposed project will be a ground-mounted PV plants with nominal capacity of 80MW.

The implementation of a project of this nature especially during the construction phase is likely to pose adverse environmental and socioeconomic impacts as a result of the interaction with the immediate environment. It is in recognition of this that NSPDL is embarking on an Environmental and Social Impact Assessment (ESIA) in order to ensure the proposed project is environmentally sound and sustainable.

The ESIA will help to identify and assess the potential environmental and social impacts of the proposed project, evaluate alternatives and propose appropriate measures to manage the significant adverse effects of construction and normal operations of the PV solar plants.

2.2 Project Objectives

The main objective of the proposed project is the provision of renewable solar energy for electricity supply to Dutse substation in line with the Renewable Energy Master Plan (REMP) and National Energy Policy.

2.3 Project Location

The proposed site for the project, known as Dutse-2, is located near the town of Dutse in Jigawa State, Nigeria covering an area approximately 204 hectares. The site falls within Latitude 11.6815N and Longitude 9.3858E. There are no human settlements within the boundary of the site, however, Sumore village is located in very close proximity to the South Eastern border of site. Bakinjeji village, Katangar Lafiya village and Rahama village are located close to the western, south western and southern boundary of the site respectively. These three villages are all further than 200m away from their respective boundaries. Access to the site is via untarred roads off Dutse-Kude-Kogin-Huguma main roads. The project location also include the 3.66km Right of Way (ROW) for the transmission route through which energy generated will be transmitted to the Dutse substation for onward connection to the national grid. The ROW does not transverse any human settlement, however, Sharafai, Gurungu and Mechanic villages are located adjacent to the transmission route on both sides.

2.4 Project Description

The project will involve the development and installation of ground-mounted PV solar modules capable of generating 80MW power using either tracker or fixed tilt system configurations. The PV panels will convert sunlight to direct current (DC) power. The panels will be connected together to form arrays, which in turn will be connected to inverters to convert the DC power to alternating current (AC) power. The voltage of the power will be stepped up by a transformer to the required voltage of the nearby electricity grid. The generated power from the project site will be evacuated through a dedicated double circuit 132 kV overhead transmission line that will connect the solar plant to the Dutse substation located approximately 3.66km northwest of the Project site.

The conceptual layout for Dutse-2 and the proposed route for new 132kV overhead line are presented in Figures 1 and 2 respectively.

2.4.1 Proposed Project Activities

The proposed project activities will include the following;

- Installation of PV plant;
- Construction of 3.66km, 132kV double circuit overhead transmission line;
- Construction of 1 Nos 132kV terminal tower outside the site;
- Construction of 1 Nos 132 kV/33kV transformer to step up the voltage from 33kV to 132kV;
- Construction of access road;.
- Provision of water and ablution facilities;

The project overview is summarized in Table 1.

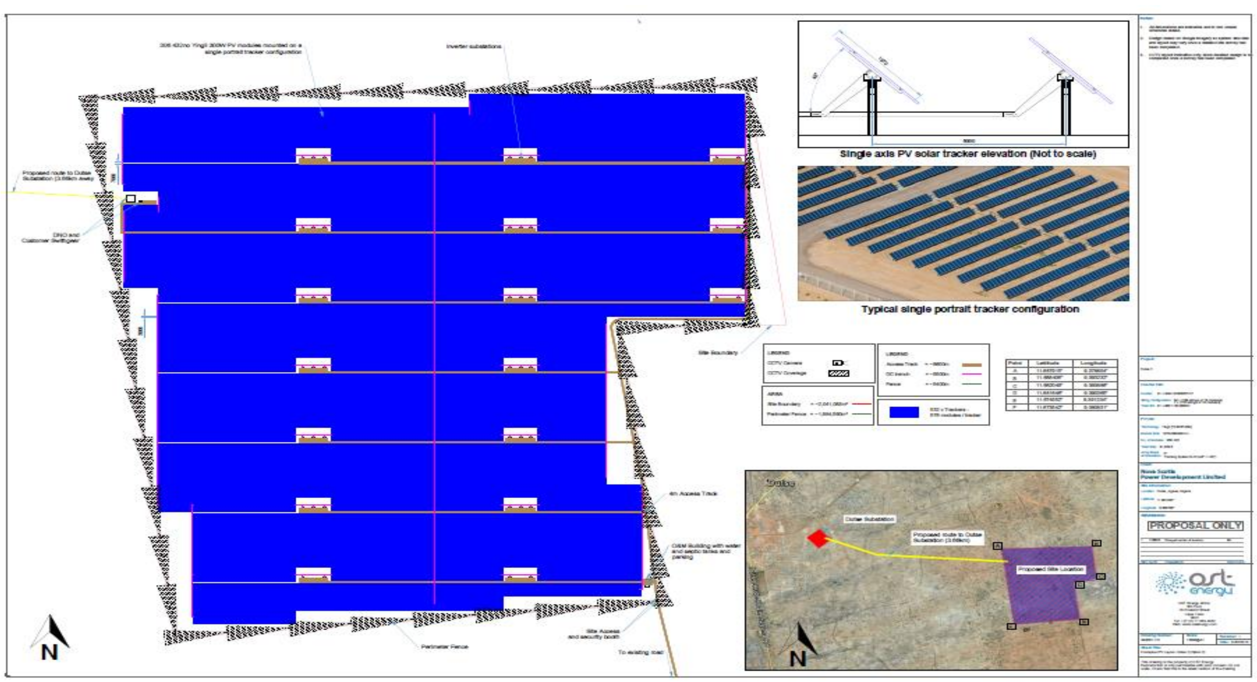


Figure 1: Conceptual PV Layout for Dutse -2

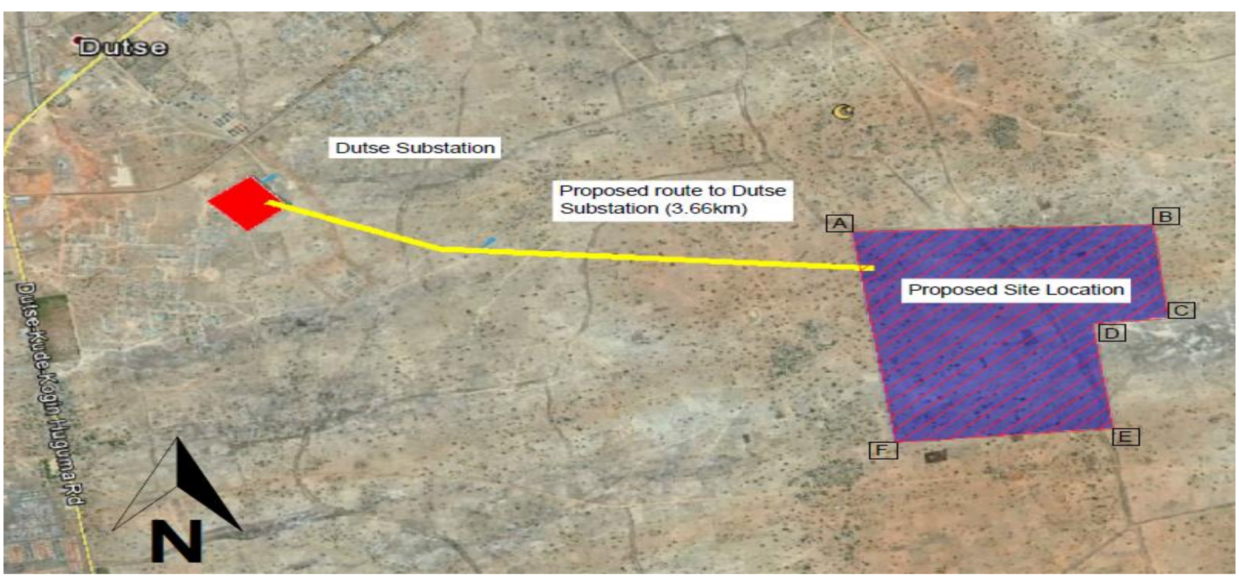


Figure 2: Proposed Route for 132KV Overhead Line

Table 1: Project Overview

S/N	ITEM	DESCRITION
1	Project Title	Environmental and Social Impact Assessment for the Proposed Development of PV Solar Plants near Dutse Town in Jigawa State.
2	Project Description	The project involves development of ground-mounted PV solar plants Dutse-2 approximately 204 hectares of land each to generate 80MWp to supply to national grid via Dutse Substation.
3	Site Area	Dutse-2 approximately 204 hectares
4	Site coordinates	Latitude 11.6815N and Longitude 9.3858E
5	Location within Nigeria	
6	Site Location	
7	Nature of Project	Power Generation and Supply
8	Production Capacity	80MWp
9	Product	Solar Power
10	Location of Project	Dutse LGA, Jigawa State, Nigeria
11	Accessibility to the Site	By Land
12	Access Road Length from Main Road	4.5 km
13	Distance of sites from nearest body of water	10km to the south and southeast of the sites
14	Current Land Use	Farmland
15	Neighbouring settlements	Sumore village at the bottom of the Eastern border. Katangar Lafiya, Rahama and

		Bakenjeji villages also surround the site.
16	Proponent	Nova Scotia Power Development Limited (NSPDL)
17	Address of Proponent	No. 15 Buchanan Crescent, Off Aminu Kano Crescent, Wuse II, Abuja, Nigeria
18	Name and Address of ESIA Consultant	GLOBAL ENVIRONMENTAL HEALTH SOLUTIONS 3rd Floor, Kojo Motors Building, Plot 1209, Kado Road, By VIO, Mabushi, Abuja, Nigeria. Telephone: +234-8059649767, +234-8112659220 E-mail: gehsolutions@gmail.com; info@gehsolutions.org Website: www.gehsolutions.org
19	Contact Person	**Dr. Lola Okwuosa** MBBS; MPH {Harvard}, Head of the organisation and Lead Consultant Telephone: 08172050223; Email: lokwuosa@gehsolutions.org

3.0 ENVIRONMENTAL MANAGEMENT

The major environmental and social impacts of a large scale solar development are often dictated by the specific nature of the site. The principal environmental and social impacts likely to arise as a result of the proposed project relate to the following key issues; alteration of landscape and aesthetic, removal of vegetation and fauna habitat, abstraction of groundwater, change in land use, construction impacts. Appropriate mitigation measures will be put in place to address these impacts. It is also envisaged that the project especially during construction will provide employment opportunities for people in the area.

However, once constructed, the solar projects will have very limited impacts on the surrounding environment. The panels are passive in nature, do not result in any emissions, do not generate waste during normal operation (aside from any required replacement of components) and require limited onsite activity. The solar farm will not result in any hazardous impacts and it does not involve any unusually complex technologies. The risk of accidents is considered low and restricted to construction and maintenance activities.

4.0 OBJECTIVES OF THE PROPOSED ESIA STUDY

The main objective of an ESIA is to evaluate proactively the potential environmental and social impacts of proposed project with a view to ensuring that it exerts minimum or no adverse impact on the physical, biological and social environment. This ESIA therefore, seeks to identify, predict and evaluate the environmental and social effects of the proposed project and recommend possible measures to prevent, mitigate and offset the significant adverse effects of the proposed project on the environment.

The goal is to improve decision making and to ensure that project activities are environmentally sound and sustainable. The specific objectives are as follows:

- Acquire all necessary environmental and socioeconomic baseline data that will form the basis for mapping the state of the environment in the project area before the installation of PV panels;
- Identify all environmental aspects of the project that may interact positively or negatively with the environment and the socioeconomic wellbeing of the project communities;
- Determine and evaluate the potential impacts of the proposed project activities on the physical, biological and human environment;
- Recommend appropriate mitigation measures for adverse impacts of the proposed project;
- Develop an Environmental and Social Management Plan (ESMP) and a Monitoring Plan;
- Provide all necessary answers to stakeholders including regulators, donors and other interested parties on the environmental and social compatibility and sustainability of the project.

5.0 SCOPE OF THE PROPOSED ESIA STUDY

The scope of work for the ESIA study shall include:

- Reconnaissance survey to acquaint the ESIA team with the environmental and social nomenclature of the project area of influence (AoI);
- Review of project-specific background documents and other relevant literatures;

- Identification and review of pertinent national and international policies, laws, regulations and guidelines governing environmental quality, environmental assessment and the project;
- Scoping exercise to determine the scope and establish the boundaries for the ESIA study;
- Field data gathering and laboratory analysis to obtain environmental and socioeconomic baseline data to fill information/data gaps;
- Description of the existing bio-physical and social environment of the project AoI including the Right of Way (RoW) for the transmission route/corridor;
- Full description of project activities and identification of potential impacts associated with preconstruction, construction, operation and decommissioning phases;
- Qualification of potential impacts, their prediction and evaluation of their significance using appropriate models;
- Identification of effective measures to avoid or reduce the effect of identified impacts on the environment and affected communities;
- Identification of interested and affected parties within the project AoI for effective consultation and engagement;
- Development of a comprehensive ESMP; and
- Preparation of ESIA Report.

6.0 APPROACH AND METHODOLOGY

The ESIA study methodology will be consistent with the Federal Ministry of Environment's relevant policies, laws, regulations and guidelines particularly the EIA Procedural Guidelines, International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability, Equator Principles of Financial Institutions, applicable World Bank safeguard operational policies and other relevant international treaties and agreements to which Nigeria is a party.

A multidisciplinary approach will be employed for the study and will specifically entail the following;

- Desktop Studies/Literature Review;
- Field Survey and Laboratory Analysis
- Public Consultation
- Impact Assessment
- Development of an Environmental and Social Management Plan (ESMP)

6.1 Field Survey

A field survey shall be carried out to obtain site specific environmental data of the project area. Data collection shall include study of all relevant physical, biological, socio economic and cultural factors. The results of the assessment shall be subjected to cross reference scrutiny of the secondary data available in the literature to test for conformability and variability in the secondary and primary data of the project area. Internationally acceptable sampling procedures will be adopted for all sampling procedures. The following environmental parameters shall be assessed:

a. Climate/Meteorology

Climatic and Meteorological data shall be obtained to cover the following parameters; Temperature; Relative Humidity; Rainfall; Wind speed and direction.

b. Air Quality

The ambient air quality of the project area shall be determined by sampling in-situ at different locations. The following parameters: Suspended Particulate Matter (SPM), SO_x, NO_x, CO_2, CO, H_2S, and Hydrocarbons shall be measured.

c. Noise Level

The baseline sound level of the area will be measured using appropriate instrument.

d. Soil

Top and bottom soil samples (reasonably representing various ecological zones in the area) shall be collected randomly at intervals and analysed. Permeability test shall be carried for soil samples to determine the soil profile and drainage pattern. Each soil sample shall be analyzed for the following parameters:

- Physical; colour, permeability, porosity, texture.
- Chemical; heavy metals, pH, moisture content, sulphate, nitrate, organic matter.
- Microbiology: total heterogenic bacteria and fungi, faecal coliform.

e. Surface and Ground Water

Water samples shall be collected for surface and underground water points across the project area. In-situ analysis shall be carried out for pH, temperature, colour, odour, turbidity, salinity and Dissolved Oxygen (DO) while other water parameters of interest such as conductivity, BOD, COD, SO_4 Cl_2 TSS, TDS, heavy metals and bacteriology (faecal coli form, total coliform) shall be undertaken in a standard laboratory.

Prevailing use of the surface water (streams) such as domestic, industrial intake, economical, recreational, irrigation and fishery shall be determined by physical observation and interviews.

f. Vegetation and Wildlife

Flora and fauna species shall be assessed in different sites in the project area to determine the type and distribution. These shall encompass a variety of diverse habitats and ecosystem features as well as species with traditional value such as food items, medicinals and wild varieties of plants. Animal species characterizing both terrestrial and aquatic species shall also be assessed.

g. Socioeconomic

Socio-economic condition of the project areas shall be sourced at two levels, namely secondary and primary sources. Secondary source shall be obtained from the varying existing pool of data while the primary data shall be sourced from using structured questionnaires and informal interviews.

The socio-economic studies shall involve:

- Description of demographic pattern of the local communities in the project area by size, land use, economic activities (with emphasis on low income groups highly dependent on primary activities), community structure, employment markets and labour supply income distribution and consumption, and migration pattern.
- Determining the views of the population through discussions with local communities.
- Study on cultural heritage/artefacts, and other historical/cultural patrimony of the communities.

h. Health

Morbidity and Mortality pattern of the project areas shall be obtained via health facilities and also by questionnaire administration and interview.

6.2 Public Consultation

Public consultation is an integral part of the ESIA process, therefore people/communities that could be affected by the project as well as other interested parties will be identified at the early stages of the ESIA process thus mainstreaming bottom up approach in the ESIA study. Through this process, views and inputs of the stakeholders, particularly the PAPs will be harnessed into decision making process of the project. These consultations shall occur throughout the ESIA process to identify key environmental and social issues and impacts and to obtain comments from stakeholders on the proposed mitigation/enhancement measures. In the course of the stakeholder consultation, responsibility arrangement and capacity need for implementation and monitoring of the ESMP will be defined or determined to ensure that action plans/recommendations of this ESIA is effectively carried out.

6.3 Impact Assessment

The identification, prediction and evaluation of associated and potential impacts shall be carried out in accordance with the standard methodologies. Impact evaluation shall be carried out using a methodology that is applicable, specific and quantifiable. The impact evaluation results shall form the basis for developing the Environmental and Social Management Plan (ESMP) for project implementation.

7.0 CONTENT OF THE ESIA REPORT

The ESIA Report shall be developed with regards to the outcomes of the tasks carried out for the study. Thus, the description of the existing environment, impacts identification and evaluation as well as the mitigation measures and ESMP shall be discussed with specific focus on the proposed project. The Report will be prepared according to recommended format as follows:

- Cover page
- Table of Contents
- Maps, Illustrations and Figures
- List of Tables
- List of Acronyms
- ESIA Preparers
- Executive Summary
- Acknowledgement
- Chapter 1: Introduction – Background Information, Description of Policy, Legal, Institutional and Administrative framework, TOR
- Chapter 2: Project Justification
- Chapter 3: Description of the Proposed Project
- Chapter 4: Description of the Existing Environment
- Chapter 5: Identification & Assessment of Potential and Associated Environmental and Social Impacts.
- Chapter 6: Mitigation Measures and Description of the Project Alternatives
- Chapter 7: Environnemental & Social Management Plan (ESMP)
- Chapter 8: Remediation Plans after Decommissioning
- Chapter 9: Conclusion and Recommendations
- References
- Appendices

8.0 CONCLUSION

A detailed description of the objectives, scope of work and other relevant issues for the ESIA study of the Jigawa PV Plant Development have been covered in this Project Proposal/Terms of Reference (TOR).

The proponent believes that the adoption of this Project Proposal/ Terms of Reference shall enhance early commencement of the ESIA study to the collective benefit of all stakeholders and to ensure environmental sustainability of the project for the overall protection of the environment and public health.

APPENDIX 1.2

DESCRIPTION AND APPLICABILITY OF RELEVANT WORLD BANK ENVIRONMENTAL AND SOCIAL SAFEGUARD POLICIES

❖ OP 4.01 - Environmental Assessment

This policy requires environmental assessment (EA) of projects/investments proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. The Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of EA process. Proposed projects are classified into one of four categories (A, B, C, and FI) depending on the type, location, sensitivity and scale of the project and the nature and magnitude of its potential environmental impacts.

- **Category A:** A proposed project likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented.
- Category B: A proposed project likely to have significant adverse environmental impacts that are less adverse than those of Category A projects.
- Category C: A proposed project likely to have minimal or no adverse environmental impacts. The only EA Action required is for a Category C project is screening.
- Category FI: A proposed project involving investment of Bank funds through a financial intermediary in subprojects that may result in adverse environmental impacts.

Specifically, the proposed solar PV plant project is classified as Category A as it may lead to some significant adverse impacts especially during the construction phase. The Environmental assessment tools that are being used to satisfy the requirements of **OP 4.01** include ESIA and Environmental and Social Management Plan (ESMP).

❖ Natural Habitats (OP 4.04).

The conservation of natural habitats like other measures that protect and enhance the environment, is essential for long-term sustainable development. This policy seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The 200 hectares earmarked for the proposed solar PV plant project is largely a modified habitat that has been converted by farming. Land use analysis revealed that about 83% of the land is currently been cultivated or left to fallow by local farmers. The OP 4.04 is triggered as there are scattered trees on the land and <1% is covered by natural scrubland.

❖ Involuntary Resettlement (OP 4.12)

This policy covers direct economic and social impacts that both result from Bank-assisted investment projects, and are caused by (a) the involuntary taking land resulting in (i) relocation or loss of shelter; (ii) loss of assets or access to assets, or (iii) loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or (b) the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons. The proposed project triggered the OP 4.12 as it involved acquisition of about 200 hectares of land which will inevitably result economic displacement of affected persons from their farmlands. It is however instructive to note that the project will not lead to physical displacement of human settlements.

❖ **Disclosure of Information (OP 17.50).**

This policy requires that all safeguards policy documents prepared for projects funded by the Bank be disclosed to the public at two levels: (1) In-Country disclosure at domains accessible to stakeholders; and (2) At World Bank infoshop.

