FINAL REPORT

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED MINI-GRID POWER PROJECTS IN NIGER STATE BY ENGIE FENIX NIGERIA

SUBMITTED TO

THE FEDERAL MINISTRY OF ENVIRONMENT HEADQUARTERS, MABUSHI, ABUJA

FEBRUARY, 2021

FINAL

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT

FOR

THE PROPOSED ENGIE FENIX NIGERIA SOLAR MINI-GRID PROJECTS IN NIGER STATE

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BY

ENGIE FENIX NIGERIA

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	-	Alternating Current
AfDB	-	African Development Bank
AIDS	-	Acquired immunodeficiency syndrome
ALARP	-	As Low As Reasonably Practicable
AoI	-	Area of Influence
APHA	-	American Public Health Association
a-Si	-	Amorphous Silicon
ASTM	-	American Standards for Testing and Materials
B.Sc.	-	Bachelor of Science
BID	-	Background Information Documents
BMSs	-	Battery Management Systems
BOD	-	Biological Oxygen Demand
BPE	-	Bureau of Public Enterprises
Ca	-	Calcium
CAPEX	-	Capital Expenditure
Cd	-	Cadmium
Cd	-	Cadmium
CdTe	-	Cadmium telluride
Cfu/ml	-	Colony-forming unit/millilitre
CH_4	-	Methane
CIDs	-	Current interrupt devices
CIGS	-	Copper indium gallium selenide
CO	-	Carbon monoxide
CoC	-	Code of Conducts
Cr	-	Chromium
Cr	-	Chromium
CSP	-	Concentrated Solar Power
CSR	-	Corporate Social Responsibility
Cu	-	Copper
DC	-	Direct Current
DFIs	-	Development Finance Institutions
DO	-	Dissolved Oxygen
DR	-	Death Rate
E&S	-	Environmental and Social
EA	-	Environmental Assessment
ECN	-	Energy Commission of Nigeria
EHS	-	Environmental, Health and Safety
EIA	-	Environmental Impact Assessment
EMF	-	Electromagnetic Field
EMS	-	Environmental Management Systems

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EnvAccord	-	Environmental Accord Nigeria Limited
EPC	-	Engineering, Procurement and Construction
EPIC	-	Electric Power Reform Implementation Committee
EPIC	-	Electric Power Reform Implementation Committee
EPR	-	Extended Producer Responsibility
EPRP	-	Emergency Preparedness and Response Plan (EPRP)
ESAs	-	Environmentally Sensitive Areas
ESIA	-	Environmental and Social Impact Assessment
ESMAP	-	Energy Sector Management Assistance Program
ESMF	-	Environmental and Social Management Framework
ESMP	-	Environmental and Social Management Plan
Fe	-	Iron
FEC	-	Federal Executive Council
FEC	-	Federal Executive Council
FGD	-	Focus Group Discussion
FGN	-	Federal Government of Nigeria
FMEnv	-	Federal Ministry of Environment
GAP	-	Gender Action Plan
GBV	-	Gender Based Violence
GDP	-	Gross Domestic Product
GHG	-	Greenhouse Gas
GO	-	Grievance Officer
GPN	-	Good Practice Note
GPS	-	Global Positioning System
GRM	-	Grievance Redress Mechanism
HIV	-	Human Immunodeficiency Virus
H&S	-	Health and Safety
H_2S	-	Hydrogen Sulphide
Hg	-	Mercury
HR	-	Human Resource
HSE	-	Health, Safety and Environment
ICREEE	-	Inter- Ministerial Committee on Renewable Energy and Energy Efficiency
IDI	-	In-depth Interview
IEC	-	International Electrotechnical Commission
IED	-	Intelligent Electronic Device
IHR	-	International Health Regulations
ILO	-	International Labour Organisation
IPAN	-	Institute of Public Analysts of Nigeria
ITCZ	-	Inter-Tropical Convergence Zone
ITDZ	-	Inter-Tropical Discontinuity Zone (ITDZ)
IUCN	-	International Union for Conservation of Nature