APPENDIX 3.1

APPLICABLE INTERNATIONAL ENGINEERING STANDARDS AND CODES FOR THE PROPOSED SOLAR PV PROJECT

S/N	Standard Code	Description
1	EN 50262	Cable glands for electrical installations
2	EN 50380	Datasheet and nameplate information for photovoltaic modules
3	IEC 50341	Overhead power lines: planning, design, construction
4	IEC 60038	Standard voltages
5	IEC 60050	Transmission lines
6	IEC 60071	Insulation coordination
7	IEC 60076	Power transformers
8	IEC 60529	Degrees of protection provided by enclosures (IP Code)
9	IEC 60826	Design criteria of overhead transmission lines
10	IEC 60904-1	Photovoltaic Device, Part 1: Measurement of Photovoltaic Current-Voltage Characteristics
11	IEC 60904-3	Measurement principles for terrestrial Photovoltaic (PV) solar devices with reference spectrum irradiance data.
12	IEC 60943	Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals
13	IEC 60990	Methods of measurement of touch current and protective conductor current
14	IEC 61140	Protection against electric shock Common aspects for installation and equipment
15	IEC 61215	Design qualification and type approval for crystalline silicon terrestrial PV modules
16	IEC 61345	UV test for Photovoltaic (PV) modules
17	IEC 61646	Thin film terrestrial photovoltaic (PV) modules - Design qualification and type approval
18	IEC 61724	Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis
19	IEC 61727	Photovoltaic (PV) systems - Characteristics of the utility interface
20	IEC 61727	PV module safety qualification
21	IEC 61730-1	Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
22	IEC 62093	Balance-of-system components for photovoltaic systems - Design qualification natural environments
23	IEC 62116	Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters
24	IEC 62305	Protection against lightning
25	IEC 62446	Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection

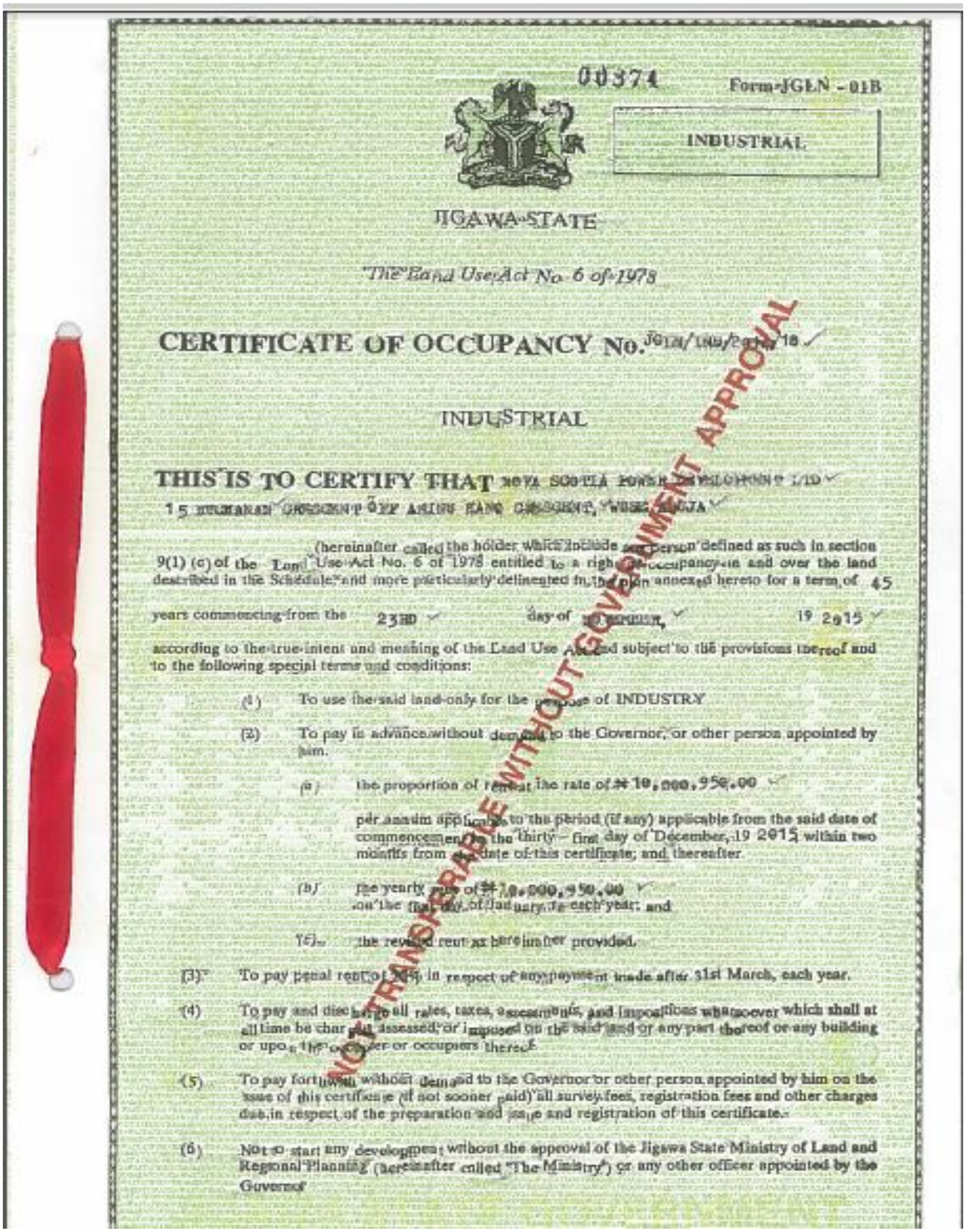
APPENDIX 3.2

APPLICABLE INTERNATIONAL STANDARDS FOR EARTHING AND LIGHTNING PROTECTION

S/N	Standards Code	Description
Earthing Specific		
1	BS7671:2008	Part 5 Section 52 and 53 on Protection and Earthing
2	BS7671:2008	Section 712 Requirements for PV Power Supply systems
3	BS 7430:2011	Code of Practice for Earthing
4	IEEE 80/2000	AC Substation grounding
5	DIN VDE 0141/2000	Earthing system for special installation with nominal voltage above 1kV
6	DIN VDE 18014/2007	Foundation Earth Electrode
7	EN 60071.0:2006 and .02 :1996	Insulation coordination
8	EN 60664.01 E2: 2007	EN 61557.08 E2: 2007 Insulation monitoring for IT System
9	IEEE 81/1983	Measuring Earth Resistivity, Ground Impedance, Earth Surface Potential
10	IEEE81.2/1991	Measurement of Impedance in Grounding Systems
11	IEC 60947-4-1: 2002	Low Voltage Switchgear : Contactors and Motor Starters
Lightning specific		
12	BS-EN 62305	Lightning protection standard
13	EN 50164 – 1/2/3	Lightning protection components
14	EN 61643.11 and .12	Surge protection devices for LV Power System
15	EN 61643.21 and .22	Surge Protection devices for telecomm and signalling system
16	IEC 60099-4: 2001	Surge Arresters

APPENDIX 3.3

CERTIFICATE OF OCCUPANCY



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INDUSTRIAL

JIGAWA STATE

The Land Use Act No. 6 of 1978

CERTIFICATE OF OCCUPANCY No. [illegible]/18

INDUSTRIAL

THIS IS TO CERTIFY THAT NOVA SCOTIA POWER DEVELOPMENT LTD
15 [illegible] CRESCENT OFF AMINU KANO CRESCENT, WUSE, ABUJA

(hereinafter called the holder which include any person defined as such in section 9(1) (c) of the Land Use Act No. 6 of 1978 entitled to a right of occupancy in and over the land described in the Schedule and more particularly delineated in the plan annexed hereto for a term of 45

years commencing from the 23RD day of [illegible], 19 2015

according to the true intent and meaning of the Land Use Act and subject to the provisions thereof and to the following special terms and conditions:

(1) To use the said land only for the purpose of INDUSTRY

(2) To pay in advance without demand to the Governor, or other person appointed by him.

(a) the proportion of rent at the rate of ₦10,000,950.00

per annum applicable to the period (if any) applicable from the said date of commencement to the thirty - first day of December, 19 2015 within two months from the date of this certificate; and thereafter

(b) the yearly rate of ₦10,000,950.00 on the first day of January in each year; and

(c) the revised rent as hereinafter provided.

(3) To pay penal rent of [illegible] in respect of any payment made after 31st March, each year.

(4) To pay and discharge all rates, taxes, assessments, and impositions whatsoever which shall at all time be charged, assessed, or imposed on the said land or any part thereof or any building or upon the occupier or occupiers thereof.

(5) To pay forthwith without demand to the Governor or other person appointed by him on the issue of this certificate (if not sooner paid) all survey fees, registration fees and other charges due in respect of the preparation and issue and registration of this certificate.

(6) Not to start any development without the approval of the Jigawa State Ministry of Land and Regional Planning (hereinafter called "The Ministry") or any other officer appointed by the Governor

NOT TRANSFERABLE WITHOUT GOVERNMENT APPROVAL

(7) Within TWO years from the date of the commencement of this right of occupancy to erect and complete on the said land buildings or other works specified in detailed plans approved by or to be approved by the Ministry or officer appointed by the Governor, such buildings or other works to be (of the value of not less than ₦150,000,000 [illegible] erected and completed in accordance with such plans and to the satisfaction of the Ministry.

(8) Not to erect or build or permit to be erected or built on the said land any buildings other than those covenanted to be erected by virtue of this certificate of occupancy nor to make or permit to be made any addition or alteration to the said buildings to be erected or buildings already erected on the land except in accordance with plans and specifications approved by the Ministry or other officer appointed by the Governor in this behalf.

(9) *(a)* Not to alienate the right of occupancy hereby granted or any part thereof by sale, assignment, mortgage, transfer of possession, sub-lease or bequest or otherwise however without the consent of the Governor first sought and obtained.

(b) Not to contravene any of the provisions of the Land Use act.

(10) To clear and keep clear from the land of stagnant water, long grass, rank, weeds and bush and accumulations and deposits of rubbish and other unwholesome matter, and to keep the same in all respect in a clean and sanitary conditions, and for such purpose to do and execute all such acts and works as the Governor or any officer authorised by him may reasonably require.

(11) To comply with all rules laid down from time to time in regard to the location of buildings; refuse pits, latrines.

(12) After the period specified in such Clause (7) above, not to allow the said land to be unoccupied for any period exceeding six months at any one time, or eight months in any year.

(13) Upon the expiration of the term of......45.........years granted under this certificate to render up to the Governor in good and substantial repair to the Governor's satisfaction;

(a) All buildings already upon the land at the commencement of the said term.

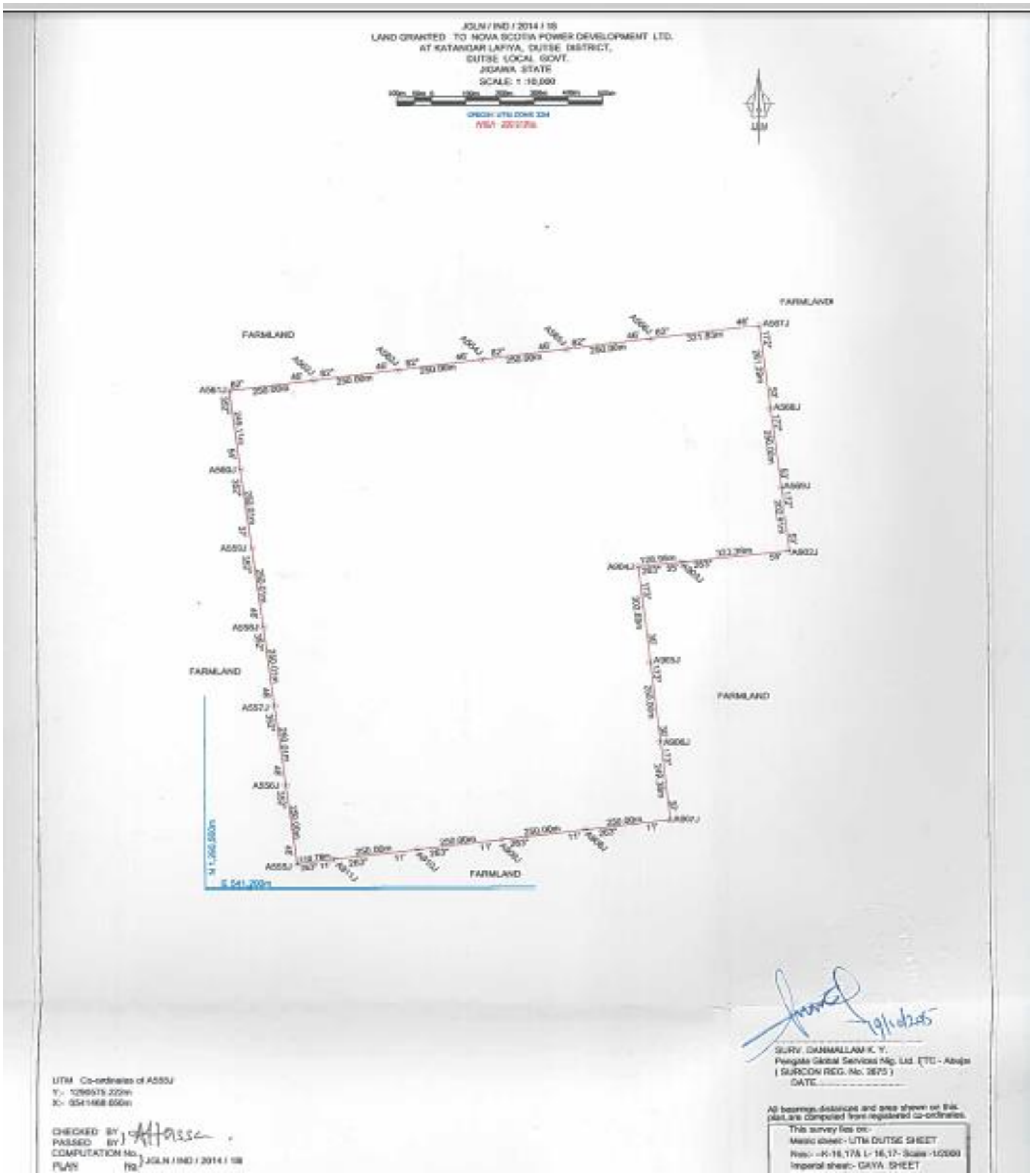
(b) All buildings erected in pursuance of the covenants herein contained except those removed with the consent of the Governor.

2. (1) For the purpose of the rent to be paid under this certificate of occupancy the term of the right of occupancy shall be divided into periods of 5 years and the Governor may as near as may be convenient to the expiration of each period of 5 years, revise the rent and fix the sum which shall be payable for the next period of years or if less than 5 years of the term shall remain, for the remainder of the term.

(2) If the Governor shall so revise the rent, he shall cause a notice in writing to be sent to the holder/holders informing him/them of the revision of the rent, and the holder/holders shall thereupon within one month of the date of the receipt of such notice or within seven days of the commencement of the period for which the rent has been revised, whichever shall happen without further demand, pay to the Governor or other person appointed by him, the difference between the unrevised rent and the revised rent for the period (if any) between the date of revision and the thirty-first day of December, in the year then current; and thereafter the holder/holders shall pay in advance on the first day of January, in each year without demand to the Governor or other person appointed by him in lieu of the said yearly rent of ₦

such revised rent as may for the time being be payable in respect of the said land or any part thereof.

(3) If the yearly rent for the time being payable in respect of the said land or any part thereof shall be in arrears for the space of three months, whether the same shall or shall not have been legally demanded, or if the holder/holders become bankrupt or make a composition with creditors or enter into liquidation, whether compulsory or voluntary or if there shall be any breach or non


LAND GRANTED TO NOVA SCOTIA POWER DEVELOPMENT LTD.
AT KATANGAR LAFIYA, DUTSE DISTRICT,
DUTSE LOCAL GOVT.
JIGAWA STATE
SCALE: 1 :10,000
FARMLAND
FARMLAND
FARMLAND
FARMLAND
FARMLAND
SURV. DANMALLAM K. Y.
DATE
All bearings distances and area shewn on this plan are computed from registered co-ordinates.
This survey lies on:-
Metric sheet:- UTM DUTSE SHEET
Imperial sheet:- GAYA SHEET
UTM Co-ordinates of A555J
CHECKED BY
PASSED BY
COMPUTATION No.
PLAN No.

Observance of any of the occupier/occupiers' covenants or agreements herein contained, then and in any of the said cases it shall be lawful for the Governor at any time thereafter to re-enter upon the said land or any part thereof in the name of the whole and thenceforth hold and enjoy the same as if the right of occupancy had not been granted but without prejudice to any right of action or remedy of the Governor for any antecedent breach of covenants by the holder/holders.

DATED this 1/ day of 12/ 19 2015

Given under my hand the day and year above written.

Governor
Jigawa State of Nigeria
Dutse.

SCHEDULE

ALL THAT PIECE OF LAND SITUATED AT KATANGAR LAFIYA IN THE DUTSE DISTRICT OF THE DUTSE ADMINISTRATIVE AREA OF JIGAWA STATE CONSISTING OF 200.019 HECTARES THE BOUNDARIES OF WHICH ARE DELINEATED BY A RED VERGE LINE ON THE ATTACHED PLAN DRAWING NO. R OF O JGLN/IND/2014/18 AND ARE MORE PARTICULARLY DESCRIBED AS FOLLOWS STARTING FROM PROPERTY BEACON A 561J THE BOUNDARY RUNS FOR A DISTANCE OF 250.00 METRES ON A BEARING OF 82 • 46 TO A562J THENCE FOR 250.00 METRES ON A BEARING OF 82 • 46 TO A563J THENCE FOR 250.00 METRES ON A BEARING OF 82 • 46 TO A564J THENCE FOR 250.00 METRES ON A BEARING OF 82 • 46 TO A565J THENCE FOR 250.00 METRES ON A BEARING OF 82 • 46 TO A566J THENCE FOR 321.85 METRES ON A BEARING OF 82 • 46 TO A567J THENCE FOR 261.29 METRES ON A BEARING OF 172 • 53 TO A568J THENCE FOR 250.00 METRES ON A BEARING OF 172 • 53 TO A569 THENCE FOR 262.91 METRES ON A BEARING OF 172 • 53 STARTING FROM PROPERTY BEACON A 902 J THE BOUNDARY RUNS FOR A DISTANCE OF 320.59 METRES ON A BEARING OF 263 • 55 TO A903J THENCE FOR 128.95 METRES ON A BEARING OF 263 • 55 TO A904J THENCE FOR 302.69 METRES ON A BEARING OF 173 • 30 TO A905J THENCE FOR 250.00 METRES ON A BEARING OF 173 • 30 TO A906J THENCE FOR 249.38 METRES ON A BEARING OF 173 • 30 TO A907J THENCE FOR 250.00 METRES ON A BEARING OF 263 • 11 TO A908J THENCE FOR 250.00 METRES ON A BEARING OF 263 • 11 TO A909J THENCE FOR 250.00 METRES ON A BEARING OF 263 • 11 TO A910J THENCE FOR 250.00 METRES ON A BEARING OF 263 • 11 STARTING FROM PROPERTY BEACON A 911 J THE BOUNDARY RUNS FOR A DISTANCE OF 110.78 METRES ON A BEARING OF 263 • 11 TO A555J THENCE FOR 250.00 METRES ON A BEARING OF 352 • 46 TO A556J THENCE FOR 250.00 METRES ON A BEARING OF 352 • 46 TO A557J THENCE FOR 250.00 METRES ON A BEARING OF 352 • 46 TO A558J THENCE FOR 250.00 METRES ON A BEARING OF 352 • 46 TO A559J THENCE FOR A BEARING OF 250.00 METRES ON A BEARING OF 352 • 57 TO A560J THENCE FOR 249.31 METRES ON A BEARING OF 352 • 54 BACK TO THE STARTING POINT THUS ENCLOSING THE AREA STATED ABOVE ACCESSIBLE CORNERS ARE MARKED BY CONCRETE BEACONS AND ALL BEARING ARE REFERRED TO NATIONAL NORTH INACCESSIBLE CORNERS ARE CO-ORDINATED NOT MARKED ON THE GROUND (SEE PLAN).

This instrument was delivered to me for registration by the Examiner of Deeds Abba Ibrahim of the Ministry of Land and Regional Planning Dutse, Jigawa State at 10:00am o'clock in the noon this 2nd day of Dec, 2015

Deeds Registrar

This instrument is registered as No. 170 at Page 170 in Volume 17 (Certificate of Occupancy) of the Lands Registry in the Office at Dutse.

Deed Registrar

APPENDIX 4.1

FMEnv Approval for One Season Sampling

FEDERAL MINISTRY OF ENVIRONMENT

Environment House

Independence Way South, Central Business District, Abuja - FCT.

Tel: 09-2911 337 www.environment.gov.ng, ea-environment.org

ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMENV/EA/EIA/3364/46
1st September, 2015.

The Managing Director,
Global Environmental Health Solutions (GEHS),
3rd Floor, Kojo Motors Building,
Plot 1209, Kado Road,
Mabushi
Abuja, F.C.T.

RE: APPLICATION FOR REGISTRATION OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE DEVELOPMENT OF PHOTOVOLTAIC (PV) SOLAR PLANTS IN DUTSE LGA, JIGAWA STATE BY NOVA SCOTIA POWER DEVELOPMENT LIMITED (NSPDC).

Please refer to your letter with Ref No: GEHS/111C/1/105 dated 11th March, 2015 and our letter with Ref no. FMENV/EA/EIA/3364/Vol.1/20 dated 16th March, 2015 on the above subject.

2. Following the Conclusion of site Verification exercise, the Ministry has placed the project in Category One (1) requiring mandatory EIA studies and a panel review meeting. Please be informed that the Terms of Reference submitted to the Ministry should also address all identified issues during the scoping workshop that are relevant to the project.

3. The field data gathering and laboratory analyses of the environmental component of the study which will be in One (1) season shall include the following as minimum, sampling points should be geo-referenced with coordinates in UTM format and the tables should be in spread sheet (excel).

S/N	ENVIRONMENTAL PARAMETERS.	PARAMETER DETAILS	NUMBER OF SAMPLES/ DISTRIBUTION	PARAMETERS TO BE MONITORED.
1.	**Climate/ Meteorology**			
2	**Ground water**	Physico-chemical & Microbial	2 Nos. + control samples	Depth to thickness, hydraulics, recharge and, uses. Colour, P^H, turbidity, salinity, hardness, heavy metals –Cu, Pb,Fe, K, Ba, DO, BOD, Phospahte, SO_4, NO_3, TSS
3	**Soil**	Physical	10 Nos. + control samples	Profile (depth type) colour, permeability, porosity, bulk density, texture(grain size)
		Chemical	10 Nos. + control samples	Heavy metals (V, Ni, Fe, Pb, Cu, Zn), pH, moisture content, sulphate, sulphate, nitrate.

		Soil Microbiology	10 Nos. + control samples	Total heterogenic bacteria (total hydrocarbon, fungi, total hydrocarbon bacteria (THB), faecal coliform.
4	**Ambient air Quality**		5 Nos. + control samples	Suspended particulate matter, NO_x, SO_x, CO_2, CO, VOCs, H_2S. .
5	**Noise**	Noise level	10 Nos + control samples	Db
6	**Ecology**	Vegetation/animal s		Flora and Fauna Habitat status, floral composition, density and distribution, vegetation suction, plant pathology.
7	**Socio-Economic**			Education, culture, distribution of livelihood, land use, etc. with structured questionnaire administration.
8	**Health Impact Assessment**			Health status and prevalent diseases in the community.

4. You are to facilitate the participation of the Ministry's officials and also ensure full quality assurance/quality control (QA /QC) measures for the laboratory analyses in line with standard practices. You should notify us in good time to enable us plan our participation in the field work.

5. I am further directed to request you to pay the sum of Five Hundred Thousand Naira (**N500,000.00**) only in bank draft to the Ministry, as the initial processing fee. Upon completion of the EIA studies, you are to submit Ten (10) hard copies of the draft EIA report along with Two (2) electronic copy of the draft EIA report to the Ministry.

6. Thank you for your co-operation.

Abbas O. Suleiman
For: Honourable Minister.

APPENDIX 4.2

SAMPLE HOUSEHOLD QUESTIONNAIRE

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF THE PROPOSED DEVELOPMENT OF 80MW PHOTOVOLTAIC SOLAR PLANT IN DUTSE LGA, JIGAWA STATE

HOUSEHOLD QUESTIONNAIRE FOR SOCIO-ECONOMIC & HEALTH SURVEY

SECTION A. IDENTIFICATION

i. Identification Number……………………………………..

ii. Landmark(s) /address at point of administration………………………………………………………………………………

iii. Community/Location of Interview……………………………………………………………………………………………..

iv. Name and Signature of Interviewer…………………………………………………………………………………………..

v. Date…………………………………………..

vi. Time Interview Started………………………….. Time Ended…………………………………………………

SECTION B: SOCIOECONOMIC ATTRIBUTES

1) Name of Respondent……………………………………………………………………………
2) Sex (M)………… (F)……………………
3) Age…………………………………………..
4) Religion (Christian)…… (Moslim)……. (Traditional)……. (Others)……….. (Please Tick One)
5) Marital Status (Single)……. (Married)…… (Divorced)……. (Widow/Widower)……(Please Tick One)
6) Number of wives…………………………………………
7) Number of children……………………………………..
8) How many persons live in your Household (i.e. Eat from the same pot as you)…………………………….
9) How many persons in your house hold fall into the following age categories?

Categories	Male	Female	Total
0-4yrs			
5-9yrs			
10-14yrs			
15-19yrs			
20-24yrs			
25-29yrs			
30-34yrs			
35-39yrs			
40-44yrs			
45-49yrs			
50-54yrs			
55-59yrs			
60-64yrs			
65-above			
Total			

What is your highest educational attainment?

(i) None (ii) Primary School (iii) Secondary School(iv) Tertiary (v) Islamic studies…

11) How many members of your household fall under the following educational categories?

Categories	Male	Female	Total
Primary School (attempted/still attending)			
Primary School-Completed (Living Certificate)			
Secondary School (attempted/still attending)			
Secondary School-Completed (O'Levels)			
Tertiary Institution (attempted/ still attending)			
Tertiary Institution (Completed)			
Islamic Studies			
Total			

12) What is your major occupation/source of income?
(i) Farming (ii) Fishing (iii) Animal rearing (iv) Hunting (v) Trading
(vi) Artisanal (vii) Fruits collection (viii) Wood gathering (ix) Public service
(x) Private company (xi) Others (Please Specify) ______

13) What is your secondary source of income (other things that support your livelihood)?
(i) Farming (ii) Fishing (iii) Animal rearing (iv) Hunting (v) Trading
(vi) Artisanal (vii) Fruits collection (viii) Wood gathering (ix) Public service
(x) Private company (xi) Others (Please Specify) ______

14) In which of the following **monthly estimate** income group do you belong?
(i). **< N15,000 (ii). N15,000 –N29,000 (iii). N30,000- N59,000**
(iv) N60,000 – N99,000 (v) N100,000 – N300,000 (vi) above N300,000

15) What do you estimate that your household spends on the following per month?

Expenditure	Amount (Naira)	Rank
Food		
Kerosene/fuel		
School fees		
Transportation		
Healthcare		
House rent		
Water		

16) What is the source of land you use for agricultural activities?
(i) Inherited Land owner (ii) land owner by lease (iii) gift (iv) rented on annual basis
(v) communal free land use

17) Does your household own any livestock? i) Yes…. ii) No

18) **If yes, complete** the following attributes on your livestock

Type of livestock	Number in stock	Cost of feeding to maturity	Duration for maturity	Selling price at maturity
Cows				
Pig				
Goat				
Poultry				
Others (specify)				

<u>For Crop Farmers:</u>

19) What type of crops do you cultivate?

Crop type	commercial	Subsistence
Guinea corn		
Maize		
Rice		
Ground nut		
Sugar cane		

Onion		
Others (specify)		

20) Are you the owner of the house where your household live in? i) Yes ii) No

21) Complete the attributes on your household housing

Type of House	**Number of Rooms**	**Number of persons in a room**
a) Mud house with thatch roof		
b) mud house with corrugated roof		
c) Brick house with corrugated roof		

22) Please describe the vulnerability condition of your household as follows?

Category	male	female
No of persons above 60 years		
No of persons with physical disability (state their disability)		
No of orphans under your roof		
No of persons unemployed		

23). What is the major source of water for your household?
(i). River/stream Pond/lake (ii). Family/public well (iii). Pipe borne
(iv) Public/private/commercial borehole (v). Water vendor (vi) Water tanker
(vii) Others? ________

24) What is the average quantity/amount of water consumed by your household per day?
(i) < 10 ltrs (ii) 11 – 20 lts (iii) 21- 30 ltrs (iv) 31 – 40 lts (v) 41 – 50 ltrs
(vi) >50 ltrs

25) How long does it take you in minutes to get to your source of water intake? _ _ _ _ _ _ _ _

26). What is the main source of electricity/ light to your community? (Please Tick One)
i) Hurricane Lamp…….. (ii) Private Generator….. iii) Community Generator….
iv) State Government Utilities Board…. v) Company Operating in your community
(vi) PHCN National Grid..

27) What is the secondary source of electricity your community depends upon? (Please Tick One)
i) Hurricane Lamp (ii) Private Generators (iii) Community Generators
(v) Company Operating in your community

28) What is the main fuel you use for cooking?
(i) Firewood (ii) Charcoal (iii) Kerosene (iv). Electricity (v). Gas
(vi) Crop residue/Saw dust

29). How much do you spend/pay in a month on fuel for generator/kerosene?..................................

30.) Are you willing to pay bill for electricity when you are connected? Yes _ _ No . . . (Tick One)

31) State the maximum amount you are willing and able to pay per month?

Monthly maximum amount	
₦ 6000	₦ 2000
₦5000	₦ 1500
₦ 4000	₦ 1000
₦ 3000	₦ 500

If you are not willing to pay, what are your reasons?

(i)………

(ii)………

(iii)………

33) How does your family/household dispose of its human waste (toilet facility)?
(i) Nearby bush (ii) Nearby stream/river (iii) Pit latrine (iv) Ventilated pit latrine (v) Water closet (vi) Others (specify) ___________________

34) How do you dispose your Household/municipal refuse?
(i) By burning (ii) By burying (iii) Nearby bush (iv) Open dump
(v) Private waste collector (vi) Municipal waste vendor (vii) Others (specify) ______

35) Which of the following do you use timber (forest resources) for regularly?
(i) Firewood (ii) Wood work (iii) Medicine

36) Where do you and your family go for medical treatment?

S/N	**Types**	**Tick**
1	General Hospital	
2	Primary Health Care Centre	
3	Private Clinic / Hospital	
4	Maternity	
5	Pharmacy/ Chemist	
6	Traditional Healing homes	
7	Faith based	
8	Others Specify…………………..	

37) Please give the name and address of the medical facility…………………………………………

38) Which of the following medical conditions affected your household in the past 1 year?

S/N	**Type of Medical Condition**	**Please Tick**
1	Malaria/ Fever	
2	Typhoid	
3	Diarrhea (*Watery stool)*	
4	Cholera *(Stooling and vomiting)*	
5	Dysentery *(blood in stool)*	
6	Skin Rashes	
7	Ashtma	
8	Upper Respiratory Tract Infections (Cough, Catarrh e.t.c.)	
9	Pneumonia	
10	Tuberculosis	
11	Hepatitis	
12	Guinea Worm Disease	
13	Hook Worm Disease	
13	Trypanosomiasis (Sleeping Sickness)	
14	HIV/AIDS	
15	Other STDs (Gonorrhea, Syphilis e.t.c.)	
16	High Blood Pressure	
17	Stroke	
18	Diabetes	
19	Accident/ Injuries/ Fractures	
20	Others (Specify):	

In the last one (1) month, how often did you or members of your household use the medical facility?

(i) None (ii) 1-2 times (iii) 3 – 5 times (iv) More than 5 times

40) What was the medical condition?..

41) How would you rate your household general health status?

(i) Excellent (ii) Good (iii) Poor

42) Do you have any concern about the effect the proposed project could have on the health and wellbeing of the people?

....
....
....

43) In order of preference, what do you think should be done to minimize these anticipated health problems?

....
....
....

44) What benefit do you expect the power project will have on the people in the area in order of importance (mark 1 for most important followed by 2, 3….)

a. Improved health and well being
b. Employment benefit
c. Economic boom (increased commercial activity)
d. Infrastructure development
e. Housing
f. Others (specify)

....
....

45) What are your fears about the proposed power project (in order of importance?

i. Loss of land (acquisition and deforestation)
ii. Damage to farmland
iii. Air pollution
iv. Noise pollution
v. Water pollution
vi. Vandalism of the installations……………………………………………………………………….
vii. Social vices in the community
viii. High cost of living
ix. Increased population
x. Disruption of business activities
xi. Disruption of traffic
xii. Others (Explain in detail)……………………………………………………………………………………………….

....

46) What would you want government to do to make this project sustainable?

....
....

APPENDIX 4.3

Geotechnical Report

1.0 Introduction

1.1 Project Description

This report summarizes the geotechnical investigation performed by Quest Universal Services Ltd for the proposed 80MW solar power park at Dutse LGA, Jigawa state. The project will consist of a solar plant, including photovoltaic (PV) panels, transformers and control room. The following loads and settlement criteria were considered for the proposed project (Table 1).

Table 1: Considered load and settlement criteria

Structure / Foundation Type	Approx. Load (Max T / m^2)	Approximate Footing Size (m)	Maximum settlement (mm)	
			Total	Differential
Transformer Pad	5	2.5 m X 2.5 m	40	40
Control Room	10	2.0 m X 2.0 m	40	40
PV Panel Support Pier	Vertical Load of 0.25 T	0.3 m-0.45 m diameter	25	NA
PV Panel Support Pier	Lateral Load of 1 T	0.3 m-0.5 m diameter	25	NA
PV Panel Support Pier	Moment of 0.5 t/m	0.3 m-0.5 m diameter	25	NA

It describes the general methodology that was used to conduct the geotechnical investigation and studies undertaken to assess the geotechnical characteristics on the project site.

The investigation was carried out based on instruction received from **Nova Scotia Power Development Limited.**

For the preparation of the proposed structure of photovoltaic solar power plant at the project site, geotechnical investigation had to be carried out to provide the design team with the required reliable geotechnical information. A 3.66km transmission line is also proposed to evacuate power generated from the solar power park to an existing 132/33kV substation.

The Geotechnical field work commenced on the 4th of October 2015. Soil investigation including Boring/SPT and trial pitting was conducted. The investigation was carried out in accordance with BS 1377 method of soil testing and procedures in civil engineering. The soil samples were analysed at the Soil mechanics Laboratory Civil Engineering Department, Kaduna Polytechnic. Summary of the laboratory analysis can be found in appendix 2. Our project task was limited to the Solar Power Farm site only. Earth resistivity test was also carried out to measure the conductivity of the soil.

At the time of investigation there was no known data and information from previous studies relevant to the present project since this is the first and only solar power project around Dutse. Information obtained from geological maps fig (4) was used to describe the geomorphology and climatic characteristics of the site.

1.2 Scope of work

The scope of work is summarized as follows:

1. To conduct SPT & excavate trial pits on selected test points.
2. To evaluate the bearing capacity of soils that is required to produce adequate foundation design and recommend the most suitable foundation for consideration.
3. To evaluate through laboratory tests, the physical properties and strength of the soils recovered from some selected soil samples on the site.
4. To carry out analysis of the chemical content in soil/ground water recovered.
5. To determine the resistivity of the soil at different locations within the entire property.

1.3 Project Objective:

1. Geotechnical investigation is intended to determine the soil bearing capacity based on the physical and strength parameters of the soil strata down to a firm soil of considerable depth below the ground surface deemed to be sufficient to support foundation consideration, and precautionary measures to be taken during construction.
2. Earth resistivity test is to make a series of resistivity measurements and obtain the average resistivity for the soil in accordance with the IEEE 80 grounding design guide. The computed resistivity will be used for the grounding design for this proposed solar power park.

1.4 Reference Documents:

i. Topographic survey drawing prepared by Pengate associates.

ii. Digital map of Dutse, Jigawa state.

iii. Digital copy of geological map Nigeria.

2.0 SITE DESCRIPTION

2.1 Project Location:

Dutse is the capital of Jigawa state located in North-West Nigeria and it is the capital city of Jigawa State (fig 1, & fig 2). The site is situated approximately 5km south-east of Jigawa broadcasting network. It can be accessed from the dirt road adjoining the state owned university. Basically, the entire property is a vast open green field with land mass of about (200 hectares) which is presently been cultivated by subsidence rural farmers.

The proposed solar park site is bounded by the following co-ordinates as shown in Table 2.

Table 2: Boundary coordinates of proposed site

S/No	Coordinate
PB 1	X = 541468.05 Y = 1290575.22
PB 7	X = 541279.21 Y = 1292062.42
PB 13	X = 542838.52 Y = 1292260.37
PB 16	X = 542927.00 Y = 1291551.66
PB 18	X = 542480.18 Y = 1291504.10
PB 21	X = 542570.98 Y = 1290707.18

It is surrounded by the some villages to the south of the project site. The villages include; Bakinjeji, Katangar Lafia, Rahama and Sumore. At the time of investigation, the entire site was over grown by cultivated farm crops. From the topographical map (Appendix 9), the terrain slopes gently eastwards of the project site. Test points positions are located on ground with the use of hand held Garmin 76 GPS meter. Extra care was taken as not to cause serious damage to the cultivated farmland. Movement of soil test equipment from test point to test point was challenging. There are no existing services present on site.

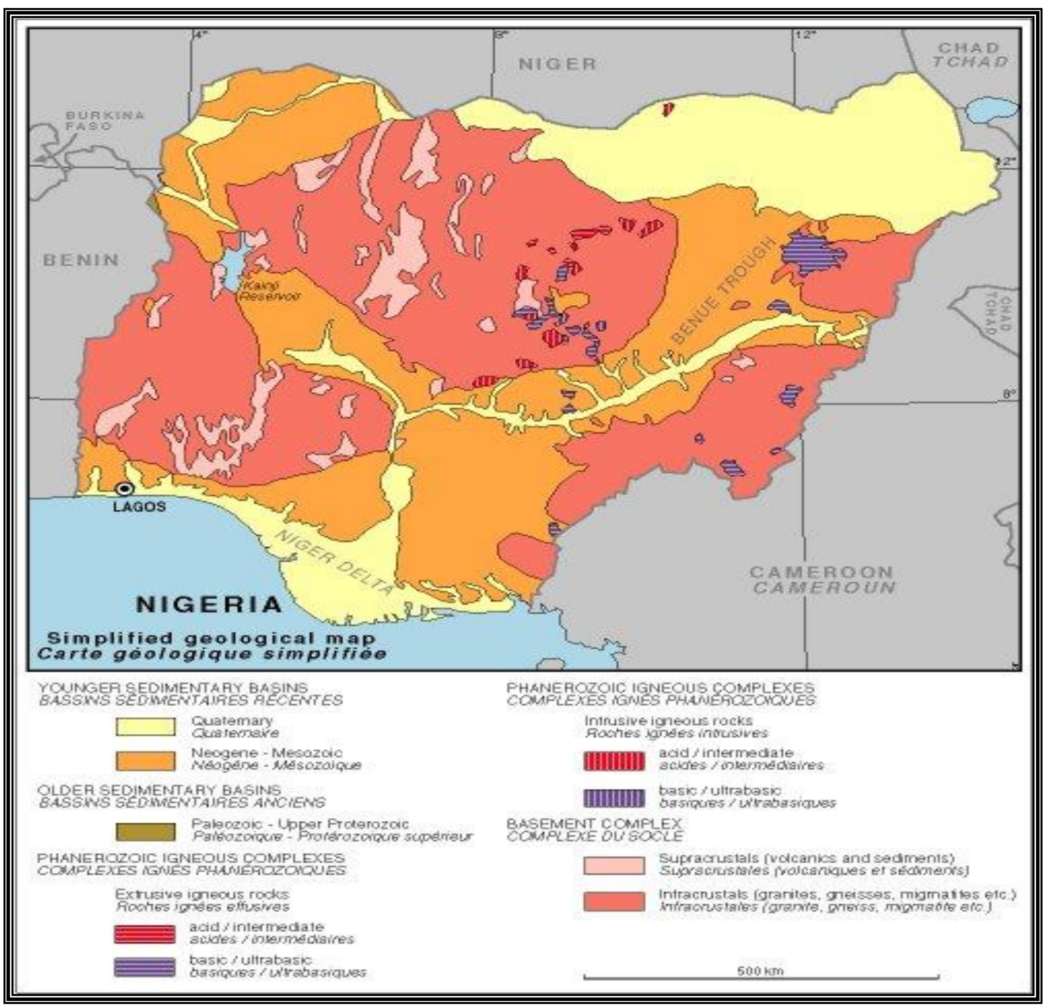
2.2 General Geology of the Dutse:

Dutse is located in the northwestern part of Nigeria and it fall within the Chad formation that consist predominantly of recent Aeolian deposits.

The rocks underlying this area are made up of 95% ancient crystalline basement complex formations. The basement complex rocks consist mainly of gneiss, migmatites, schists, quartzites and marble. Locally, granite or syenite and intrusion of amphiobolites and olive rich dykes are found.

Sandy beds which are products of aeolian deposits from the sahara desert are formed over impervious clay of the chad formation. The soils are generally sandy at the top and compact at depth with often hard pans.

Fig 4: Geological map of Nigeria



2.2.1 Geology of the Project site

The soil encountered on the site is profiled in appendix 6.

It is clear from the profile that borings at the different locations shows similarities that consist of very fine to fine grained silty sand graduating to ferretic hard pan laterite with occasional gravels. Termination of Boring usually is at depth below ground level where resistance to penetration becomes difficult or hard pan is encountered.

The Aeolian sand that is characterised by loose to medium-dense soil but as soon as it is excavated, it forms loose non-cohesive sand. This was confirmed by the physical observation and laboratory test carried out on the soil samples obtained.

As shown in the borings logs, soil encountered during our soil investigation at shallow depth generally consisted of fine sand & silty fine sand. (Site pictures: 1&2)

2.2.2 Soil type

The Chad sediments are concealed by sand dunes with no surface outcrops. The sandy beds formed over the impervious clays of the Chad Formation form the main source of water supply in the dry season. The soils are generally silty sandy at the top and compact as penetration deepens with often hard pans.

2.2.3 Climate

Dutse is semi-arid, characterised by two seasons which are, a long dry season and a short wet season. The climatic varies considerably over the years and is often erratic. The temperature regime is from warm to hot. The mean annual temperature is about 25^{o} C. Although the mean monthly temperature ranges ranges between 21^{o} C in the coolest month and 31^{o} C in the hottest month.

However, the mean daily temperature could be as low as 20^{o} C during the months of December and January when the cold dry harmattan wind blows from the Sahara Desert.

Evapo-transpiration is very high and relative humidity is highest in August (up to 80%) and low in January through March (23% to 30 %) when it is moderated by the harmattan. The year is characterised by well-marked dry and wet of seasons.

2.2.4 Vegetation

Vegetation at the proposed site falls within the northern guinea savannah zone. Extensive open grasslands, with few scattered stunted trees, are characteristics of the vegetation. Due to the silty-sandy nature of the soil, Guinea corn, Millet and Groundnut are the major food crops which are grown around this area. (Site pics 3 & 4)

Neem tree and Baoba trees are some of the common trees that can be found along the route.

3.0 GEOTECHNICAL INVESTIGATIONS

3.1 Field EXPLORATION:

3.2 Soil Profiling

(Refer to Appendix 6: Borehole & Trial Pit location)

3.2.1 Trial pitting

30 test pits were excavated on the project site using Manual labour sourced from the surrounding villages. The positions of the test pits positions were determined using Garmin 76 Handheld GPS (Appendix 7: Borehole & TP Coordinates). The test pits were excavated to refusal or the maximum of 2m.

Soil samples from the excavation test pits were taken to Soil Mechanics and Geology Laboratory, Civil Engineering Department, Federal Polytechnic Kaduna for soil analysis. The testing was aimed at classifying the soils and to determine the suitability of the soils for use as construction materials.

The test pits were profiled and logged according to Jennings, Brink and Williams (1973). (Appendix 7: Borehole & TP Coordinates).

3.3 SPT boring and sampling

A Total of 60 nos. test borings were carried out using cathead percussion SPT rig Boring method at the site. The locations of the borings were selected to represent the entire project area. Refer to (Appendix 6: Borehole & Trial Pit location)

The investigation included Boring of test boreholes using Cat head Boring rig with HW (4") casing followed by laboratory testing of selected samples. The procedure consists of driving down a standard split spoon, as set forth in ASTMD 1586. Sampling procedures were followed as set forth in the code of practice for site investigation BS 5930, 1981.

Sampling and In-situ test were carried out systematically with the advancement of the Boring and these were carried out as follows:

Samples materials were taken within the overburden, at regular intervals and at change of strata as at when necessary. These samples were taken in such a way as to represent the materials encountered in the course of Boring. Materials from the split spoon samples of the Standard Penetration Test (SPT) were collected.

The sampler was lowered down the borehole until it rests on the layer of cohesionless soil to be tested. It was then driven into the soil for a length of 450mm by means of a 65kg hammer falling free 760mm for each blow. Standard Penetration Test (SPT) was carried out at an interval of 1.5m within the overburden strata by driving a 51mm diameter split spoon sampler into the soil. The number of blows required to drive the last 300mm is recorded and this figure designated N value of the soil (the first 150mm of the driving is ignored because of possible loose soil in the bottom of the borehole from the boring operations). After the tube has been removed from the borehole it was opened, and its contents examined.

Terzaghi and peck (1948) evolved a qualitative relationship between the relative density of the soil tested and the number of blows from the standard penetration test, N. Gibbs and Holtz (1957) put figures to this relationship which is given in fig 5.

Fig 5: Relative Density of sand Terzaghi and peck (1948)

0–4	very loose	0–15%
4–10	loose	15–35
10–30	medium	35–65
30–50	dense	65–85
over 50	very dense	85–100

An important feature of the standard penetration test is the influence of the effective overburden pressure on the count. Sand can exhibit different N values at different depths even though its relative density is constant. Terzaghi and peck make no reference to the effects that this can have, but Gibbs and Holtz examined the effects of most of the variables involved and concluded that the significant factors affecting the N values are relative of the soil and the value of the effective overburden pressure removed.

The value of N corresponding to the critical density about 15 and Terzaghi and peck suggests that if the number of measured blows N is greater than 15, it should be assumed that the density of the tested soil is equal to 15+0.5(N-15)

i.e True N = 15+0.5(N-15)

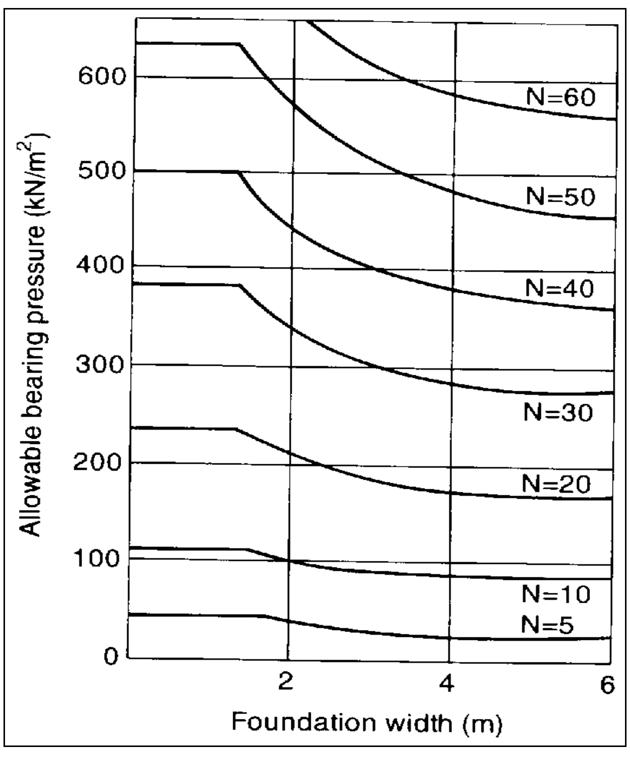
N = actual number of blows recorded in the test

True N = number of blows from which N should be evaluated.