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K - Potassium
KII - Key Informant Interview
KW - Kilowatts
LEMP - Labour and Employment Management Plan
LEMP - Labour and Employment Management Plan
LGA - Local Government Area
M.Sc. - Master of Science
Mg - Magnesium
mono-Si - Mono-crystalline silicon
MW - Megawatt
Na - Sodium
NAAQS - Nigerian Ambient Air Quality Standards
NACOP - National Council on Power
NBS - National Bureau of Statistics
NDC - Nationally Determined Contributions
NEEAP - National Energy Efficiency Action Plans
NEP - Nigeria Electrification Agency
NEPP - National Electric Power Policy
NERC - Nigerian Electricity Regulatory Commission
NESREA - National Environmental Standards and Regulations Enforcement Agency
Ni - Nickel
NiCd - Nickel cadmium
NIMET - Nigerian Meteorological Agency
NiNAS - Nigeria National Accreditation Service
NISEPA - Niger State Environmental Protection Agency
NO_2 - Nitrogen dioxide
NPC - National Population Commission
O&M - Operations and Maintenance
OHS - Occupational Health and Safety
OP - Operational Policy
OPC - Organic photovoltaic cells
OSH - Occupational Safety and Health (OSH)
Pb - Lead
PHCN - Power Holding Company of Nigeria
PMT - Project Management Team
poly-Si - Polycrystalline silicon
PPE - Personal Protective Equipment
PSRIP - Power Sector Recovery and Implementation Programme
PSRP - Power Sector Recovery Programme
PTC - Positive Temperature Coefficient
PV - Photovoltaic

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QA/QC	-	Quality Assurance and Quality Control
QHSE	-	Quality, Health, Safety and Environment (QHSE)
REA	-	Rural Electrification Agency
RFS	-	Rapid Field Biodiversity Survey
RH	-	Relative Humidity
SEA	-	Sexual Exploitation and Abuse
SEP	-	Stakeholder Engagement Plan
SO_2	-	Sulphur dioxide
SOP	-	Standard Operating Procedure
TBH	-	To Be Hired
TDS	-	Total Dissolved Solids
TFSC	-	Thin-film Solar Cell
THB	-	Total Heterotrophic Bacteria
THF	-	Total Heterotrophic Fungi
THUB	-	Total Hydrocarbon Utilizing Bacteria
THUF	-	Total Hydrocarbon Utilizing Fungi
TM	-	Tropical Maritime
TMP	-	Traffic Management Plan
TOC	-	Total Organic Carbon
TSP	-	Total Suspended Particulate
TWh	-	Terawatt-hour
V	-	Vanadium
Vmp	-	Voltage at Maximum Power Point
VOC	-	Volatile Organic Compounds
VRFB	-	Vanadium Redox Flow Battery
WBG	-	World Bank Group
WHO	-	World Health Organisation
WMP	-	Waste Management Plan
WRI CAIT	-	World Resources Institute Climate Data Explorer
Zn	-	Zinc

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This report presents the Environmental and Social Impact Assessment (ESIA) for the proposed solar mini-grid power projects to be developed in ten rural communities in Niger State. The projects are being developed as part of the Nigeria Electrification Project (NEP), a private sector-driven initiative of the Federal Government of Nigeria that seeks to provide electricity access to households, micro, small and medium enterprises in off-grid communities across the country through renewable power sources. The NEP is being implemented by the Rural Electrification Agency (REA) in collaboration with the World Bank, African Development Bank (AfDB) and other partners.