3.3.1 Estimation of allowable bearing pressure from the standard penetration test

Having obtained N', we then multiply by 10 hence the determination of the allowable bearing pressure. This is generally based upon an empirical relationship evolved by Terzaghi and Peck (1948) that is based on the measured settlement of various foundations on sand (Fig 6). The allowable bearing pressure for these curves (which are applicable to both square and rectangular foundations) was defined by Terzaghi and Peck as the pressure that will not cause a settlement greater than 25mm assuming a differential settlement of 20mm which can be easily tolerated by most structures.

Fig: 6: Settlement of footing from standard penetration resistance



The table above was derived based on (Terzaghi and Peck 1948). It will be seen from the analysis table that 300/305mm interval was used to predict the soil properties.

That is, from the number of blows, the state of packing/relative density, angle of shearing resistance and allowable bearing capacity can be predicted. Refer to appendix 1 for summary of Standard Penetration Test.

3.3 Sampling

Disturbed and undisturbed samples were obtained from the various test pits. The samples recovered were logged, labeled and placed in polyethylene bags and sent to laboratory for testing.

3.2 Laboratory testing

Table 3 lists the laboratory tests conducted on undisturbed and disturbed soil samples collected from various depths to find the soil parameters. The summary of the test results obtained in the laboratory is shown in appendix 2

Table 3: Types of test carried out

Tests	Recommend procedure
Moisture Content	BS 1377 Part 2: 1990 Cl.3
Compaction	BS 1377 Part 4: 1990 Cl.3.5 & 3.6
Dry Unit Weight	ASTM D 1556: 2000
Specific Gravity	ASTM D 854-00
Liquid Limit	BS 1377 Part 2: 1990 Cl.4
Plastic Limit/Plastic index	BS 1377 Part 2: 1990 Cl.5
Particle size distribution	BS 1377 Part 2: 1990 Cl.8
Consolidation	BS 1377 Part 6
Shear strength by direct shear	BS 1377 Part 7: 1990 Cl.4
pH of soil	BS 1377 Part 3: 1990
Acid soluble sulphate content	BS 1377 Part 3: 1990
Acid soluble chloride content	BS 1377 Part 3: 1990

3.4 Result of Chemical Analysis of soil

Table 4: Types of test carried out

SAMPLE	pH	Sulphate (Mg/Kg)	Chloride (mg/kg)
BH 2 @ 5.25m	6.4	398.67	326.60
BH 4 @ 2.25m	6.9	367.70	319.50
BH 5 @ 3.2m	7.6	384.16	262.74
BH 11 @ 2.25m	6.0	343.84	376.23
BH 13 @ 2.25m	5.9	373.02	227.20
BH 18 @ 2.25m	5.2	399.63	362.10

Table 4a: EPA STANDARD

NOTE:
PH EPA limit: (6--9)
Sulphate EPA limit: (250-400mg/kg)
Chlorine EPA limit: (≤600mg/kg)

BH 42 @ 2.25m	5.6	393.38	376.32
BH 44 @ 3.75m	6.3	381.80	366.47
BH 52 @ 2.25m	5.9	381.44	343.11
BH 59 @ 3.75m	6.1	340.31	383.30
TP 3 @ 1.2m	6.6	380.04	397.6
TP 8 @ 2m	7.6	368.61	275.70
TP 13 @ 2.0m	6.7	343.10	343.63
TP 15 @ 1.5m	5.9	350.41	360.45
TP 23 @ 1.5m	6.0	364.04	29.15
TP 30 @ 2.0m	6.4	350.02	360.50

3.5 Geophysical Survey

All geological formations possess properties called electrical resistivity when the current flows through them. Soil resistivity data is the key factor in designing a grounding system for a specific performance objective. All soils conduct electrical current, with some soils having good electrical conductivity, while the majority has poor electrical conductivity.

The resistivity of soil varies widely throughout the world and changes dramatically even within small areas. Soil resistivity is mainly influenced by the type of soil (clay, shale etc), moisture content, the amount of electrolytes (minerals and dissolved salts) and finally, temperature. When designing grounding system for a specific performance objective, it is necessary to accurately measure the soil resistivity of the site where the ground is to be installed. The practice of connecting electrical systems to earth using grounding electrodes has historically been the preferred means to safeguard against results of accidental contact of electrical power to earth.

3.5.1 RESISTIVITY MEASUREMENT METHOD

The testing depth of a soil resistivity test is determined by the spacing between the four test rods as shown in fig 7. The recommended practice is to test the soil at various depths in order to determine the best depth for grounding electrode system. For example, if the test rods are 2meters apart, the measurement will be an average of the soil from the surface down to 2meters. As the spacing between the rods is increases, results for corresponding deeper samples are directly obtained.

Table 8 lists the soil depths measured for different rod spacing distances.

Fig. 7 WENNER FOUR PIN METHOD

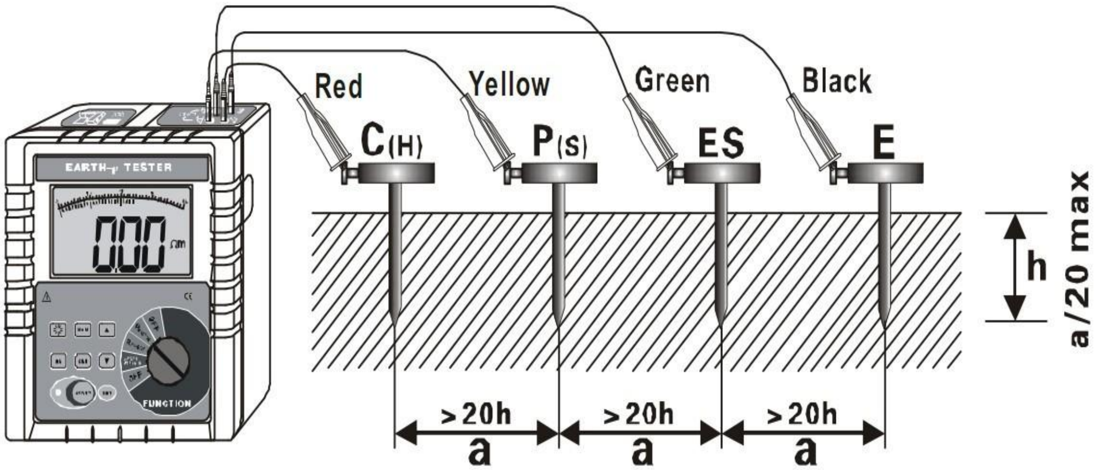


Table 5: Soil Depth Measured as a Function of Rod Spacing

Rod Spacing	Soil Depth Measured
2m	2m
4m	4m
6m	6m
8m	8m
10m	10m
12m	12m

3.5.2. WENNER FOUR PIN METHOD

The soil resistance method adopted for this investigation is the Wenner four-pin method as shown in fig. 7. In 1915, Wenner demonstrated that field test measurements of soil resistivity are commonly obtained by use of the four pin method. Blattner (1982) compared the four pin method and concluded that the Wenner four pin method is the simplest to perform.

The equipment used in conducting the soil resistivity test is ETCR3000B Earth Resistance Soil Resistivity Tester.

Fig. 8 ETCR3000B Earth Resistance Soil Resistivity Tester

The maximum depth of the probe did not exceed 20cm nor exceed 1/20TH of the probe spacing distance ‘a’. A series of resistivity readings are taken for various spacing of the probes. For this site the spacing increased to enable the soil resistivity to be assessed at a greater depth.

The probes were connected to the tester, with the outer probes connected to the C and E terminals, and the inner probes to the P and ES terminals (fig 7). The instrument was kept in a central position and a series of resistivity measurements made as the four electrodes were moved out in equal distances from the central point.

3.5.3 **Result (S**ee tables below)

Table 6.1. Soil Resistivity Test Records

Test Locations		Power supply DC(V)	Pin Spacing a(m)	Pin Depth h(mm)	Soil Resistivity ρ(ohm-m)
ERT 1	1	9	2	150	501.3
	2	9	4	150	262.8
	3	9	6	150	122.8
	4	9	8	150	81.93
	5	9	10	150	56.54
	6	9	12	150	45.23
AVER. RESISTIVITY	214.12 Ω-m				

Table 6.2. Soil Resistivity Test Records

Test Locations		Power supply DC(V)	Pin Spacing a(m)	Pin Depth h(mm)	Soil Resistivity ρ(ohm-m)
ERT 2	1	9	2	150	596.8
	2	9	4	150	393.8
	3	9	6	150	200.1
	4	9	8	150	14.07
	5	9	10	150	0
	6	9	12	150	0
AVER. RESISTIVITY	240.9 Ω-m				

Table 6.3. Soil Resistivity Test Records

Test Locations		Power supply DC(V)	Pin Spacing a(m)	Pin Depth h(mm)	Soil Resistivity ρ(ohm-m)
ERT 3	1	9	2	150	60.44
	2	9	4	150	27.89
	3	9	6	150	22.61
	4	9	8	150	21.61
	5	9	10	150	18.22
	6	9	12	150	21.86
AVER. RESISTIVITY	34.5 Ω-m				

Table 6.4. Soil Resistivity Test Records

Test Locations		Power supply DC(V)	Pin Spacing a(m)	Pin Depth h(mm)	Soil Resistivity ρ(ohm-m)
ERT 4	1	9	2	150	63.08
	2	9	4	150	77.65
	3	9	6	150	82.93
	4	9	8	150	95.5

	5	9	10	150	102.4
	6	9	12	150	116.1
AVER. RESISTIVITY	107.5 Ω-m				

Table 6.5. Soil Resistivity Test Records

Test Locations		Power supply DC(V)	Pin Spacing a(m)	Pin Depth h(mm)	Soil Resistivity ρ(ohm-m)
ERT 5	1	9	2	150	113.3
	2	9	4	150	70.87
	3	9	6	150	47.12
	4	9	8	150	23.12
	5	9	10	150	13.82
	6	9	12	150	0
AVER. RESISTIVITY	53.6 Ω-m				

Thus, the apparent resistivity is calculated as follows and the results:

$\rho a1 = 214.12$ ohm-meter.

Similarly,

$\rho a2 = 240.9$ ohm-meter

$\rho a3 = 34.5$ ohm-meter.

$\rho a4 = 107.5$ ohm-meter.

$\rho a5 = 53.6$ ohm-meter.

Approximate Uniform Soil Resistivity.

The approximate uniform soil resistivity is given by:

$$\rho = \frac{\sum_{\rho a1}^{\rho a(n)} \rho}{n}$$

$$\rho = \frac{\sum_{\rho a1}^{\rho a(n)} \rho}{5}$$

$$= \mathbf{130.2\ \Omega\text{-}m}$$

4.0 DISCUSSION OF FOUNDATION PROPOSAL AND RECOMMENDATION.

4.1 ASSESSMENT OF CIVIL ENGINEERING REQUIREMENTS

Ground water (GW) was not observed during investigation although localised perched water was observed at a few test points (TP12, TP14, TP16, TP27).

Borings at the different locations shows similarities in the soil type. The soils are generally loose silty sandy soil at the top and often overlaying hard pan lateritic layers.

Termination of boring is usually at depth below ground level where resistance to penetration becomes difficult or hard pan is encountered. From the SPT boring log, it was noted that resistance to penetration of the soil increases with depth (Appendix 3)

4.2 Excavation Consideration

Excavation for foundation structures will encounter Aeolian silty sandy grained soil material at a shallow depth. Removal of these soils could be carried out either manually (hand dug) or using conventional earthmoving equipment, such as hydraulic excavator, or backhoe.

4.3 Reuse of excavated materials

Most of the spoils derived from the excavation at the site should be suitable for reuse as engineered filling from a geotechnical perspective, since the materials that will be excavated are mainly sandy. The fill material can be placed beneath the shallow foundations such as plinth of structures or in sub grade filling for embankment of road.

4.4 PV/Substation structure foundation

For the control building and residential structures, the conditions on site are such that excavation will not posed any serious challenge. Due to the sandy soil type on the project site, reinforced concrete raft foundation is recommended. This will provide a stable foundation without excessive excavation.

The reinforced concrete raft foundation should be designed to transmit the whole load of the building from the raft to the ground where the small spread loads will cause little if any appreciable settlement.

Structural foundations can be constructed on soil mattresses constructed within the Aeolian sands with a bearing capacity of **90kPa at 1.65-2.00m**.

5.0 CONCLUSION

- From standard penetration test, allowable bearing capacity of **90kN/m^2 at 1.65m-2.00m** below natural ground level is considered adequate for design consideration.
- The site is underlain by Aeolian sand that consists of silty and clayey sands that are underlain by laterite at different levels.
- Proper storm water and groundwater control system should be design to adequately take care of all drainage challenged that may pose during the lifetime of the project.
- The result of the chemical analysis suggests that the soil is slightly acidic with medium sulphate and chloride content. Although the test suggests that the materials are within the acceptable PH EPA limit of [6—9] for concrete). Damp Proofing Membrane (DPM) such as Polythene should be laid over the blinding concrete. Ordinary Portland cement of higher mix ratio should have no deleterious effect from sulphate or acidic attack.
- Since the resistivity varies appreciably with depth, it becomes desirable to use an increased range of probe spacing in order to obtain an estimate of the resistivity of deeper layers. This is possible

because, as the probe spacing is increased, the test source current penetrates deeper distant areas in both vertical and horizontal directions regardless of how much the current path is distorted due to the varying soil conditions. Based on the composition of the soil and site conditions, the soil gives a very good indication as to what order of resistivity is to be expected. From the approximate uniform soil resistivity calculated, the average resistivity value of the area, where the test was conducted is **130.2 Ω-m.**

- It is advisable to place concrete in foundation as soon as excavation work is done.

  Foundations excavation and construction should be carried out in accordance with internationally accepted code of Practice for foundations and earthworks.

  This is to reduce the possibility of the foundation soil softening quickly if in contact with water.

- Based on this analysis, design and construction of all foundations should be carried out in accordance with internationally accepted code of Practice for foundations and earthworks.

APPENDIX 4.4

INVITATION LETTERS FOR SCOPING WORKSHOP

35

GEHS Global Environmental Health Solutions

CHIEF EXECUTIVE OFFICER TRANSMISSION COMPANY OF NIGERIA (TCN) 28 AUG 2015 RECEIVED

Global Environmental Health Solutions Ltd

"Providing sustainable solutions to environment related health challenges"

28th August, 2015 GEHS/111C/II/30

The CEO
Transmission Company of Nigeria
Plot 441, Zambezi Crescent,
Maitama,
Abuja.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE
INVITATION TO ATTEND SCOPING WORKSHOP

Nova Scotia Power Development Limited (NSPDL) is planning to develop a 80MW$_{AC}$ solar photovoltaic (PV) plant near the town of Dutse in Jigawa State. Consequently, Global Environmental Health Solutions (GEHS) Ltd has been commissioned by NSPDL as the independent Environmental Consultant to undertake an Environmental and Social Impact Assessment (ESIA) study of the proposed project.

2. An integral part of the ESIA study is Stakeholders' Engagement. This is undertaken to ensure that the interests, concerns and inputs of affected communities and other stakeholders are integrated into the overall project plan. To this end, a Scoping Workshop is being organized to duly inform stakeholders about the proposed project and provide them the opportunity to express their views and concerns early in the ESIA process.

3. As a key stakeholder, we hereby invite your organization to participate in the Scoping Workshop scheduled to hold as follows:

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State.
Date: Tuesday, 8th September, 2015
Time: 11.00am prompt.

4. To facilitate an informed and participatory deliberation during the workshop, kindly find attached a concise Background Information Document (BID) about the proposed project and the ESIA study.

5. We look forward to your contribution and active participation.

Thank you and kind regards,

Dr. Lola Okwuosa MBBS; MPH (Harvard)
Head/Lead Consultant

3rd Floor, Kojo Motors Building,
Plot 1209, Kado Road, By VIO, Mabushi, Abuja, Nigeria.
Tel: 08112659220, 08059649767 Email: info@gehsolutions.org gehsolutions@gmail.com Website: www.gehsolutions.org

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Global Environmental Health Solutions

Global Environmental Health Solutions Ltd

"Providing sustainable solutions to environment related health challenges"

28th August, 2015 GEHS/111C/II/31

MINISTRY OF ENVIRONMENT
JIGAWA STATE
RECEIVED
DATE 02/09/015

The Honourable Commissioner
Ministry of Environment
Old Secretariat, Block 59-60,
Dutse, Jigawa State.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE
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Head/Lead Consultant

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Tel 08112659220, 08059649767 Email info@gehsolutions.org gehsolutions@gmail.com Website www.gehsolutions.org

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GEHS
Global Environmental Health Solutions

Global Environmental Health Solutions Ltd

"Providing sustainable solutions to environment related health challenges"

28th August, 2015 GEHS/111C/II/31

MIN OF LANDS HOUSING URBAN DEV REGIONAL PLAN DUTSE
02 SEP 2015
RECEIVED

The Honourable Commissioner
Ministry of Lands, Housing, Urban Dev & Regional Planning
Glass House, No 1 Justice Dahiru Mustapha Road,
Takur,
Dutse, Jigawa State

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE
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Tel 08112659220, 08059649767 Email info@gehsolutions.org gehsolutions@gmail.com Website www.gehsolutions.org

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Global Environmental Health Solutions

Global Environmental Health Solutions Ltd

"Providing sustainable solutions to environment related health challenges"

28th August, 2015 Alhassan Musa GEHS/111C/II/37

The Head
Rahama Village
Dutse LGA,
Jigawa State.

08109189797

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE

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3. As a stakeholder, we hereby invite you as well as the women and youth leaders in your community to participate in the Scoping Workshop scheduled to hold as follows:

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State.
Date: Tuesday, 8th September, 2015
Time: 11.00am prompt.

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5. We look forward to your contribution and active participation.

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Dr. Lola Okwuosa MBBS; MPH (Harvard)
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Global Environmental Health Solutions Ltd

"Providing sustainable solutions to environment related health challenges"

28th August, 2015 GEHS/111C/II/38

The Chairman
Katanga Lafiya Development Association
Katanga Lafiya,
Jigawa State.

Sale umar
K/lafiya 08036920278

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE

INVITATION TO ATTEND SCOPING WORKSHOP

Nova Scotia Power Development Limited (NSPDL) is planning to develop a 80MW_{AC} solar photovoltaic (PV) plant near the town of Dutse in Jigawa State. Consequently, Global Environmental Health Solutions (GEHS) Ltd has been commissioned by NSPDL as the independent Environmental Consultant to undertake an Environmental and Social Impact Assessment (ESIA) study of the proposed project.

2. An integral part of the ESIA study is Stakeholders' Engagement. This is undertaken to ensure that the interests, concerns and inputs of affected communities and other stakeholders are integrated into the overall project plan. To this end, a Scoping Workshop is being organized to duly inform stakeholders about the proposed project and provide them the opportunity to express their views and concerns early in the ESIA process.

3. As a stakeholder, we hereby invite a representative of your association to participate in the Scoping Workshop scheduled to hold as follows:

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State.
Date: Tuesday, 8th September, 2015
Time: 11.00am prompt.

4. To facilitate an informed and participatory deliberation during the workshop, kindly find attached a concise Background Information Document (BID) about the proposed project and the ESIA study.

5. We look forward to your contribution and active participation.

Thank you and kind regards,

Dr. Lola Okwuosa MBBS; MPH (Harvard)
Head/Lead Consultant

3rd Floor, Kojo Motors Building,

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GEHS
Global Environmental
Health Solutions

Global Environmental Health Solutions Ltd

"Providing sustainable solutions to environment related health challenges"

28th August, 2015 GEHS/111C/II/39

The Secretary
AAHUU Environmental Consultant
Dutse,
Jigawa State.

Attention: Mr. Haladu Bulama

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE
INVITATION TO ATTEND SCOPING WORKSHOP

Nova Scotia Power Development Limited (NSPDL) is planning to develop a 80MW_{AC} solar photovoltaic (PV) plant near the town of Dutse in Jigawa State. Consequently, Global Environmental Health Solutions (GEHS) Ltd has been commissioned by NSPDL as the independent Environmental Consultant to undertake an Environmental and Social Impact Assessment (ESIA) study of the proposed project.

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5. We look forward to your contribution and active participation.

Thank you and kind regards,

Dr. Lola Okwuosa MBBS; MPH (Harvard)
Head/Lead Consultant

2/9

3rd Floor, Kojo Motors Building,
Plot 1209, Kado Road, By VIO, Mabushi, Abuja, Nigeria.
Tel: 08112659220, 08059649767 Email: info@gehsolutions.org gehsolutions@gmail.com Website: www.gehsolutions.org

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Global Environmental Health Solutions Ltd

"Providing sustainable solutions to environment related health challenges"

28th August, 2015 GEHS/111C/II/34

The Principal Manager Transmission (PMT)
Dutse Work Centre
Dutse,
Jigawa State.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE
INVITATION TO ATTEND SCOPING WORKSHOP

Nova Scotia Power Development Limited (NSPDL) is planning to develop a $80MW_{AC}$ solar photovoltaic (PV) plant near the town of Dutse in Jigawa State. Consequently, Global Environmental Health Solutions (GEHS) Ltd has been commissioned by NSPDL as the independent Environmental Consultant to undertake an Environmental and Social Impact Assessment (ESIA) study of the proposed project.

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3. As a key stakeholder, we hereby invite you to participate in the Scoping Workshop scheduled to hold as follows:

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State.
Date: Tuesday, 8th September, 2015
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Thank you and kind regards,

Dr. Lola Okwuosa MBBS; MPH (Harvard)
Head/Lead Consultant

ENGR MUH'D LADAN YANKUZO
PMT, DUTSE WORKS CENTRE
DUTSE, JIGAWA STATE.

2-9-15.

3rd Floor, Kojo Motors Building,
Plot 1209, Kado Road, By VIO, Mabushi, Abuja, Nigeria.
Tel: 08112659220, 08059649767 Email: info@gehsolutions.org gehsolutions@gmail.com Website: www.gehsolutions.org

APPENDIX 4.5

ATTENDANCE SHEET OF PARTICIPANTS AT THE SCOPING WORKSHOP

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

SCOPING WORKSHOP

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Tuesday, 8th September, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Amit Modi	MD	Nova Scotia Power		amodi@ cdevint.ca	
2	Nasiru Isyaku	Director	✓		nasirui@gshoorom	
3	Hamim nSanusi Dan iyan Dutse	council member	Dutse Emirate coun	08035682529	mohhamim@hotmail.com	
4	Abdulrahman Farouk	Project manager	NSPDL	07068859885	afarouk@ nspdl.ca	
5	Ali Abe	Member	Bijeji	07030812577	—	
6	A. Idris Abubakar	✓	✓	08068636427	—	
7	Ibrahim Abdu	HAMIDU	BAKNJaJ,	08160829321	—	
8	Bello Abdulhamid		Bakin Jeji	08069325376	—	
9	SAHABU MOHAMMA	YOUTH Leader	BuloRI	08065150267		
10	MOHAMMAD MUSA	FARMERS Grou	BuloRI	07032599218		
11	ISA SAEHU	FARMER LEADER	BuloRI	—		
12	ISAH MALLAM	KATANGAR	LAFIYA	07036814387		
(13)	Adamu BELLO	KAWAYE		07036144474		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

SCOPING WORKSHOP

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Tuesday, 8th September, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	YAU ADAMU	DIRECTOR H&H	M. O. W. Res.	08039432845	yaudamu@gmail.com	
2	Balarabe Muhammad	Chairman N.A.T.A.	Nigeria Automobile Tech Associat	08034679755	balarabeMuh@gmail.com	
3	Tijjani Tasiu	Chairman N.A.T.A Dutse	"	08069546007		
4	Namadi Sunusi		A.B.U, Biological Sci.	08038476394	hubbidaha@gmail	
5	DR-GADZAMA, I.M.K.	Biodiversity group (ZOOLOGIST)	A.B.U. ZARIA	08069720914	ibsmadu@yahoo.com	
6.	Dr Wisdom S. Japhet	Biodiversity Study Group, Botanist	A.B.U Zaria	07056427972	wisdomjaphet@ Yahoo.com	
7	UMAR SHEHU G.	BIO-DIVERSITY GROUP. A-BU	A-BU ZARIA	08026877650		
8	Sale Umar	Chairman	Killafiya Devlop	08036920278		
9	Mohd. Lawal/Gou	Farmer Leader	✓			
10	MUSA ABUBAKAR			07035564115		
11	AUWALU ABUBAKAR			08069785160		
12	HAMUZA YUSIFA					
13.	YAU ABDULLAHI		M. Ungwar Rahon	0813459460 92		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

SCOPING WORKSHOP

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. Date: Tuesday, 8th September, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Mohammed J. S	AD	FMEnv Abuja	08062547380	mohammed jiya49@yahoo.com	
2	Alh. Aliyu Hadejia	AD	Ministry of ENV, Dutse	08065028349	—	
3	Haladu Balamy	DDF	AHUU Dutse	07039816317	—	
4	Engr Mustapha Hassan	S.M Elect	PHCN TCN Dutse	08033850430	musfating@gmail	
5	Engr. Shittu Fonko	TX Dutse SM (P&M)	TCN Dut.	08065750235	shittumlonko@gmail.com	
6	Philip Mechu	AM (FXA)	✓ ✓	08023740791	—	—
7	Jamilah Farouk	Director	Invest Jigawa	08167574342	jfarouk@...	
8	Ali Garba	—		08067736162		
9	IBRAHIM SABO	—	Dutse		—	
10	NASIRU I. BABURA	S/O	BABURA	08063345067		
11	MOHAMMED MUSA	DRIVER	FAGOJI QUARTERS	08186437875		
12	BINTA MUSA	HAUSE WIFE	FAGOJI Quarters	09097307456		
13	SHEHU ALI	"	FAGOJI	08149526093		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

SCOPING WORKSHOP

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. Date: Tuesday, 8th September, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Hon. Sanusi Abdul'Aziz	CHAIRMAN LGC	LG CHAIRMAN	08067136709		
2	BABANGIDA MUSA	Hod [Pers Dept.	DUTSE L.G.	08081514932		
3	Ayuba Ahmed Maje	HOD Works	DUTSE L-G	08036612646		
4	Adamu Musa		Dutse Local Govt	08066044941		
5	MOHD SHEHU	REGISTRAR	Dutse	080-31514313		
6	Alhassan Musa	Chairman	Nagarta S.H.G	08109989297		
7	Aliyu Dayyabu	Member	K/Lafiya SHG	07032716427		
8	Abdulsalam D. Dakata	AM S/L	TCN D/work Garden	08030810152		
9	USMAN S. IDRIS	Manager (Elect)	TCN Dutse works	07038232314		
10	GARBA HASSAN	FAGOJI	FAGOJI Youth Group	08069580795		
11	Bashir Moha	Zai	Zai Youth Group	08064637102		
12	HALADU ALASSAN	KARGO	KARGO	08036267530		
13	RABI'U SALEHU	KAWAYE	KAWAYE S.H.G.	08069011777		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

SCOPING WORKSHOP

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Tuesday, 8th September, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1						
2.	MOHD SALISU MOH'D	DEF	JISEPA	07065675197		Salisu
3	YAHAYA BUBA	CHAIRMAN BULORI ASS.	BULORI	07033541260		Buba
4.	DAHIRU MOHD	SHUGABAN MA				
5	ENGR. YAHAYA A. I	ASS- DIRECTOR	JSWB	08065659016	engyahaya@gmail	[illegible]
6	ENGR M.L YANKUZO	PM, TCN, DUTSE WORKS CENTRE	DUTSE WORKS CENTRE	08065415822	engyankuzo@g-mail.com	[illegible]
7	Abubakar Abdulla.	✓	✓	07065692631		[illegible]
8	A. M. Abubakar	✓	✓	07039646478	babanihsan01@gmail	[illegible]
9	Yusuf Mohd Illallah	M&E OFFICER	STOWA	08035730539	Yillallah@ymail...	Yusuf Illallah
10	Alhasan Bello	—	M/ sharifai	08068146933		[illegible]
11	ISA - ISMAILA		DUTSE			
12	Ahmad S. Muazu	Computer O.	STATE LIBRARY	08035179164	asmazz@gmail	[illegible]
	IDRIS Adamu		A/ Sefa	07035884028		[illegible]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

SCOPING WORKSHOP

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Tuesday, 8th September, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
14.	BELLO AHMED SA'AN	VILLAGE HEAD	KAWAYE	07036144474		[illegible]
15	SHEHU YAHAYA	FARMER LEADER	KAWAYE	07067944682		Shehu
16.	ALASAN YAKUBU	YOUTH LEADER	KAWAYE			A/ASAN
17	Nafisa Yakubu	M-SC	Dutse	08038299578		[illegible]
18	SAHURATU HASSAN	NYSC	Dutse	07063431804		[illegible]
19	GARBA DATIJO	Teacher	Dutse	07034928942		[illegible]
20	Hamid S Nuhu	W/ H/DUTSE	DUTSE	08069991043		[illegible]
21	Danlami Farngmun Datul	Admin Officer	GEHS Abuja	07035995671	farngmundatul@gmail.com	[illegible]
22	Dr Lola Okuwosa	Head	GEHS, Abuja	08066823007	lokuwosa@yahoo.com	[illegible]
23	Seunayo Adebayo	Environmental Scientist	GEHS, Abuja	08173711313	seunadebayo2@gmail.com	[illegible]

APPENDIX 4.6

MINUTES OF THE SCOPING WORKSHOP FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT NEAR DUTSE, JIGAWA STATE HELD AT CONFERENCE HALL, DUTSE STATE LIBRARY, ADAMU MAJE ROAD, DUTSE, JIGAWA STATE ON TUESDAY, 8TH SEPTEMBER, 2015

Participation	Representatives from the under-listed affected communities as well as Federal and State Ministries, Departments and Agencies (MDA) attended the meeting: • Katangar Lafia village • Bakin Jeji village • Kawaye village • Bulori village • Rahama village • Auto Mechanic Village • The Emirate Council (Dutse Emirate) • Federal Ministry of Environment • Transmission Company of Nigeria • Jigawa State Ministry of Environment • Jigawa State Environmental Protection Agency • Dutse Local Government Authority • Invest Jigawa Detailed attendance list is provided in Appendix 4.5.
Apologies	• International Centre for Energy, Environment and Development (ICEED)
Absentees	• Federal Ministry of Power • Nigerian Electricity Regulatory Commission • Nigerian Bulk Electricity Trading Plc • Jigawa State Ministry of Lands, Housing, Urban development and Regional Planning

INTRODUCTION, REMARKS AND PRESENTATIONS

Introduction	The meeting started at about 12.45pm with an opening prayer from one of the participants. This was followed by the introduction of all invited participants from the respective affected communities, Federal and Jigawa State MDAs, NGOs and other stakeholders.
Opening Remark by NSPDL	Mr. Nasiru Isyaku, a Director from NSPDL, welcomed all stakeholders on behalf of the Company. He provided the background to the proposed project and briefly introduced the project and its benefits to all stakeholders.
Remark by ESIA Consultant	The ESIA Lead Consultant, Dr. Lola Okwuosa in her own remark highlighted that the ESIA is commissioned in compliance with the Environmental Impact Assessment (EIA) Act No 86 of 1992. Dr. Okwuosa explained that the objective of the ESIA is to ensure that the project is carried along in a sustainable manner without harm to the environment and the people. She further emphasized the importance of engagement with all stakeholders especially affected communities and others with interest in the project.
Remark by the Representative of FMEnv	Mr. J.S. Mohammed, representing the FMEnv stressed the importance of the meeting as part of the ESIA process where all stakeholders particularly affected communities come together to express their views and concerns about the project. He encouraged stakeholders not to be silent on their concerns and urged them to give their support to the project due to its immense benefits to the region and the nation at large.
Remark by the	The Principal Manager Transmission (Dutse Work Centre) welcomed NSPDL to Jigawa State and

Representatives of the Transmission Company of Nigeria (TCN)	expressed optimism that the project will improve electricity generation and supply in Jigawa State and the nation at large. He requested to know when the proposed project will be implemented
Remark by representative of InvestJigawa	Mrs. Jemilah Farouk, (Director, Advocacy and Strategy at InvestJigawa) introduced InvestJigawa as an agency of Jigawa State government concerned with the promotion of investment in the state. On behalf of the agency, she welcomed NSPDL as an investor to the state and urged all stakeholders to support the project aimed at generating electricity for Jigawa State.
Remark by representative of Dutse LGA	The Chairman, Dutse LGA, represented by Mr. Nusa Babangida (HOD, Water and Sanitation) welcomed all stakeholders to the meeting and prayed the proposed project will bring development to the people of the LGA.
Presentation on Project Overview by NSPDL	Mr. Amit Modi (Managing Director, Technical, NSPDL) gave a presentation with the aid of MS Office Power Point. He introduced NSPDL as an energy developer who has developed solar project throughout Africa including Uganda and South Africa. Mr Amit further gave a technical overview of the proposed project, the proposed location and planned project implementation activities and schedule. He stressed on the effort of the company so far at obtaining necessary permits and seeking collaborations with the government of Jigawa. The MD highlighted the numerous benefits of the projects including generation of renewable electricity and job creation amongst others. He solicited for the support of all stakeholders especially the affected communities and urged them to express their views and concerns so as to help NSPDL initiate a specific Corporate Social Responsibility (CSR) programme that will meet the their needs. In his closing remarks, Mr. Modi introduced NSPDL and the ESIA team to stakeholders.
Presentation on Environmental and Social Safeguard Issues by ESIA Consultant	Following presentation on the proposed project, the ESIA lead consultant, Dr. Lola Okwuosa briefly described some of the envisaged project activities such as preconstruction and construction activities and highlighted some of the potential impacts that may be associated with these activities such as noise and dust generation. She emphasized the role of the ESIA in establishing measures to mitigate these impacts on the environment and the people. She urged the stakeholders to freely express their concerns on how they feel the project will impact on their health and the environment at large. Dr. Okwuosa encouraged all stakeholders to participate actively in the Question and Answer sessions as this will provide first hand information to the ESIA team on areas to focus on later on in the ESIA process.

HIGHLIGHTS OF QUESTIONS, CONCERNS FROM STAKEHOLDERS AND RESPONSES

S/N	Questions and Concerns	Responses
1	Mr. Garba from Bulori Community who is also a farm owner in the project location asked what will happen to their land when the project is decommissioned after its full life span. He also asked what will be the benefit of affected communities during and after construction.	MD, NSPDL responded by saying the project is not likely to be removed after 25 years but old panels may be replaced with new ones and the project will continue to generate renewable electricity as far as the government is desirous with the sustainability of the project. The MD further stated that the major benefits of the project will be job creation for the affected communities. He stressed that hundreds of jobs will be created during construction. He remarked that people will be trained to operate and maintain the plant after construction.
2.	Mr. Idris from TCN, Dutse asked how will the panels generate electricity during the winter months when there is limited amount of sunshine	MD, NSPDL responded that the panels only needs a little bit of sunlight to generate electricity. He stressed that the system works perfectly in countries where there is little sunlight such as Germany and Canada
3.	Mr. Yahaya Buba from Bulori expressed fears and concerns about their lands to be taken over by the project. He asked about compensation and benefits of the project to their community as they will no longer	Mr. Oliver Nwuju, Socioeconomic Expert with the ESIA team responded by assuring the concerned stakeholders that NSPDL will pay compensation and will follow a transparent process and best practice in addressing the

	have enough lands to farm.	issue of land compensation.
4	Balarabe Mohammed, Chairman, Nigerian Automobile Technician Association asked if the Auto Mechanic Village allocated to the auto-mechanic service operators by Jigawa State Government will be affected by the project.	He further assured the representatives from the mechanic village that there will be a visit by the socioeconomic team to their village to establish whether or not their land will be affected. He added that if it is confirmed that their land is within the 15 meter radius of the transmission right of way, NSPDL will liaise with the state government to ensure that they are resettled before displacement. He concluded that NSPDL will liaise with the state government through the Ministry of Land and InvestJigawa to ensure appropriate measures are taken regarding land take and compensation.
5	Mr. J.S Mohammed from the FMEnv expressed concerns about the issue of compensation and urged the affected communities to point out other issues relating to land such as sites of important cultural properties, burial grounds etc. This point was further emphasized by Alhaji Aliyu representing Jigawa State Ministry of Environment. He urged the affected communities to let the proponent know of these important cultural sites, if any is present on the proposed site.	
6.	Mr. Umar from Katangar Lafiya asked NSPDL to provide more clarity on how the land owners will be compensated.	Mr. Oliver Nwuju responded on behalf of NSPDL that the process of land take and compensation will be transparent. He further stressed that all land owners will be identified and compensation will be paid directly to them with the assistance of the Ministry of Land. He also stated that alternative options including land for land will be provided for those who may not want money for their land. He emphasized the process will be transparent.
7	Regarding the issue of land take and compensation, Mrs. Jemilah Farouk, (Director, Advocacy and Strategy at InvestJigawa) assured the landowners that her agency will be fully involved in the process to ensure that the rights of the people are protected. She mentioned that InvestJigawa is planning to organize a meeting that will involve the Ministry of Lands, Village Heads of all affected communities and other stakeholders. She stressed that the meeting will be in the interest of farm owners and affected communities to ensure no one is cheated in the process of land take and compensation.	

Remark by the representative of the Emir of Dutse	The Emir of Dutse, Alhaji Nuhu Sanusi, represented by his son (Daniya Hamim) stressed that the people should be calm as the process of land take and compensation will be transparent. He told the people that the Emir is aware of the issues and all he wants from the proponent is to adequately compensate his people. He stressed that NSPDL has assured him that the compensation will be in compliance with the laws of Nigeria and applicable international guidelines and standards. He urged NSPDL to ensure land owners and affected communities are happy with the process so that they will in turn protect the project as stakeholders. He rounded up by urging the members of the host communities to cooperate with NSPDL as the company has made promises to provide employment and improve infrastructure.
Closing remarks	The meeting ended at about 3.40pm with a short remark from Mr. Nasiru (NSPDL) urging members of affected communities to receive and support the ESIA team in their respective communities when the team visits for socioeconomic survey. He stressed that the survey is another key component of the ESIA study and the continuation of the stakeholders' engagement programme for the proposed project. The meeting was concluded with closing prayers.

APPENDIX 4.7

PROCEEDINGS OF FOCUS GROUP DISCUSSIONS AND INDEPTH INTERVIEWS HELD IN AFFECTED COMMUNITIES

INDEPTH INTERVIEW/FOCAL GROUP DISCUSSION AT BAKIN-JEJI VILLAGE

Date: 09/09/2015.

Name of Village Head Rep.: Hamza Yusuf

The Village Head: The history of this village Bakin-Jeji can be traced far back. It is a community where the young are known to respect the elderly. We grew up ensuring that right things our culture promotes are met. This is the kind of attitude our parents translated down to our own generation and we are doing the same to the next generation. We are well known for our peaceful co-existence as a people.

Moderator (Moderator; Emir's daughter): I have some questions I will want to ask you. You have just given us a brief history of your community. How would you describe the chain of command in this community?

The Village Head: Well, the Village Head stands as the mouth piece of the people. He settles all disputes within the community.

Moderator: What are the kinds of trade practice within your community?

The Village Head: We have carpenters, we have children who are engaged in welding works, and we have those engaged in butchering of animals at the local abattoir. We also have farmers within Bakin-Jeji. We have those engaged in buying and selling farm produce like groundnut, beans, groundnut oil.

Moderator: Do you have a major concern within this community?

The Village Head: We thank God, for now, we do not have any major concern. We have been living very peacefully as a people.

Moderator: How will you describe the role of men within your community?

Village Head: The man is the head of the home. He provides the needs of his family. He makes laws within his household. Who trains the child? The role of both parents, we send our children to school and pay their school fee.

Moderator: What are the roles of women within their household?

The Village Head: Well, it all depends on the situation. This is because the wife is under the control of her husband. Her major role is to ensure that she takes care of her husband and also the children.

Moderator: Aside from taking care of the house, what other things do your women do?

Village Head: Oh yes. They engage in trade. They are into the sale of groundnut oil, fire wood, snacks etc. They do all of this to support their husbands.

Moderator: Do you have some husbands who do not allow their wives go into petty trade?

Village Head: I will say no to that. I have never encountered that. Our culture does not stop women from engaging in trade.

Moderator: How is farmland disputes settled within the community?

The Village Head: The Village Head serves as the leader of the community. He calls on both parties and resolves such issues. In a situation where the dispute cannot be resolved, the dispute is transferred to the community leader, then to the district head and to the Emir. If the Emir is not able to resolve the conflict, the matter will be forwarded to the police or the court.

Moderator: What are the major concerns within the community?

Village Head: The main concern in this village includes lack of good access roads into the community, hospital, school and good drinking water. We only have a primary school in which the standard is very poor. We don't even have desk for our children to sit on. We also have Arabic schools. They are two in number. The knowledge of the holy Quran is passed to our children at the tender age. We don't have secondary school. We don't even have a medical store nor a chemist, we have to travel some distance in the town of Dutse to get drugs.

Moderator: How would you describe your nature of water?

The Village Head: We have a borehole that serves the whole community. They are three in number but we only have two operating now. The other one is spoilt.

Moderator: What are the facilities here?

The Village Head: We have the MTN and Glo networks. We don't have NEPA light.

Moderator: How do you dispose human waste?

Village Head: We have pit latrine even though some of our children prefer the nearby bush. Our refuse are gathered outside. During the rainy season like this, the rain water comes and washes it away. The remaining ones, we burn them.

Moderator: What are the types of ill health that are prevalent to the people of this community?

The Village Head: Many houses experience cholera, malaria, typhoid. Malaria is always on the increase.

Moderator: How do you advise the government or do you have any concern about the solar project coming soon?

The Village Head: We want government to help us find a land to serve as our burial ground. We want good roads, schools and hospitals. We want government to bring things that will enhance our life.

Consultant: Who settles disputes?

Community Member: The ward head, then to the Village Head, to the district head.

Consultant: Who is the district head?

Community Member: The district head is called Hakimi under Dutse district head under the Emir. So the arrangement is, the head in Dutse is Emir, followed by the Hakimi, followed by Bade Kode, followed by Village Head, ward head and the households, the father then mother.

Consultant: In this village, do you have a land owned by the community or is it individuals that own their lands?

Community Member: It is owned by individuals. It is by inheritance.

Consultant: If the Hakimi dies today, who becomes the Hakimi?

Community Member: His son automatically becomes the Hakimi. If his son is not of age, they can pass it to the extended family.

Consultant: At what age?

Community Member: Now, it depends, if the person has western education and Islam education, and also based on your behavior. The specific age can be 18 years and above.

Consultant: Do women in this place inherit property?

Community Member: Yes, some women inherited land from their parents.

Consultant: You said everyone has land. Does everyone have enough land to farm?

Community Member: Like one, if I farm I will have the food I can eat for a year. If I plant now and harvest, I will wait for another rainy season again next year.

Consultant: How long do your rainy season last?

Community Member: It reaches up to about 5months-7months.

Consultant: Do you do dry season cropping?

Community Member: No only on-season, but we sometimes do irrigation farming.
Consultant: I heard that you grow Guinea corn, beans, millet, groundnut, which crops are common for everybody?

Community Member: The common ones are all the things you have mentioned. We also have the sesame seed, it's called "Ridi" in Hausa. The common are maize, millet, Guinea corn, groundnut and Beans.
Thank you.

FOCAL GROUP DISCUSSION AT KATANGAR-LAFIA VILLAGE

Date: 09/09/2015.

Consultant: We welcome and thank you all for your patience; we are all gathered to discuss your concern about the forthcoming solar project. This study is required by the government at the centre. There are two kinds of study that are important, that will have to take place before the commencement of the project. We want to hear from you first if you want the project. We need the answer to take it back to them.

Community Members: We all want the project. We are all happy with the development.

Consultant: Now that you said that you want the project, there are two studies we want to do. Impact assessment is needed because, we want to know how the project will affect your environment, your water, soil, and the health of your environment. How it will affect your crops, farm and animals. If we know that the project will affect the things I have mentioned, we will look for a way together with you on how we can stop those impacts or mitigate them.

Community Members: Ok, we are happy then.

Consultant: The way the project works now is not like before. This time, project within the community, community works with the project developers. So part of the things we will be asking you would be, we want to know if you have surface water. If you have underground water, where do you take your water from? If you have hospital e.t.c. If you don't have we shall look for a way in our report together with you to do the things that will improve your life. At the end of the day, this project is going to contribute positively to you and to your children without leaving you with adverse impacts. This project will create employment, it will create income, you will have enhanced electricity and your total wellbeing. That is why we are doing this study on the environment, in order to do this, we have some questions we will be asking families and households. With your help and assistance, we will love to have the exact concerns.
The next study, I said there are two. The other that will come later is the study on how to compensate or re-settle those that have land and economic trees. So that one too, either us or another team will come and visit you soon. We are also seeking your cooperation with the team when we come back. Why do we want to do that study? We want to ensure that international best practices are carried out in compensating for your land or whatever thing that was affected. So that this project does not cheat you in anyway and what belongs to another land owner is not given to another person. Everything will be done transparently. This will be the first time in Dutse and you will know that we are sincere. So for the Village Head, there are some questions we will be asking you. We have gone to your sister village, Bakin-Jeji. Is there any relationship between Bakin-Jeji and Katangar-Lafia?

Village Head: Oh yes.

Consultant: What is that relationship?

Village Head: All the things we do as a community, we do it together. Things like inter-marriages and we do our cultural things the same as well.

Consultant: Is there a market here?

Village Head: No, we don't have, even the people in Bakin-Jeji.

Consultant: So where do you go to, to sell your produces?

Village Head: We go to Shuwari in Dutse.

Consultant: How far is Shuwari from here?

Village Head: It's about 20km
Consultant: How do they go to Shuwari?

Village Head: We use a car, or a cow cart or our motor cycle.

Consultant: So if they leave at 8:00am, when will they reach on a cow cart?

Village Head: He will get there around 11:00am or 12noon.

Consultant: You said you always use cars? What type of cars do you use?

Village Head: We use pick-up vans and trucks.

Consultant: How much do you pay?

Village Head: We pay #70 naira per head.