Engie Fenix Nigeria (Engie Fenix), a subsidiary of the Engie Group specializes in the design, manufacture, distribution, finance and provision of last-mile service for Solar Home Systems and Mini-Grid solutions. Engie Fenix, in collaboration with the REA, intends to develop and operate solar power mini-grid projects in ten (10) rural communities in Niger State, Nigeria. The project will be developed as part of the Performance-Based Grant sub-component of the World Bank-sponsored NEP being implemented by the REA. The beneficiary communities are located in rural areas within Niger State without connection to the national grid, and they include the following:

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1. Gbangba Community
2. Sheshimandiko Community
3. Kuchitagi Community
4. Dakpan Community
5. Dokogi Community
6. Naoko-Siyidi Community
7. Ragidda Hausawa Community
8. Mashigi Community
9. Mayaki Community
10. Kpanje Community

In compliance with the provisions of the Nigeria Environmental Impact Assessment (EIA) Act, No 86 of 1992 (now codified as the EIA Act CAP E12 Law of the Federal Republic of Nigeria, LFN, 2004) as well as the requirements of relevant international standards and guidelines such as the World Bank Safeguard Policies. Engie Fenix commissioned Environmental Accord Limited (EnvAccord), an accredited environmental and sustainability consulting firm to conduct an Environmental and Social Impact Assessment (ESIA) study for the proposed mini-grid solar power Projects. The ESIA study is also in fulfilment of commitments documented in the Environmental and Social Management Framework (ESMF) for NEP, as well as the corporate policies of Engie Group on the protection of the environment and human health.

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

- EIA Act CAP E12 LFN 2004
- National Policy on the Environment, 1989 (revised in 1999 and 2017)
- World Bank Safeguard Policies on Environmental Assessment
- National Environmental (Energy Sector) Regulations, 2014
- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991
- National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991
- National Environmental (Sanitation and Wastes Control) Regulations, 2009
- National Environmental (Noise Standards and Control) Regulations, 2009
- Niger State Ministry of Environment and Forestry Laws on Environmental Protection
- Basel Convention on the Control of Trans-Boundary Movement of Hazardous Wastes and their Disposal
- The United Nations Framework Convention on Climate Change
- Declaration of the United Nations Conference on Human Environment
- International Labour Organisation (ILO): ILO-OSH 2001 - Guidelines on Occupational Safety and Health (OSH) Management Systems

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2.0 PROJECT JUSTIFICATION

Need for the Project

The beneficiary communities in Niger State are mainly rural communities with little or no access to the national grid due to their remote locations. The proposed projects will generate electricity through a renewable energy source (Solar) to serve the communities. The deployment of off-grid power solutions to these underserved and unserved communities will provide significant benefits such as enhancement in the standard of living, health, and wellbeing of people in rural communities. The proposed projects will also be part of Nigeria's contribution to Africa's renewable energy target and as well improve the carbon footprint of Nigeria as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

Project Benefits

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

- Provision of clean, affordable and steady power supply to selected beneficiary communities within the project AoI.

- Improved standard of living for the beneficiary communities as access to electricity will enable them to use domestic appliances (e.g. pressing iron, fridges, television sets, washing machines, etc.).
- Reduction of human health risk (respiratory diseases, eye strain, etc.) associated with CO_2 emission from generators and use of Kerosene lamps, typically used indoors by the rural communities.
- Improved health characteristics and improved lifespan. The project will result in many families replacing kerosene lamps and generators for lighting with electricity there-by reducing disease burden at the family level and on the government.
- Multiplier effects from the availability of affordable power supply. These include the reduction in lightening costs to households, an increase in disposable income, more savings, and engendering inclusive growth, etc.
- Improved communications through electricity access for mass media and information sources such as televisions, radios, and mobile phones. This will be useful for informed decision making with regards to various aspects of their lives.
- Alleviating the daily household burdens of women, reducing women's drudgery, saving their time, improving their health and enhancing their livelihoods through the uptake of electrical appliances to enable them to perform domestic tasks and livelihood activities more efficiently and productively.
- Promoting gender equality, women's empowerment, and women's and girls' access to education, health care, and employment.
- Technology transfer and acquisition of new skills during construction and operation.
- Increase in local and regional business/commerce in the communities during and after construction through local material sourcing and sale of materials for use in the project.
- Development of cleaner power project with minimal Greenhouse Gas (GHG) emissions compared to petrol or diesel-fueled power projects.
- Provision of support to the Government's Renewable Energy Policy through the use of PV panels power generation rather than the use of gasoline and diesel generators.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to the acquisition of new skills and the introduction of all manners of income-generating spill-over effects.
- Increase in the local and regional economy through the award of contracts and purchase of supplies for Project development.

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Envisaged Sustainability of the Project

Technical Sustainability: The Project development shall be handled by qualified and experienced personnel according to the pre-established standards and procedures. The construction phase of the Projects shall be overseen by qualified engineers from Engie Fenix. Also, standard operating manuals and appropriate documentation regarding the operation and maintenance of the Projects shall be put in place. These documents will be used as the basis for providing facility-specific training to relevant personnel prior to start-up to further ensure technical sustainability of the Projects.

Environmental Sustainability: The environmental sustainability measures for the Projects include the use of renewable source of energy (solar) for electricity generation (with negligible GHG emissions compared to fossil fuel-burning power projects). The project is also in line with the FGN's efforts to keep greenhouse gases (GHG) emissions at the barest minimum, as part of efforts towards climate change mitigation and adaptation.

Economic Sustainability: The proposed solar mini-grid projects will be owned and operated by Engie Fenix. A cost-reflective service charge (to be determined based on consultation with beneficiary communities and relevant stakeholders) shall be implemented for all households connected to the project. All connected users will be metered and billed based on their power consumption. The generated income from the project shall be used to recover the construction costs and sustain the operational expenses.

Social Sustainability: Stakeholder consultation has been carried out as part of the ESIA development, to assist in ensuring that all relevant stakeholders are presented with the opportunity to provide input into the Project. This has also assisted in laying a good foundation for building relationship with the stakeholders.

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Project Alternatives

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

3.0 PROJECT DESCRIPTION

The proposed Engie Fenix solar mini-grid projects are planned to be located in ten (10) beneficiary communities which are distributed in four local government areas (Gbako, Edati, Lapai and Mashegu) in Niger State. The sites allocated for the proposed project are within rural communities with no access to electricity from the national grid. The topographies of the sites are relatively flat and there are no surface water bodies within 1km radius of each site. The vegetation within the sites are mostly grasses, shrubs and a few trees as majority of the sites are abandoned farmlands.

The solar PV panels will be installed within the project sites in arrays and power generated from the panels will be transmitted to the building to be constructed within the sites. The building will house the batteries, inverters and other associated electronic equipment for the proposed project. Also, another building will be constructed within the site to serve as the security post.

The power generated by the project components is planned to be distributed to the households within the communities where the project is sited using a single-phase system for household consumers, and three-phase system for productive power consumers. The transmission lines will emanate from the main distribution board at the project site and be distributed via overhead poles to the households. These lines will T-off as distribution lines in strategic points. The distribution lines will run through the households to power them, and electric meters shall be installed for monitoring power consumption for billing.

Each project site will have protection systems such as breakers and fuses in place, installed on the power generation components and within the power distribution network. Earthing design for the power generation units at each project site shall be by means of earth mat.

The pre-construction phase activities for the Project will include site clearing, and mobilization of equipment and construction materials to site. The construction phase activities will include civil, mechanical and electrical works; installation of PV panels and associated components such as mounting structures, inverters, batteries, and switchgear. Following the construction phase, the facilities will be tested and commissioned before operational phase. Activities during the operational phase will include power generation and distribution, and routine maintenance such as periodic cleaning of the PV panels.

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

The number of workers to be engaged for the construction phase will be determined by the engineering procurements and construction (EPC) contractor to be engaged for the project. During the operations phase, the project sites in the State will be overseen by the Cluster Manger, while local operators will be engaged to manage all day-to-day activities at each project site. Field Technicians and commercial officers will also be engaged for the proposed Projects.

A Technical manager to be selected by Engie Fenix shall manage and oversee the Health, Safety and Environment (HSE) aspects of the Project. The HSE personnel shall ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans; and also monitor implementation of environmental and social protection measures.