Consultant: By cow cart, how much?

Village Head: We pay #150

Consultant: Can you tell us a little history of this village?

Village Head: Yes. Well, I have my father here, he will tell us, that's not me.

Inuwa Umaru: My name is Inuwa Umaru, I am the brother to the Village Head. I am 64 years. All these people you see around are members of this community; we do not have any form of discrimination. We are all one. We live in peace, everyone respecting the other. We are our brother's keeper. We were at the old village community "SohunGari" before we relocated to this place. The rains and flood chased us out of that side, before we relocated to this place. We have spent about 52years so far in this present community after relocation.

Field Staff: Who settles dispute among the Community Members?

The Village Head: They always come to me in such times.

Field Staff: Whenever such matters are not resolved within your power, what happens?

The Village Head: We always forward it to the community head, then to the District head, and to the Emir in Dutse.

Consultant: Do you have visitors living within this community?

Village Head: We have.

Consultant: I mean settlers, where do they always come from?

The Village Head: We have people from Wuluma who are living among us.

Moderator: What are the major occupations of your people?

Village Head: Farming that is the only occupation here. We have small children going to school. We also engage in rearing animals.

Consultant: Where is the youth leader here?

Village Head: Where is Buhari- Buhari he is the youth leader.

Moderator: What are the roles your women play?

Village Head: Most of them are tailors, they engage in petty trade, like sale of groundnut oil, bean cake, pap, masa, pan-cakes, moi-moi.

Moderator: What are your major concerns?

Village Head: we don't have good drinking water, any good roads, hospitals and health care facility. We are farmers. Farming has been our major occupation. Now we don't have enough farmland because government wants to take our land. We only have two wells within the community. It is not enough.

Field Staff: When a woman is due or in labor, what do you do?

Village Head: We look for a vehicle or any fastest means of transportation to carry her to Dutse general hospital.

Field Staff: So what are the facilities within your community?

Village Head: We only have a primary school. It is just about 5minutes walk from here. We don't have a secondary school.

Moderator: What about adult Islamic school?

Village Head: Oh yes, we have. We also have the telecommunication networks within our community.

Field Staff: How do you dispose your waste? Both human and material waste?
We have pit latrines. For the refuse, all we do is to burn them up. Thank God for the rainy season. The rain washes the refuse dump anytime it rains.

Village Head: One of our major concerns is the drainage control system. We need a culvert to control movement on runoff water. We also need a police station around just like other cities and towns.

FOCAL GROUP DISCUSSION WITH SELF-HELP GROUP KATANGAR-LAFIA (YOUTH GROUP) AT KATANGAR-LAFIA VILLAGE

Date: 09/09/2015.

Consultant: So what are your objectives as a Self-Help Group?

Community Member: Our plans and objective is to assist our members. If there is anybody within our social group who cannot do anything on his farm or house, like now, if there is a heavy rainfall and it destroys his house, or farmland, we contribute money to individuals that are in critical need.

Consultant: So how many people are in this self-help group?

Community Member: I can't say the number now, I don't have the register with me now.

Consultant: Do you people meet daily or weekly?

Community Member: We usually meet end of the month.

Consultant: What is your position there? What are the structures?

Community Member: I am the chairman; we have a secretary, a treasurer and others.

Consultant: The common interest is to help people in critical needs. Now for this self-help group, with respect to this solar project do you have any interest?

Community Member: Yes, oh yes. Our people are there without job. When they start this project, we want them to give our people job. Apart from that, we have scarcity of water here in this our village. We don't have water, we don't have clinic. We want the project to give us water/clinic.

Consultant: Do you have fear over this project?

Community Member: We don't have any fear.

Consultant: No concern.

Community Member: Well, our concern is the way our compensation will be, that's our concern.

Consultant: Any other thing?

Community Member: If we get a chance or an opportunity from the contractor or project makers, we can participate through direct labour or through contract like supply of materials, security etc.

Consultant: In what way do you think the proposed project will benefit the community? Do you think the electricity will help the community either positively or negatively?

Community Member: Well, we don't know the project, we have not seen it. We don't know whether the project will come with smoke or wind blowing dust very much.

Consultant: Do you people have electricity here?

Community Member: No, when we have electricity, it will improve our health. We only have solar borehole that supply water.

Consultant: What do you think will be the benefit of this project to the community?

Community Member: The benefit, I told you earlier, job creation for our youths.

Consultant: What do you think should be done to reduce the impact of that dust during the project to mitigate it?

Community Member: The project makers should do the necessary things.

Consultant: What are the health needs of this community?

Community Member: We don't have health centers, these are the things we need.

Consultant: Where do your women go to when they want to give birth?

Community Member: To the hospital at Dutse.

Consultant: Your number sir?

Community Member: 09092205055

Consultant: Your name sir?

Community Member: Saleh Umar.

FOCAL GROUP DISCUSSION AT RAHAMA VILLAGE

Date: 12/09/2015

Moderator: We are here to listen to your concerns about the solar project and also to know how the project can affect your community. They are going to be asking questions, such questions will include the types of health facilities you have, social amenities etc. After all of this, they will go back to the government/the project makers to channel your concerns. They will also ask you questions about the modes of compensation, either payment of the money equivalent or land swap. The major question here is, as a community, do you really want this project?

Community Member: Of course, we are happy, we want the project very close to us. It is unfortunate that we are located very close to the state capital in Jigawa state but yet we don't have any reasonable thing that shows development. In the areas of education, healthcare, access roads, even pipe borne water within the whole community, we only have a hand pumping borehole. When it gets spoilt, the cost of repairing it is always very difficult.

We see these as development not only to Jigawa state but to the nation at large. We believe this project will bring about jobs, it will keep our youths engaged. My name is Alhassan Musa, I am the chairman Self-help group Rahama village. Our major concern so far has always been on the need for compensation on our farmlands. What are the methods the government will want to use? Farming has been our major occupation and also the rearing of animals.

Moderator: Please we will love the Village Head to give us a small background of this village Rahama.

Village Head: My name is Rau Abdullahi, I am the Village Head of Rahama. Our parents gave birth to us here. We grew up living in harmony. The peaceful nature of our villages gave birth to the name Rahama. We are happy about the solar project; this is a project that will bring about development to our people. We are happy about any project that will bring about development to our people. Our prayer is that may this project bring about the desired development.

Field Staff: Do you have any relationship between Bakin-Jeji and Katangar-Lafia?
Village Head: Just like Katangar-Lafia, they are our close neighbours, they are our brothers and we have the same heritage. We always engage in inter-marriages among us. This is also the same with Bakin-Jeji, Bolori and also kawaye.

Moderator: Were you relocated from a place before the formation of this village Rahama?

Village Head: Oh yes. Some of us can trace the history to the movement from Hamayayi, some from Katangar-Lafia and from different places. This is how the name Rahama came into play.

Moderator: These people have come over to you as the Village Head to please ensure the cooperation of your people as they ask questions that relate to the concern of your people. They are going to have interactive session with the youth group, farmland owners and also the people around the community. We want the people to speak out their concerns.

Village Head: As a community, we have individuals in charge of different aspects and occupation. We have for example, the leader for all farms here. Mr. Saleh, please come over.

Moderator: Which of these villages will you say in your own thinking is the largest among Kawaye, Bolori, Katangar-Lafia, Bakin-Jeji and Rahama which is the largest in form of population.

Mallam Saleh: Bakin-Jeji is the biggest in terms of population followed by Katangar-Lafia, followed by Kawaye, Rahama, Bolori then lastly Sharifai.

Moderator: How many cows do you have within the community?

Mallam Saleh: Almost every household you go to in this community has cattles.

Consultant: Are there incidents between cattle rearers and farm owners?

Mallam Saleh: Oh yes. If farmers cultivate their farmland and plant their desired crops, the cattle rearers sometimes allow their cattles to invade the plants and crops planted. These are sometimes deliberate.

Consultant: Why will he say that when every household owns a cattle?

Mallam Saleh: You are right. We have two types of cattle. Take for example this type, almost every household has two cows. We also have the types that are reared by the Fulani herdsmen who always move from somewhere. They are the people that bring about problem among us.

Consultant: So how do you settle such dispute?

Mallam Saleh: The problem we have here is that Fulani herdsmen lack proper grazing field for their animals that is why we always have such problems.

Consultant: So how do you feed your own cattles?

Mallam Saleh: We always go to the bush and get the needed grass for our animals at home.

Consultant: What are your concerns as regards the solar project?

Mallam Saleh: What we have as our major concern is that we want government to give the farm owners their compensation. The second appeal is that when this job is fully operational, we want our people to be engaged as well. The third concern is that we don't have hospitals and healthcare centers, we don't have schools, we don't have enough drinking water, we don't have burial grounds, we don't have good roads.

Consultant: Please let the people know that all what he has mentioned are not the responsibilities of the project. Their major concern is to provide solar power, but this project will inturn attract investors.

Mallam Saleh: If the project proponent will play its part as expected especially during the compensation, our people don't want any form of land swap. What they want is the compensation package.

Consultant: How much will you love to be paid?

Mallam Saleh: Well, I cannot come out now to really say this is how much I want. I don't know how landed properties are sold, I am not a land dealer. The people who are in charge should do the needful.

Consultant: Based on what he has said, is he assuring us that whatever estimate we get from the ministry of land he will accept because it's an official estimation?

Mallam Saleh: This is a project that concerns everyone who has a land. If they will do everything with the fear of God, I will accept.

Ali Magaji: I am also a farmer. The estimation of our lands have been done already, we are in support of that but we don't want you to involve the people working within the ministry of lands and housing, including our chief as regard the payment of compensation. We don't want that, what we want is, the company that was involved in the land estimation should be the one in charge of the compensation and should be done with all transparency and the fear of God. The ministry of land and the chiefs were involved during the compensation for the university. Many people were not happy at the end. This is what we want; the company should deal with us directly.

Consultant: Are you a land owner?

Ali Magaji: Yes I have about three (3) over there.

Consultant: I want to assure you that everything will be done with all transparency. Thank you for your time.

FOCAL GROUP AT KAWAYE VILLAGE.

Date: 13/09/2015.

Field Staff: Warm greetings to you all. We are happy to meet you all. Can you tell us your name and your position?

Bello Ahmed: I am the Village Head of Kawaye.

Field Staff: Can you give us a brief history of this village?

Bello Ahmed: Yes, this village has been in existence as old as mankind.Even the main town within Dutse, is not as old as this village. It was never formed as a result of migration. It is a town that has been in existence since. We have things that can really show that this town is an old town.

Field Staff: How long have you been staying in this village?

Bello Ahmed: I was born in this village and I have spent all my life in this village.

Field Staff: How would you rate the relationship between Kawaye and the neigbouring communities?

Bello Ahmed: We have been living in peace with one another. There has never been any form of conflict among us. If you go round, you will find out that our people engage in inter- marriages among them. So we are all one big family. We all know that without peace among ourselves, no parent will allow his son or daughter to marry such.

Field Staff: How are farmland conflicts resolved within the village?

Bello Ahmed: What we do first of all, is to know the history of such a land. Who was the first person to inherit the piece of land? It is the responsibility of the Village Head to bring the worried parties together, to find a solution. We call on witnesses among us, trace the history of the piece of land then we can find the true owner.

Field Staff: So what do you do in situations where such matters are not resolved?

Bello Ahmed: I move such matters to the person ahead of me. That is the community head, Emir. If all of these processes are carried out and there is no reconciliation, such a matter is then taken to the court.

Field Staff: Can you please tell us the nature of the occupation of your people.

Bello Ahmed: Our major occupation here is farming. We are farmers. We plant guinea corn, maize, beans and millet.

Field Staff: What about the women? What is their occupation?
Bello Ahmed: Most of them aside from farming, they also engage in petty trade. They sell pan cakes, groundnut oil, etc.

Field Staff: What are your concerns about the proposed solar project?

Bello Ahmed: The first thing here is, within this village, we don't have adequate water, school, and hospital. Aside, we are farmers; government has come over to measure our piece of land, and also tell us about this solar project. You see all these things that I have mentioned, if government will help us by providing the needed things and also an adequate compensation plan which can also help some of us to move to other places and acquire land. Some can also startup businesses as well to help better our livelihood.

Field Staff: You just mentioned, using part of the money for compensation to obtain land elsewhere for business. Would you prefer an exchange of land for land?

Bello Ahmed: No, no way.

Field Staff: What do you want?

Bello Ahmed: What we want is, government should buy our properties and give us our money.

Field Staff: Where do you go for medical care?

Bello Ahmed: We always go to the general hospital in Dutse. The distance to the hospital is always very far.
Field Staff: Do you have any other concern that you have not mentioned?

Bello Ahmed: You have asked me and I have answered you. The major concern is the method to be used for compensation. Please we want the government and the project proponent to help us. Our youths have no job, just like they promise us. We hope they will do all of that.

Field Staff: Do you have a police out post within this community?

Bello Ahmed: No, we do not have. We are also appealing to government to bring such development to us.

Fears and concerns of the people of Kawaye

Shehu Mohammed: We are living in fear. When is this project starting? Is it going to affect our crops on the farm? Is it now or later, after we have harvested our crops?

Consultant: You will be allowed to harvest your crops. I think between now and February, 2016 by God's grace.
Is there anyone with another question?

Nasiru Garba: after this project is completed, would the current or the general electricity be of harm to our lives and family health wise?

Consultant: No, electricity does not affect your health except, may be when you are talking about electric shock. But then, remember this is solar panel, so it is safe.

One of the reasons for the study is to make sure that everything that has to do with safety of the people within the community from this project is well taken care of.

Consultant: I want to know from this community the population of this place.

Community Member: We don't know the exact number

Consultant: Do you have strangers living within this village, Kawaye?

Community Member: No we don't have strangers around ma.

Consultant: Do you have lands that are in dispute among Community Members case at the Village Heads office or anywhere?

Community Member: No, we don't have such.

Consultant: Do you really know each land owner around the project site and the demarcation?

Community Members: Oh yes, we all know that.
Consultant: Do you have primary school in this place?

Community Members: No, we don't have. Our children attend school at Modubi. It's a village very far from here.

Consultant: Do you have a hospital or clinic here?

Community Members: No, we don't have any hospital except for the General Hospital in Dutse.

Consultant: I saw that you have a pump/ tap here. Who brought that development to you?

Community Members: It has spoilt. It is not working.

Consultant: So where do you get drinking water from?

Community Members: We have to dig out well by our self.

Consultant: How many people suffer from typhoid?

Community Members: They are many; we don't have the exact number.

Consultant: What about malaria?

Community Members: Malaria is paramount.

Consultant: I thank you all for your time. This project when it comes will attract other projects. Once there is light here, other people will come to do things here which will help to develop the village. I am asking you to do everything possible to make sure that this land issue does not make the project to slip away.

Community Member: We are always praying that this project becomes successful and real.

Consultant: I want to assure you all that there will be transparency and adequate payment of your compensation as expected.

Community Member: We wish you well as you carry out your assignments.

FOCAL GROUP DISCUSSION WITH HUNTERS AND FARMERS AT BOLORI VILLAGE

Date: 10/09/2015.

Consultant: Can you please tell us the types of animals you find around the project site?

Sule Bolori: Rabbits, bush fowl, are some of the animals we hunt within our community.

Consultant: Has there been any changes? What I mean is that in the last 10years, in terms of this animal you use to catch, do you still catch them like before?

Sule Bolori: We don't have them in much quantity like before.

Consultant: Do you make a living out of hunting or it's just for subsistence?

Sule Bolori: It is just on a subsistence level. Just to put some food on the table.

Consultant: So what do you do to generate income?

Sule Bolori: What I do is farming.

Consultant: With the communities surrounding you like Kawaye, Rahama, Katangar-Lafia, Bakin-Jeji, Bolori. Along the transmission line is Sharifai and the mechanic village. Do you know these villages well?

Community Members: Yes we do.

Consultant: I want you to really help me. We want to take a sincere estimate of the population. Help us out, among all these villages, which one is the biggest in population?

Community Member: First of all, Katangar-Lafia, followed by Bakin-Jeji, then Bolori, then Kawaye before Rahama last.

Consultant: Can you tell us a brief history of this community?
Isah Bolori: This village was coined under the community called 'Kargo'. Our history has been such that, everything we do, for example, during elections, or doing anything that involves our culture, Bolori, Kawaye, Sabon Gari, Masa, everything we do, we do it together. Here at Bolori, we all live in peace with one another. What I am saying is that Bolori and Kawaye emerged from the village called 'Kargo'.

Consultant: Where is Kargo located?
IsahBolori: That is where our ward head is situated.

Consultant: Is there any relationship between Bolori and other villages.
Isah Bolori: We are related. We share the same culture, tradition and religion. We also engage in inter-marriages.

FOCAL GROUP DISCUSSIONS AT SHARIFAI VILLAGE

Date: 14/09/2015.

Field Staff: Can you please tell us your name, Position and express any concerns you have about the proposed solar project.

Mallam Alhassan Bello: I am the Village Head of Sharifai. Our major concern here is that measurement/estimates were made on our farmlands. During those times in which estimates on farmland were carried out, the Village Heads were not informed to go and witness all of that. We were not present at the land measuring ceremony.
After this was done, we were then informed to write our names and then migrate to a small committee. We were told to write down our names, phone numbers and sign. The only thing I know so far is that, once in a while we are called on for a meeting. The major concerns of my people have been, how are they going to carry out the compensation plan? Government has not clearly come out to tell them the modalities of payment. They are still afraid that government will pay them only what they feel like paying for this, no tentative date has been fixed for the payment.
Having said that, as the custodian of the people within the community, we want the need of our people to be met especially the compensation plan. Our people are farmers, that is the only occupation we took after our parents. Some families have 10-20 children and it is only through farming that some of these families take care of the children. I am appealing to you to ensure that everything is done in the interest of the people. I want the project proponent to create job opportunities for the youths within the community.

Field Staff: Do you have a school here?
Alhassan Bello: Yes, we have a school but we are facing challenges. It is to your left, over there.

Field Staff: What is the name of the school?
Alhassan Bello: It is called Ganda Sarki primary school.

Field Staff: Do you have secondary school, Hospital?
Alhassan Bello: No, no

Field Staff: Where do you go to access medical care?
Alhassan Bello: We always move to the Dutse general hospital to access medical care

Field Staff: What are the kinds of crop you plant?
Alhassan Bello: We cultivate ground nuts, millets, guinea corn, beans and groundnut. Guinea corn is common among our people.
Their produce are the things they also use to feed their family and sell to have some income. These lands are now going to be taken by the government.

Field Staff: What are the major occupations for women among the community?
Alhassan Bello: Our women engage in trades. They make rice and dish it out to the young ladies to sell. They bake groundnut cakes, pan cakes, and sell groundnut oil. Just to mention a few.

Field Staff: Any final word?
Alhassan Bello: Please, I am appealing to the government to please look into the compensation plan and ensure that our people are not cheated. We will continue to support the project as the people custodians.

FOCAL GROUP DISCUSSION AT MECHANIC VILLAGE

Date: 09/09/2015.

Balarabe Mohammed: I am the Chairman; General Automobile Association of Technicians.
These people have come to hear our concerns as regards the solar project that has been proposed. The transmission station as we are told will pass through the mechanic village. That is why they have come so we can discuss. Please feel free and air only your voice to all questions they will ask you.

Consultant: I am the leader of the group. On Tuesday, we had a meeting with stake holders to discuss issues concerning of the solar panel power project which is meant to generate about 80MW of energy which will be added to the national grid. The good thing about this project is that, it will boost the supply you already have here in Jigawa. We are here today because, when you want to do such a project, it's a big project, we know that there are people the project may affect in one way or the other. We want to consider all safety issues, all environment and social issues to make sure that together we can plan together on how we can avoid impacts that are avoidable and mitigate the ones we cannot completely avoid. So, the site where the solar plant will be is somewhere inside here. The only thing that will affect people at the mechanic village will be that the transmission line is a bit bigger, so they may pass through here. Even as we talk now, it has not been completely established where it will pass but there is something we are going to do shortly after now. We are going to take the coordinates of your own area of land here, then plot the coordinates we have taken before for the transmission line. When we plot it, we will be able to know if it will enter your own land area and if does, we will also come back to tell you and find a way to do it. The idea is that no one should be under a transmission line. Having said that, we want you to discuss with us in a very interactive way so that you can air out what your concerns and suggestions are and how we can go forward. One of the things I will love to know is the land area you are staying now. Is it a temporal place or a permanent place? How did you get this place, so that just in case it passes through here, we may know how to go about it?

Abdulwahap Yinka: I am one of the officials here. I am the secretary of Dutse local government here. What I want to advice on this issue is if eventually this thing will affect our people, we will want things to be done according to the law. People that this thing will affect will not end up without anything. If they are affected, we will like to know, whether a plot of land. Whatever we don't want to be scattered, we have been brought here by the government. We were compelled to come here; it was the government that relocated us here. We have been here for the past 7years now and this place is for each and everyone one of us. This place is a permanent place for us, this is the place we get our own daily bread.

Consultant: What we are doing here is cooperating. It is not hard. Government will not come and clear a place and work but what we are doing here is to follow international best practices because the life and livelihood of peasants, artisans, is of importance within the framework of international community, so we don't want to compromise that. This is why we doing the underground work first. It is important to know also from you, what is the process here as it were of getting this place or that you have a C of O? What was the process? Like you said, it's good to follow the law. We want to know the actual circumstance in which this place was given.

Chairman Auto Mobile Technician: If I may come in, this place as we relocated to this place, formerly, we were in the town, government decided to bring us here. They said because of the nature of our job, they don't want us to pollute the environment with oil, smoke etc. So we were relocated back here. Each of us that have a place within the mechanic village obtained it from government. We have a paper written to individuals saying so and so meter belong to you. We also have some business people who are having shops around the place. Government is aware of our stay here. It has brought some social amenities to us such as water; we have two boreholes here, we have our surface tank, and we have a generator and also public conveniences. Then we have light here. We have our own transformer here. Completely, this has become the mechanic village.

Field Staff: What will you say are some of the concerns you have as mechanics as it relates to this solar project.

Chairman Auto mobile technicians: We don't have any fears, what we want to see now is where exactly the thing will affect so that we will sit down and discuss within ourselves. After we have finished that we can then invite the company to also discuss the way out.

Consultant: Oga, you said you have paper, what was the title on the paper?

Mechanics: It is from Dutse capital development authority.

Field Staff: How is the leadership structure within the mechanic village? We have the chairman, secretary, financial secretary and what have you?

Chairman: Every mechanic you see here must be registered under the association. We have meetings every month, we have a land set aside for the building of a mosque. We have another land for the mosque down there (Two Mosques all in all).

Field Staff: In terms of conflict within mechanics, how do you resolve that?

Chairman: We resolve that because we have strong leadership here. We tackle the issue within ourselves but if the thing supersedes our intervention, we then take it to the police in Dutse.

Consultant: You said you have two mosques?

Chairman: Yes, we have two mosques and a land for another mosque. We have a land for clinic.

Consultant: So the land here was allocated on individual basis but that of the clinic and mosque group?

Chairman: Yes. We build the mosque ourselves

Field Staff: Do you have women mechanic?

Chairman: No. We don't have such here

Consultant: Do you know the exact size of this land?

Chairman: Until when I go to JCDA to find the exact number.

Field Staff: Do you have your family staying far away from the workshop or they stay around the workshop?

Chairman: We have our house in the town, this is like a company, and this mechanic workshop does not have a staff.

Field Staff: What is the resumption time and closing time here?

Chairman: You can see people here as early as 6:00 am and close around 6-7pm. We have the security men who always remain here after everyone has closed.

Field Staff: Do you witness issues of theft here?

Chairman: Everything falls back to organization. If you don't steal, your boys will not steal. We make sure that we are in control of our boys.

Consultant: Can we now at this point look around at where the land is. Chairman, this is important, there are two ways, and first thing we do in a project like this is to plan. Can we avoid this impact? Or change the design. If this is your land, point A, B, C, D and this is where the transmission line is coming from and what we will be asking is can we make it go like this? To change the direction. We shall liaise with the engineers. If this will cause a problem then we plan and see how we can reduce the impact.

Generator Operator: This is the generator set government has given to us by the government. We are provided with diesel every week. We usually operate this generator once in two days, just to pump water into the water tank to serve the mechanic village.

Field Staff: Is there any further concern?

Generator Operator: I think you would have asked if the fuel government supplies us with is enough or not?

Field Staff: So how is the fuel like?
Generator Operator: We were getting 50litres every 4 days but right now; sometimes it takes about a month before we get another one. Well we will appreciate it if government will continue to assist us.

IN-DEPTH INTERVIEW WITH A MECHANIC AT THE MECHANIC VILLAGE.

Date: 09/09/2015.

Field Staff: What is your name?

Matthew James: People call me Baba Golf. I specialize inVolkswagen products.

Field Staff: Are you a mechanic or a panel beater?

Matthew James: I am a mechanic.

Field Staff: How will you describe the mechanic village?

Matthew James: The mechanic village is okay but we don't have good road.

Field Staff: Do you have customers coming?

Matthew James: Oh yes, they always come but complain about the road.

Field Staff: How will you rate your average daily pay?

Matthew James: Sometimes we make like N10, 000- N15, 000 every day. Many customers do not want to bring their cars here. They always complain about the road.

Field Staff: Do you have any concern about the solar project?

Matthew James: This is the very first time I am hearing this.

Field Staff: What will be your view, perhaps if you are relocated?

Matthew James: Well, for me if we are moved again, I don't have a problem with that, I will take it as an act of God.

APPENDIX 4.8

NEWSPAPER ADVERT

DAILY TRUST, Monday, October 26, 2015
16 Like us on **Facebook.com/dailytrust** follow us on Twitter: **@daily_trust**
NEWS

Lagos to deploy drones to combat crime

From Femi Akinola, Lagos

The Lagos State Government has disclosed that it may deploy drones in addition to the 1,000 CCTV surveillance camera mounted across Lagos as part of the efforts to effectively monitor developments and collect data in the state.

Commissioner for Science and Technology, Mr. Olufemi Odubiyi revealed this during a chat with journalists in Lagos.

"The use of unmanned drones to effectively receive updates and monitor developments in a megacity of our size may also not be out of place," he said.

Odubiyi said there was urgent need to upgrade and add to the existing 1,000 CCTV cameras in the state to complement the other crime prevention initiatives of the government which include the Security Trust Fund, Street Signage, House Numbering and the provision of three-digit number for emergency calls.

He said the present administration is set to deploy technology to dispassionately drive efficient allocation and development of resources.

He added that his ministry would soon embark on the re-configuration of the Enterprise GIS platform to make it more user-friendly, accommodate all government agencies, thereby enhancing informed decision making and better citizen-government relations.

Bilkisu wanted to die in the act of worship - FOMWAN

From Nazifi Dawud Khalid, Kano

The death of late veteran journalist and civil society activist, Hajiya Bilkisu Yusuf, in the Hajj stampede was consistent with her wish to die in the act of worship, Chairperson of the Federation of Muslim Women in Nigeria (FOMWAN), Hajiya Sa'adatu Hasheem said.

Sa'adatu, who made the remarks Saturday during a symposium organized by Bayero University, Kano in honour of Bilkisu, said the late activist lived an austere life exemplified by her passion for the wellbeing of vulnerable and downtrodden women in the society.

"Hajiya Bilkisu never wore expensive clothes because she was always mindful of the fact that there are millions of poor people in need. Her aim was always to make positive impact on the lives of others and she died the kind of death she had always wished for, which is in the act of worship," she said.

She noted that Bilkisu, who was the founding member of FOMWAN, also contributed immensely to the growth of various non-governmental organizations that were now making progress in championing the cause of women in the country.

Also in his speech, Professor Abubakar Momoh said Bilkisu once assured him that until her death, "she will never buy any dress worth more than N20,000".

"I asked her why and she replied that her advocacy and work with rural women has proven to her the value, significance and what difference N20,000 can make in the lives of disempowered and rural women. This deeply touched me and told me something rare, uncommon and noble about the personality of Hajiya Bilkisu," he said.

Equally extolling her virtues, Dr. Bala Muhammad, a columnist with Daily Trust, described the deceased as a down-to-earth mentor, journalist and an intellectual who was always ready to assist in times of need.

On his part, Dr. Sule Bello of History Department, BUK, remembered Bilkisu as a personality who through knowledge and practice of Islam could turn a non-Muslim into an instant convert.

"Bilkisu was an exceptionally devout Muslim and a role model, who represented a staunch opposition to people who worship at the altar of power and greed. She was a woman who, despite facing the enormous demands of society, was able to perform her matrimonial duties diligently," he said.

Niger sends 15 commissioners nominees to assembly

From Ahmed Tahir Ajobe, Minna

Niger state Governor Abubakar Sani Bello has sent the names of commissioners nominees to the Niger State House of Assembly for screening, Daily Trust learnt yesterday.

Assembly source disclosed that names of 15 commissioners was received by the Speaker Ahmed Marafa Thursday evening and it is expected to be unveil early this week during a plenary.

Daily Trust learnt that list of 15 commissioners nominees was sent for the exiting ministries as well as the state's planning commission that will be headed by a commissioner who statutory is the vice chairman of the commission.

Source said each of the zones has five nominees, except the Niger north where the governor hailed from which has four.

However, screening for nominees from Agaie, Wushishi and Katcha as well Gbako ll Progressives Party (APC) is said to be still on-going.

The chief press secretary to the governor Ibraheem Dooba confirmed that list of commissioners nominees has been transmitted to the assembly for consideration.

The APC in the state had last week through a seven- man committee chaired by the party chairman Engineer Mohammed Imam and key stakeholders screened the list of nominees for onward transmission to the assembly.

The party was said to have insisted on "integrity test" for nominees through screening by a committee in order to make the "process credible."

Olanipekun seeks more budget for education

From Doyin Adebusuyi, Ado Ekiti

A former President of the Nigerian Bar Association, Chief Wole Olanipekun, has urged the federal and state governments to comply with UNESCO recommendation that 26 per cent of the nation's annual budget should go to the education sector.

Olanipekun said it was unfortunate that the international organisation's recommendation was not being complied with in the country, lamenting that the development is responsible for collapse of the sector.

He warned that Nigeria would not improve in terms of development and value reorientation without proper education reform, adding that President Muhammadu Buhari's quest to combat corruption and other vices will be a mirage, unless concrete steps are taken to reform the sector.

He spoke on Saturday in Ikere Ekiti, while giving scholarships to 181 secondary, university and Law School students, to mark the 2015 edition of the annual Wole Olanipekun Scholarship Award.

Olanipekun described the 19-year old annual award as a way of helping the indigent to pursue their chosen careers.

He said: "Education opens the eye of any society, so President Buhari must allow education renaissance to be the focus of his government. Where there is proper education, people will know how to vote right, how not to be terrorists, they will shun corruption, they will be industrious and show extreme measure of patriotism to their country. No society with proper education can be corrupted".

NDLEA raids drug stores, seizes cough syrup, others

The National Drug Law Enforcement Agency (NDLEA), Plateau Command, said it seized 1,510 bottles of cough syrup and 824 kilogrammes of hard drugs in a recent raid on drug stores.

Its Commander, Dr Ngozi Madubuike, made this known in an interview with newsmen in Jos on Sunday. She said the drug stores raided were in Jos-Bukuru metropolis, adding that the NDLEA officers also confiscated psychotropic substances.

She said the syrup was seized because it contained codeine, noting that it was a controlled drug and was not meant to be sold over the counter.

``We have been able to raid some drug stores and chemists in Jos-Bukuru metropolis who are not supposed to sell such drugs over the counter because the drugs are controlled drugs. They are to be sold by qualified medical personnel, not just by any person because the drugs are controlled; the diversion of these drugs makes them accessible to those who abuse them. From our findings, such persons take the drugs as stimulants because of the codeine in it which is a narcotic drug used medically for the production of some cough syrup," she said.

She lamented that most youths who were into drugs buy the cough syrup not to treat cough ``but to make them high and prepare them for nefarious activities."

Madubuike revealed that the command had earlier seized 824.517 kilogrammes of cannabis, cocaine and psychotropic substances.

The commander said the office has been able to secure the conviction of 48 males between the ages of 17 to 56 years, who she said are serving various jail terms ranging from one month to three years.

According to her, the command's rehabilitation centre rehabilitated and discharged 34 male patients between January and now.

He said that there are about 26 people at the centre receiving treatment at the moment and called on parents to monitor their children and wards to ensure that they do not depend on or peddle drugs.

The NDLEA official, who identified notorious drug flash points to include Farin-Gada, Gada-Biyu, Congo-Russia, Mangu and Bukuru, appealed to the public to co-operate with the agency by providing vital information. (NAN)

Nova Scotia Power Development Limited (NSPDL)

PUBLIC NOTICE

PUBLIC CONSULTATION FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT IN DUTSE LGA, JIGAWA STATE

Nova Scotia Power Development Limited (NSPDL) is planning to develop a ground-mounted Solar Photovoltaic (PV) plant capable of generating 80MW near the town of Dutse in Jigawa State, Nigeria. The proposed project will generate and supply an additional 80MW of renewable electricity to boost both local and national power supply and promote economic development.

In line with the provisions of the **Environmental Impact Assessment Act No 86 of 1992 (as amended by EIA Act Cap E12 LFN 2004)**, NSPDL is embarking on an Environmental and Social Impact Assessment (ESIA) in order to ensure the proposed project is environmentally sound and sustainable.

As part of the ESIA process, a public consultation forum is being organized to ensure that the interests, concerns and inputs of stakeholders are integrated into the overall project plan. To this end, NSPDL hereby invites the general public to participate in the public consultation forum schedule to be held as follows:

Date: Wednesday, 28th October, 2015.
Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State.
Time: 1.00pm prompt.

Signed
Managing Director, Technical

APPENDIX 4.9

ATTENDANCE SHEET OF PARTICIPANTS AT THE PUBLIC CONSULTATION FORUM

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

PUBLIC CONSULTATION FORUM

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Wednesday, 28th October, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Idris Ibrahim B...	Director Land...	Urban Development Board	08036A...		
2	RABIU	SALIHO	KAWAJE	08069041777		
3.	Yahaya Buba	Chairman	Bulori Dev. Association	07033541269	yahayabuba7108	
4	Alhaji M. Garba	Director	AA Hull En. consult	08026678674	alhajigarba...@...com	
5	Nasiru Garba	Member	KAWAYE	07039022652		
6	Alh. Idris Mafabi	Member	Dutse Town	08036892139		
7	Nuhu Yahaya	Member	Gurungu	08068991561		
8	Ali MOHD		B I K	07066769009		Ali
9	Sanusi Abubakar	Member	Kawaye	08100009734		SANI
10	IBIRAHIM	BARIJA	0709930			
11	Abubakar Ali	Member	Dutse Town	08105215770		
12	ADAMU		"			
13	Abubakar Sani	Member	"	08097466962		Sani

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

PUBLIC CONSULTATION FORUM

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Wednesday, 28th October, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Aliyu Ubah	Member	Bakin jeji	07030512597	—	
2	Umar Yakubu	Village head	Kwaimawa	07069365578	—	
3.	Zubairu Sule	C/Member	Gurungu	07065961857	—	
4	Abdulrahman Farouk	Project Manager	NSPDL	07068859885		
5	Alhassan Musa	Chairman	Magoffa S.H.G	08109189797	—	
6	Musa Adamu	Member	Rahama S/Noma	08066024413	—	Musa
7.	Umar Mohd Bashir	S/Noma	B/Jeji	08092699830 08609...	—	
8	Aminu Dahiru	B/Jeji	B/Jeji	08134180049	—	
9	Bello Saadu	Village head	Kawaye	07063144474	—	
10	Auwalu Abubakar	Member	B/jeji	08069785160	—	AU
11	Yahuza Mohd	Village head	B/jeji	08173700827	—	
12	Kwangmun Dafus	Admin Officer	GEHS, Abuja	07035995671		
13	Seun Adebayo	Env. Sci I	GEHS, Abuja	08173711313		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

PUBLIC CONSULTATION FORUM

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Wednesday, 28th October, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Gukut, Bala H	Fed. Controller of Environment	Fed. Min. of Environment	08033148266	bhgukut@yahoo.com	[signature]
2.	Muhammad Haladu	SEO	"	07038288500	muhdhaladu@yahoo	[signature]
3.	Adamu Muse	Business man	Fagoji quarters	08066064944		[signature]
4.	Binta Musa	Wife House	Fagoji quarters	09097307186		[signature]
5.	Mohammed Musa	Business man	Fagoji quarters	08064249427		[signature]
6	Rabiu Adamu	Civil Servant	Fed. Min. of Environment	08032377940		[signature]
7	Nasiru Mardaki	HTO Ministry of Commerce	Ministry of Commerce Industry Tourism	08030928440	Mardakinasiru@yahoo.com	[signature]
8	Abdu Ta'u	Farmer	federal ministry of Env	NIL		ABD
9	Ibrahim Garbati K	NSCDC Environmental	Civil Defence	08079500385		[signature]
10	Mohd Salisu Mory	Dir. Enforcement	JISEPA	07065675197	—	[signature]
11	Ahmed Abubakar	farm owner	Kawaye village	08036371724	—	[signature]
12	Shehu Yahaya	farm owner	Kawaye Village	07067944682	—	SHEHU
13	Garba Hassan	Farmer	Bakin Jeji Dutse	08069580795	X/12	[signature]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

PUBLIC CONSULTATION FORUM

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Wednesday, 28th October, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
01	Aminu Maina	Representing NSCDC.	Nig. Sec & Civil Defence Corp	08179285956		[signature]
11	Bello Abdulhamid Bakin Jeji			08069225376		[signature]
2	Mahmoud Lawal		Katangan Lafia			[signature]
4	Zuberu Isah		Kawaye			SUBIRU
5	Ya'au Adamu		Kawaye	08035899832		YAU
6	Safiyanu Sule		Kawaye	08167791286		[signature]
7	Sale Umar		K/Lafiya	08036920275		[signature]
8	Isah Mohd		K/Lafi	07036814357		[signature]
9	Idris Muhammad		ABU Zaria	07039412342		[signature]
10	idris Abubakar		Bakin Jeji	08068636472?		IDI
11	Ibrahim Tukur		Kawaye	08104834441		[signature]
12	Usama Bello		Kawaye	07037715265		[signature]
13	Rabiu Lawal		Mechanic Village	08065578789		[signature]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

PUBLIC CONSULTATION FORUM

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Wednesday, 28th October, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Al-hassan Audu		Bakin Jeji	08160026321		
2	Mohammed Musa	Chairman youth	Bolori	07032599286		
3	Adamu Bello	Member	Kanwaye	07063144474		
4	Abdullahi Kani	Member	Bakin Jeji	08069173218	[illegible]	
5	Idris Adamu	Member	" "	07035884088		
6	Ya'u Adamu	Director Hyd	M.O.W. Resources	08039432845		
7	Samaila		Bakin Jeji	07086667341		
8	Mohammed Tukur		Bakin Jeji	08104505581		
9	[illegible]	[illegible]	Bakin Jeji	0703672404		
10	Balarabe Mohd	State Chair NATA.	NATA Mech Village	08034679755		
11	Usaini Hamza	Farmer	Gurugu - Com.	08009262874		
12	Nasiru Isyaku	Director	NSPDL	08138000004		
13	Dr. John Okwuosa	Head/Lead Consult	GEHS, Abuja	08066823007		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED DEVELOPMENT OF SOLAR PV PLANT NEAR DUTSE, JIGAWA STATE

PUBLIC CONSULTATION FORUM

Venue: Conference Hall, Dutse State Library, Adamu Maje Road (Near GTB), Dutse, Jigawa State. **Date:** Wednesday, 28th October, 2015

ATTENDANCE SHEET

S/N	NAME	POSITION	ORGANISATION/ COMMUNITY	PHONE NO	EMAIL	SIGNATURE
1	Ado Al-Hassan		Bakin Jeji	0703515888		
2	Jamilah Farouk	Director	Invest Jigawa	08167574342		
3	Shitu Abubakar		Bakin Jite	08038162592		
4	Musa ~~[illegible]~~		Bakinjite	07049652070		
5	Inusa Gabara		Bakinjite	"		
6	Bala Mamma		Bakinjite	08031595562		
7	Bello M. Md		Bello	[illegible]		
8	Sibe Ibrahim	Bakin Jeji				
9	Suleman Abdullahi		Yol wawa	08131509353		
10	Sabitu Madauzu		Bakin Jeji	08135411722		
11	Ustas Ali	C.I.B	SHG[illegible]	07035578811		
12	Oliver O.	Socio-Economic Consultant	GEHS, Abuja	08034110341		
13	Moses Konko	Asst. Consultant	GEHS, Abuja	08063247003		

APPENDIX 4.10

MINUTES OF THE PUBLIC CONSULTATION FORUM FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE PROPOSED DEVELOPMENT OF 80MW SOLAR PHOTOVOLTAIC (PV) PLANT NEAR DUTSE, JIGAWA STATE HELD AT CONFERENCE HALL, DUTSE STATE LIBRARY, ADAMU MAJE ROAD, DUTSE, JIGAWA STATE ON WEDNESDAY, 28TH OCTOBER, 2015

Participation	Representatives from the under-listed affected communities, Federal and State Ministries, Departments and Agencies (MDA) and NGO attended the meeting: • Katangar Lafia village • Bakin Jeji village • Kawaye village • Bulori village • Rahama village • Dutse Town • Auto Mechanic Village • Nagarta Social Club, Rahama • Federal Ministry of Environment • Jigawa State Ministry of Environment • Jigawa State Environmental Protection Agency (JISEPA) • Jigawa State Ministry of Commerce, Industry and Tourism • Jigawa State Ministry of Lands, Housing, Urban development and Regional Planning • Invest Jigawa • Nigeria Security and Civil Defence Corps (NSCDC) • AAHUU Environmental Consult Detailed attendance list is provided in Appendix 4.9.
Apologies	• The representative of the Emir of Dutse.
Absentees	• Dutse Local Government Authority • Jigawa State Ministry of Environment • Transmission Company of Nigeria • Federal Ministry of Power • Nigerian Electricity Regulatory Commission • Nigerian Bulk Electricity Trading Plc
Moderator	• Mr Oliver Nwuju (Socioeconomic Expert, ESIA Team)

INTRODUCTION, REMARKS AND PRESENTATIONS

Introduction	The meeting commenced at about 1:30pm with an opening prayer from one of the participants. Thereafter the moderator invited the under listed to the high table: 1) Mr. Nasiru Isiaku (Director, NSPDL) 2) Dr. (Mrs) Lola Okwuosa (Head/Lead Consultant, GEHS) 3) Mr. Bala Gukut (Jigawa State Comptroller, Federal Ministry of Environment) 4) Mallam Idris Ibrahim (Director, Urban Development {Jigawa State Ministry of Lands, Housing, Urban Development & Regional Planning}) 5) Mr. Aminu Maina (Representative of Jigawa State Commandant, NSCDC). Participants from the Federal and Jigawa State MDAs as well as members of affected communities and other stakeholders were introduced.
Opening Remark	The opening remark was presented by Dr (Mrs.) Okwuosa (ESIA Lead Consultant). She welcomed participants and set the tone for the meeting. Dr. Okwuosa reminded participants of the Scoping Workshop which took place on the 8th September, 2015 and reiterated that the Public Consultation

	forum is a continuation of the stakeholders' engagement programme for the on-going ESIA. She stated that the purpose of the forum is to recap highlight of the scoping workshop particularly to inform stakeholders who were not present at the last meeting about the proposed project, its purpose and benefits. She also stressed that the public consultation forum is organized to give stakeholders feedback on some of the concerns and issues raised during the Scoping Workshop and to provide answers and clarifications. This is to reassure stakeholders that the ESIA team took all issues and concerns raised into consideration in the ESIA study. Lastly, the forum is organized to inform stakeholders of the progress made in the ESIA study since the last Scoping Workshop.
Brief Description of Project Development	Mr. Nasiru Isyaku (Director, NSPDL) briefly provided the background to the proposed project and presented the project objectives and benefits. Mr. Isyaku stated that the project basically involves the use of the sun to provide electricity. It is a project that requires a large land mass where the solar panel will be installed to generate about 80MW of electricity. He further stated that the 80MW will be fed to the state of Jigawa. He reminded stakeholders that without electricity there cannot be any sensible development and he gave several illustrations to back his claims. He remarked that the project is highly needed as development can never be achieved without adequate electricity. Mr. Isyaku pointed out that NSPDL is the first investor bringing solar project to Jigawa State and the company has discussed extensively with the government regarding the allocation of a suitable land for the project. He reminded stakeholders that, the state government has a laid down law on how compensation should be carried out regarding land acquisition. He stressed that due process will be followed in conjunction with the Ministry of Lands, Housing, Urban Development & Regional Planning and all relevant stakeholders. He concluded by encouraging stakeholders to feel free to express themselves, make comments, ask questions as the forum progresses.
Highlights of Issues Raised During Scoping Workshop	Mr. Oliver Nwuju presented the main issues highlighted during the last scoping workshop. This was done to ensure that there were no omissions and to reassure stakeholders that their concerns will be addressed accordingly in the ESIA. a. Loss of farm land. b. Compensation (how will the project compensate them? Who will compensate them? Is it the government or the company? If compensation is to come, how is it going to be paid? c. Compensation should not be paid through their leaders. d. Project decommissioning after 25 years (Does it mean we will go back to the days of darkness? What will happen to our land?) e. Electricity generation during wet seasons (What will happen during cold season or harmattan?) f. Mechanic village (if their site is affected by the project are they going to be displaced? what becomes their condition? Are they going to be compensated? How are they going to go on with their work?) g. Ownership of the project: is this project jointly owned by the state government and company? Is it owned by state government alone? Or is it owned by the private firm alone? h. Employment: Will the project employ local people? At the end of his presentation, stakeholders echoed that all their concerns were captured and nothing was left out.
Update on ESIA Study and Steps taken so far to address issues and concerns raised by stakeholders	Dr. Lola Okwuosa briefed stakeholders about the progress made so far in the ESIA Study. Below are highlight of her presentation: She enumerated the objectives of the ESIA study which is to ultimately ensure that the project can be carried out in such a way that does not negatively affect the environment as well as the health and livelihood of inhabitants of the project area. In order to be able to achieve this, she explained that what has been done so far was to assess the environment including water, air, soil, vegetation, forest, animals etc, before the project starts. This was done to establish the condition of the area before the project in order to be able predict and assess the likely impacts of project, measure any changes to the environment and be able put

	measures to prevent any damage to the environment during implementation and the entire life cycle of the project. She also mentioned that the ESIA team had gone to the communities in the project area to assess the socioeconomic and health status before the project. During the visit, the ESIA team met and had discussions with different groups of people including the women, the mechanic group, farmers, community leaders etc to capture enough information to be documented in the ESIA Report. She further stated that the ESIA Report will be made available for everybody to read and comment at the appropriate time. Dr. Okwuosa also addressed some of the issues raised during the last meeting particularly those raised by members of the mechanic village regarding land take for the transmission line RoW. She explained that the ESIA team has traced the route and with the aid of the GPS equipment verified that no settlement is within 15m of the transmission line from both sides as stipulated by TCN. Consequently, no community will be displaced by reason of the transmission route. Dr. Okwuosa concluded by emphasizing that all issues raised will be evaluated in the ESIA and appropriate measures to avoid, reduce or compensate for project impacts will be documented. She urged all stakeholders to look out for the report to verify that all their concerns were addressed. She mentioned that publication will be made in the national dailies inviting stakeholders to review a copy of report that will be displayed at Dutse LGA secretariat. Stakeholders still have the opportunity to also comment on the Report even at review stage.
Steps taken so far by NSPDL to address issues and concerns raised by stakeholders	Mr. Nasiru Isyaku presented the highlight of steps NSPDL has taken so far to address issues relating to compensation raised by participants during the scoping workshop: Mr. Isyaku remarked compensation is the next stage after having identified the land for the project. He maintained that compensation was part of the conditions given to NSPDL by the government and must be completed before the land will be fully handed over to them for the project. He stressed that NSPDL will be applying best practice to ensure that everyone will be given what is due to them. Mr. Isyaku told stakeholder that NSPDL has been working with the Surveyor General's office and the Ministry of Land and this collaboration will continue to identify owners of farm lands. He appealed to stakeholders particularly the land owners to be patient as the process is rigorous and painstaking. He however assured farm owners that each land owner will be identified and there will be witnesses before any compensation is paid. He maintained that so far NSPDL has done appropriate land drawings, compiled the names of land owners and identified the actual size of land belonging to each owner. This has been submitted to the government for scrutiny. NSPDL is waiting for response from the government before going ahead with payment of compensation. He assured all stakeholders that project work on the land will not commence until full compensation has been paid.
Update from InvestJigawa	Mrs. Jemilah Farouk, (Director, Advocacy and Strategy at InvestJigawa) remarked that the Agency has initiated the process to bring all affected land owners together with their respective village leaders to discuss issues bordering on compensation such that no single land owner is cheated. She stated that InvestJigawa has informed the District Head of Dutse and currently awaiting response to fix the date that will be convenient for everyone. She promised that by the following week, the date will be fixed and communicated to all concerned.

HIGHLIGHTS OF QUESTIONS, CONCERNS FROM STAKEHOLDERS AND RESPONSES

S/N	Questions and Concerns	Responses
1	Mr. Nasiru Madaki (representatives, Jigawa State Ministry of Commerce, Industry and Tourism)	The Moderator, Mr. Nwuju made reference to the emphasis placed on ensuring due process is observed during

	appealed to the project owners to ensure the youths are given opportunities during project implementation. He also enjoined the project owner to ensure the right people are paid compensation to avoid any break down of law and order.	compensation and reiterated NSPDL commitment to comply with all applicable national and international requirements regarding compensation.
2.	Mr. Adamu (Businessman/Land owner from Kawaye) raised issues regarding the plan by InvestJigawa to invite District Heads to participate in meetings regarding compensation. He expressed fears that if the District heads is involved, they may not have justice as regards compensation.	Mr. Nasiru Isyaku assured all stakeholders that the process of compensation will be transparent and everyone will be carried along. He maintained that the District head is also part of the process. The village head and all the relevant stakeholders are part of the process. Invest Jigawa, the office of the Governor and Dutse LGA are also involved. He pointed out that compensation is not a one man show and the process will not be disrupted by the presence of one or two persons. He appealed for stakeholders to be patient as nobody is going to be cheated.
3.	Alhaji Idris Mai Fulani (from Dutse Town) expressed satisfaction that the project has come to Jigawa state giving its numerous benefits. He urged project owners to ensure land owners with multiple pieces of land in the area are compensated for all land acquired from them and not just for one piece of land. He referred to their past experience during land acquisition for the Federal University Dutse project where persons with 5 - 6 pieces of land were treated same way as persons with just one piece. He appealed that full compensation should be paid on all the lands belonging to an individual.	Mr. Nasiru Isyaku assured that NSPDL already has a very big document which contains the details of every individual and the number and sizes of their land and compensation will be paid according to the cumulative size of land belonging to each land owner. He also emphasized that economic trees within the farmlands will be counted and duly compensated for as well.
5	Mr. Oliver Nwuju suggested that after compilation, the names of all land owners and the cumulative size of their respective lands should be displayed where people can come and see and be assured their lands have been adequately captured before compensation is paid.	Mr. Nasiru Isyaku assured that NSPDL will liaise with InvestJigawa and Ministry of Lands to ensure copies of the compiled list is made available publicly so that all errors can be rectified before compensation is paid.
6.	Saleh Umar (from Katangar Lafia) asked to know the methods to be used in terms of employment/recruitment of staff? He expressed concerns that majority of their youths do not have western education and so may not have the required qualification and also may not be able to write applications. He advised NSPDL to establish a school or organize workshop where individuals will be taught on the maintenance of solar plant as this will help the youths within the communities to secure jobs on the project.	Mr. Nasiru Isyaku reassured stakeholders that there is going to be a training center as part of the project to train people to work on the project. He also maintained that there will be rooms for skilled people and unskilled people will also be trained to become skilled in order to work on the project. Mr. Nwuju added that the project will also create a lot of indirect jobs for people of the area
7	**Abdul Kari Numa** (Director from AAHUU Environmental Consult {NGO}), expressed his excitement about the public consultation forum. He also expressed his happiness about the potential benefits of the project to the people of Jigawa State. He however requested NSPDL to critically look at	Dr. Lola Okwuosa assured stakeholders that NSPDL is committed to ensuring the project is carried out in a way that is very sustainable with low or minimal impact on the environment. She added that an Environmental and Social Management Plan will be developed in the ESIA report to ensure protection of the environment and people and

	Bakin-Jeji, Sharifai and Katanga Lafia with great concern. He further expressed concerns about environmental issues regarding the project and encouraged NSPDL to ensure mitigation measures in the ESIA Report are enforced during project implementation.	appropriate authorities such as the FMEnv have roles in monitoring to ensure the Plan is implemented. She invited all stakeholders especially affected communities and NGOs to be involved.

Remark by the representative of the FMEnv: Mr. Bala Gukut (Jigawa State Comptroller, Federal Ministry of Environment)	Mr. Gukut thanked NSPDL and the ESIA consultant. He exclaimed that since he has been attending technical sessions and EIA reviews, this forum is the best he has attended. He rated NSPDL as the best proponent he has had the opportunity to be involved in their project. He expressed satisfaction with the conduct of the ESIA as the Consultant had actually visited affected communities unlike other Consultants who do not. Overall, he gave the ESIA study a good commendation. His major advice to those that will be compensated for their farmlands and economic tree was to go and get another land elsewhere. He appealed to them not to consider additional wife as an option when the money comes. He encouraged them to plan their lives as well as their families. He expressed satisfaction about what he has witnessed and he could not envisage any problem when the ESIA goes for technical review.
Closing	The meeting was concluded with a closing prayer at 4:30pm

APPENDIX 7.1

GENERAL ENVIRONMENTAL MANAGEMENT CONDITIONS FOR CONSTRUCTION CONTRACTS

General

1. In addition to these general conditions, the Contractor shall comply with any specific Environmental Management Plan (EMP) or Environmental and Social Management Plan (ESMP) for the works he is responsible for. The Contractor shall inform himself about such an EMP, and prepare his work strategy and plan to fully take into account relevant provisions of that EMP. If the Contractor fails to implement the approved EMP after written instruction by the Supervising Engineer (SE) to fulfill his obligation within the requested time, the Owner reserves the right to arrange through the SE for execution of the missing action by a third party on account of the Contractor.

2. Notwithstanding the Contractor's obligation under the above clause, the Contractor shall implement all measures necessary to avoid undesirable adverse environmental and social impacts wherever possible, restore work sites to acceptable standards, and abide by any environmental performance requirements specified in an EMP. In general these measures shall include but not be limited to:

   (a) Minimize the effect of dust on the surrounding environment resulting from earth mixing sites, asphalt mixing sites, dispersing coal ashes, vibrating equipment, temporary access roads, etc. to ensure safety, health and the protection of workers and communities living in the vicinity of dust producing activities.

   (b) Ensure that noise levels emanating from machinery, vehicles and noisy construction activities (e.g. excavation, blasting) are kept at a minimum for the safety, health and protection of workers within the vicinity of high noise levels and nearby communities.

   (c) Ensure that existing water flow regimes in rivers, streams and other natural or irrigation channels are maintained and/or re-established where they are disrupted due to works being carried out.

   (d) Prevent bitumen, oils, lubricants and waste water used or produced during the execution of works from entering into rivers, streams, irrigation channels and other natural water bodies/reservoirs, and also ensure that stagnant water in uncovered borrow pits is treated in the best way to avoid creating possible breeding grounds for mosquitoes.

   (e) Prevent and minimize the impacts of quarrying, earth borrowing, piling and building of temporary construction camps and access roads on the biophysical environment including protected areas and arable lands; local communities and their settlements. In as much as possible, restore/rehabilitate all sites to acceptable standards.

   (f) Upon discovery of ancient heritage, relics or anything that might or believed to be of archaeological or historical importance during the execution of works, immediately report such findings to the SE so that the appropriate authorities may be expeditiously contacted for fulfillment of the measures aimed at protecting such historical or archaeological resources.

   (g) Discourage construction workers from engaging in the exploitation of natural resources such as hunting, fishing, collection of forest products or any other activity that might have a negative impact on the social and economic welfare of the local communities.

   (h) Implement soil erosion control measures in order to avoid surface run off and prevent siltation, etc.

   (i) Ensure that garbage, sanitation and drinking water facilities are provided in construction workers camps.

   (j) Ensure that, in as much as possible, local materials are used to avoid importation of foreign material and long distance transportation.

   (k) Ensure public safety, and meet traffic safety requirements for the operation of work to avoid accidents.

3. The Contractor shall indicate the period within which he/she shall maintain status on site after completion of civil works to ensure that significant adverse impacts arising from such works have been appropriately addressed.

4. The Contractor shall adhere to the proposed activity implementation schedule and the monitoring plan / strategy to ensure effective feedback of monitoring information to project management so that impact management can be implemented properly, and if necessary, adapt to changing and unforeseen conditions.

5. Besides the regular inspection of the sites by the SE for adherence to the contract conditions and specifications, the Owner may appoint an Inspector to oversee the compliance with these environmental conditions and any proposed mitigation measures. State environmental authorities may carry out similar inspection duties. In all cases, as directed by the SE, the Contractor shall comply with directives from such inspectors to implement measures required to ensure the adequacy of rehabilitation measures carried out on the bio-physical environment and compensation for socio-economic disruption resulting from implementation of any works.

Worksite/Campsite Waste Management

6. All vessels (drums, containers, bags, etc.) containing oil/fuel/surfacing materials and other hazardous chemicals shall be bunded in order to contain spillage. All waste containers, litter and any other waste generated during the construction shall be collected and disposed of at designated disposal sites in line with applicable government waste management regulations.

7. All drainage and effluent from storage areas, workshops and camp sites shall be captured and treated before being discharged into the drainage system in line with applicable government water pollution control regulations.

8. Used oil from maintenance shall be collected and disposed of appropriately at designated sites or be re-used or sold for re-use locally.

9. Entry of runoff to the site shall be restricted by constructing diversion channels or holding structures such as banks, drains, dams, etc. to reduce the potential of soil erosion and water pollution.

10. Construction waste shall not be left in stockpiles along the road, but removed and re-used or disposed of on a daily basis.

11. If disposal sites for clean spoil are necessary, they shall be located in areas approved by the SE, of low land use value and where they will not result in material being easily washed into drainage channels. Whenever possible, spoil materials should be placed in low-lying areas and should be compacted and planted with species indigenous to the locality.

Material Excavation and Deposit

12. The Contractor shall obtain appropriate licenses/permits from relevant authorities to operate quarries or borrow areas.

13. The location of quarries and borrow areas shall be subject to approval by relevant local and national authorities, including traditional authorities if the land on which the quarry or borrow areas fall is traditional land.

14. New extraction sites:

a) Shall not be located in the vicinity of settlement areas, cultural sites, wetlands or any other valued ecosystem component, or on high or steep ground or in areas of high scenic value, and shall not be located less than 1km from such areas.

b) Shall not be located adjacent to stream channels wherever possible to avoid siltation of river channels. Where they are located near water sources, borrow pits and perimeter drains shall surround quarry sites.

c) Shall not be located in archaeological areas. Excavations in the vicinity of such areas shall proceed with great care and shall be done in the presence of government authorities having a mandate for their protection.

d) Shall not be located in forest reserves. However, where there are no other alternatives, permission shall be obtained from the appropriate authorities and an environmental impact study shall be conducted.

e) Shall be easily rehabilitated. Areas with minimal vegetation cover such as flat and bare ground, or areas covered with grass only or covered with shrubs less than 1.5m in height, are preferred.
f) Shall have clearly demarcated and marked boundaries to minimize vegetation clearing.

15. Vegetation clearing shall be restricted to the area required for safe operation of construction work. Vegetation clearing shall not be done more than two months in advance of operations.

16. Stockpile areas shall be located in areas where trees can act as buffers to prevent dust pollution. Perimeter drains shall be built around stockpile areas. Sediment and other pollutant traps shall be located at drainage exits from workings.

17. The Contractor shall deposit any excess material in accordance with the principles of the general conditions, and any applicable EMP, in areas approved by local authorities and/or the SE.

18. Areas for depositing hazardous materials such as contaminated liquid and solid materials shall be approved by the SE and appropriate local and/or national authorities before the commencement of work. Use of existing, approved sites shall be preferred over the establishment of new sites.

Rehabilitation and Soil Erosion Prevention

19. To the extent practicable, the Contractor shall rehabilitate the site progressively so that the rate of rehabilitation is similar to the rate of construction.

20. Always remove and retain topsoil for subsequent rehabilitation. Soils shall not be stripped when they are wet as this can lead to soil compaction and loss of structure.

21. Topsoil shall not be stored in large heaps. Low mounds of no more than 1 to 2m high are recommended.

22. Re-vegetate stockpiles to protect the soil from erosion, discourage weeds and maintain an active population of beneficial soil microbes.

23. Locate stockpiles where they will not be disturbed by future construction activities.

24. To the extent practicable, reinstate natural drainage patterns where they have been altered or impaired.

25. Remove toxic materials and dispose of them in designated sites. Backfill excavated areas with soils or overburden that is free of foreign material that could pollute groundwater and soil.

26. Identify potentially toxic overburden and screen with suitable material to prevent mobilization of toxins.

27. Ensure reshaped land is formed so as to be inherently stable, adequately drained and suitable for the desired long-term land use, and allow natural regeneration of vegetation.

28. Minimize the long-term visual impact by creating landforms that are compatible with the adjacent landscape.

29. Minimize erosion by wind and water both during and after the process of reinstatement.

30. Compacted surfaces shall be deep ripped to relieve compaction unless subsurface conditions dictate otherwise.

31. Re-vegetate with plant species that will control erosion, provide vegetative diversity and, through succession, contribute to a resilient ecosystem. The choice of plant species for rehabilitation shall be done in consultation with local research institutions, forest department and the local people.

Water Resources Management

32. The Contractor shall at all costs avoid conflicting with water demands of local communities.

33. Abstraction of both surface and underground water shall only be done with the consultation of the local community and after obtaining a permit from the relevant Water Authority.

34. Abstraction of water from wetlands shall be avoided. Where necessary, authority has to be obtained from relevant authorities.

35. Temporary damming of streams and rivers shall be done in such a way that avoids disrupting water supplies to communities downstream, and maintains the ecological balance of the river system.

36. No construction water containing spoils or site effluent, especially cement and oil, shall be allowed to flow into natural water drainage courses.

37. Wash water from washing out of equipment shall not be discharged into water courses or road drains.

38. Site spoils and temporary stockpiles shall be located away from the drainage system, and surface run off shall be directed away from stockpiles to prevent erosion.

Traffic Management

39. Location of access roads/detours shall be done in consultation with the local community especially in important or sensitive environments. Access roads shall not traverse wetland areas.

40. Upon the completion of civil works, all access roads shall be ripped and rehabilitated.

41. Access roads shall be sprinkled with water at least five times a day in settled areas, and three times in unsettled areas, to suppress dust emissions.

Blasting

42. Blasting activities shall not take place less than 2km from settlement areas, cultural sites, or wetlands without the permission of the SE.

43. Blasting activities shall be done during working hours, and local communities shall be consulted on the proposed blasting times.

44. Noise levels reaching the communities from blasting activities shall not exceed 90 decibels.

Disposal of Unusable Elements

45. Unusable materials and construction elements such as electro-mechanical equipment, pipes, accessories and demolished structures will be disposed of in a manner approved by the SE. The Contractor has to agree with the SE which elements are to be surrendered to the Client's premises, which will be recycled or re-used, and which will be disposed of at approved landfill sites.

46. As far as possible, abandoned pipelines shall remain in place. Where for any reason, no alternative alignment for the new pipeline is possible, the old pipes shall be safely removed and stored at a safe place to be agreed upon with the SE and the local authorities concerned.

47. AC-pipes as well as broken parts thereof have to be treated as hazardous material and disposed of as specified above.

48. Unsuitable and demolished elements shall be dismantled to a size fitting on ordinary trucks for transport.

Health and Safety

49. In advance of the construction work, the Contractor shall mount an awareness and hygiene campaign. Workers and local residents shall be sensitized on health risks particularly of AIDS.

50. Adequate road signs to warn pedestrians and motorists of construction activities, diversions, etc. shall be provided at appropriate points.

51. Construction vehicles shall not exceed maximum speed limit of 40km per hour.

Repair of Private Property

52. Should the Contractor, deliberately or accidentally, damage private property he shall repair the property to the owner's satisfaction and at his own cost. For each repair, the Contractor shall obtain from the owner a certificate that the damage has been made good satisfactorily in order to indemnify the Client from subsequent claims.

53. In cases where compensation for inconveniences, damage of crops etc. are claimed by the owner, the Client has to be informed by the Contractor through the SE. This compensation is in general, settled under the responsibility of the Client before signing the Contract. In unforeseeable cases, the respective administrative entities of the Client will take care of compensation.

Contractor's Environment, Health and Safety Management Plan (EHS-MP)

54. Within 6 weeks of signing the Contract, the Contractor shall prepare an EHS-MP to ensure the adequate management of the health, safety, environmental and social aspects of the works, including implementation of the requirements of these general conditions and any specific requirements of an EMP for the works. The Contractor's EHS-MP will serve two main purposes:

- For the Contractor, for internal purposes, to ensure that all measures are in place for adequate EHS management, and as an operational manual for his staff.
- For the Client, supported where necessary by a SE, to ensure that the Contractor is fully prepared for the adequate management of the EHS aspects of the project, and as a basis for monitoring of the Contractor's EHS performance.

55. The Contractor's EHS-MP shall provide at least:

- a description of procedures and methods for complying with these general environmental management conditions, and any specific conditions specified in an EMP;
- a description of specific mitigation measures that will be implemented in order to minimize adverse impacts;
- a description of all planned monitoring activities (e.g. sediment discharges from borrow areas) and the reporting thereof; and
- the internal organizational, management and reporting mechanisms put in place for such.

56. The Contractor's EHS-MP will be reviewed and approved by the Client before start of the works. This review should demonstrate if the Contractor's EHS-MP covers all of the identified impacts, and has defined appropriate measures to counteract any potential impacts.

EHS Reporting

57. The Contractor shall prepare bi-weekly progress reports to the SE on compliance with these general conditions, the project EMP if any, and his own EHS-MP. It is expected that the Contractor's reports will include information on:

- EHS management actions/measures taken, including approvals sought from local or national authorities;
- Problems encountered in relation to EHS aspects (incidents, including delays, cost consequences, etc. as a result thereof);
- Lack of compliance with contract requirements on the part of the Contractor;
- Changes of assumptions, conditions, measures, designs and actual works in relation to EHS aspects; and
- Observations, concerns raised and/or decisions taken with regard to EHS management during site meetings.

58. It is advisable that reporting of significant EHS incidents be done "as soon as practicable". Such incident reporting shall therefore be done individually. Also, it is advisable that the Contractor keep his own records on health, safety and welfare of persons, and damage to property. It is advisable to include such records, as well as copies of incident reports, as appendixes to the bi-weekly reports. A sample format for an

incident notification is shown below. Details of EHS performance will be reported to the Client through the SE's reports to the Client.

Training of Contractor's Personnel

59. The Contractor shall provide sufficient training to his own personnel to ensure that they are all aware of the relevant aspects of these general conditions, any project EMP, and his own EHS-MP, and are able to fulfill their expected roles and functions. Specific training should be provided to those employees that have particular responsibilities associated with the implementation of the EHS-MP. General topics should be:

- EHS in general (working procedures);
- emergency procedures; and
- social and cultural aspects (awareness raising on social issues).

Cost of Compliance

60. It is expected that compliance with these conditions is already part of standard good workmanship and state of art as generally required under this Contract. The item "Compliance with Environmental Management Conditions" in the Bill of Quantities covers this cost. No other payments will be made to the Contractor for compliance with any request to avoid and/or mitigate an avoidable EHS impact.

Example Format: EHS **Report**

Contract: **Period of reporting:**

EHS management actions/measures:

Summarize EHS management actions/measures taken during period of reporting, including planning and management activities (e.g. risk and impact assessments), EHS training, specific design and work measures taken, etc.

EHS incidents:

Report on any problems encountered in relation to EHS aspects, including its consequences (delays, costs) and corrective measures taken. Include relevant incident reports.

EHS compliance:

Report on compliance with Contract EHS conditions, including any cases of non-compliance.

Changes:

Report on any changes of assumptions, conditions, measures, designs and actual works in relation to EHS aspects.

Concerns and observations:

Report on any observations, concerns raised and/or decisions taken with regard to EHS management during site meetings and visits.

Signature (Name, Title, Date):

Contractor Representative

Example Format: EHS Incident Notification

EHS Incident Notification
Provide within 24 hrs to the Supervising Engineer
Originators Reference No:...
Date of Incident:... **Time:**.......................
Location of incident:..
Name of Person(s) involved:..
Employing Company:..
Type of Incident:...
Description of Incident:
Where, when, what, how, who, operation in progress at the time (only factual)
Immediate Action:
Immediate remedial action and actions taken to prevent reoccurrence or escalation
Signature (Name, Title, Date):..
Contractor Representative