Waste Management

Engie Fenix is committed to ensuring that the proposed Project is designed, developed and operated in a sustainable manner. Thus, effective waste management practices that comply with the relevant local requirements and international best practices shall be implemented during all phases of the proposed Project. To achieve this, all contractors engaged during the lifecycle of the Project will put in place and comply with a site waste management plan. The potential waste streams associated with the proposed project phases include:

A. Pre-construction and construction phase: cleared vegetation, excavated soil, general refuse, garbage, inert construction materials, metal scraps, concrete waste, food waste, and used packaging materials.
B. Operational phase: paper waste, food packaging, e-wastes (damaged/discarded batteries, panels, inverters, cables, equipment, etc.).

The Extended Producer Responsibility (EPR) program will be implemented for solar panels, inverters, batteries and other electrical components to be installed for the Project. Damaged or discarded PV panels and inverters will be collected and sent to the manufacturer for recycling in line with the EPR model. Spent, damaged or expired batteries will also be returned to the manufacturer for recycling. In addition, an e-waste management company (Enviroserve) will also be engaged for all e-waste collection and recycling associated with the proposed project during the construction and operational phases of the project.

Project Schedule

At present, the pre-project planning activities (ESIA, Energy demand audits, engineering design, etc.) are ongoing. The pre-construction phase activities of the proposed project are scheduled to commence in Q2, 2021, and construction is scheduled to start in Q3, 2021 at the different sites. The proposed Project is planned to be operational by the fourth quarter (Q4) of 2021 within the communities.

4.0 DESCRIPTION OF THE ENVIRONMENT

The description of environmental conditions of the Project's area of influence is based on desktop studies and field investigations conducted at each beneficiary community in Niger State. Field sampling was conducted from October 12 to 19, 2020 by a team of environmental and social specialists.

Based on the consideration of the potential environmental and social footprints of the proposed Project, as well as the need to ensure that all the sensitive receptors that

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could be potentially affected by the proposed Project have been captured, a 1 km radius from the centre of the Project sites was selected as the spatial boundary for biophysical and socio-economic survey for each site.

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

Climate and Meteorology: the climate of Niger State is tropical and under the influence of the Inter-Tropical Convergence Zone (ITCZ) or Inter-Tropical Discontinuity Zone (ITDZ). Movement of these air masses results in two main seasons; a wet season from April to October, and a dry season from November to March. During the dry season, there are periods when the harmattan (a period characterized by dry dusty winds and relatively low temperatures) is experienced. This typically occurs during the months of December and January. Rainfall generally occurs from April to October with peak periods (highest rainfall values) from July to September. The highest average monthly sunshine hours occur from October to May, while August is the least.

Geology and Hydrogeology: About one half of the landmass of Niger State is underlain by the Basement Complex rocks while the other is occupied by the Cretaceous sedimentary rocks of the Bida Basin and part of the Sokoto (Iullemeden Basin). The boundary between these runs in a northwest – southeast direction, with the Basement rocks to the north and the sedimentary Formation to the south.

Air Quality and Noise: A total number of five (5) sampling locations were established for ambient air quality and noise study for each project site. The parameters measured at each site include Sulphur (IV) Oxide (SO_2), Nitrogen (IV) Oxide (NO_2), Carbon Monoxide (CO), Carbon (IV) Oxide (CO_2), Volatile Organic Compounds (VOC), Hydrogen Sulphide (H_2S) and Total Suspended Particulate (TSP). The results obtained from all the project sites were within the FMEnv and World Bank maximum permissible limits. This could be attributed to the rural setting of the project sites and remoteness from any major emission sources.

Soil Quality: The dominant soil type within the Project sites was clay soil based on the grain size analysis conducted on samples obtained from each project site. No heavy metal and hydrocarbon pollution was recorded in the soil samples collected from any of the Project sites. Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni) were below the detection limits in the samples from the Project site and AoI. The concentration of Zinc (Zn) and Iron (Fe) measures within the samples were also within the naturally occurring limits.

Groundwater Quality: Groundwater samples were collected from boreholes and hand-dug wells in the study areas (mostly from sources close to the Project site and within the local communities). The concentrations of parameters analyzed in the groundwater samples were generally within the FMEnv and WHO limits for

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substances and characteristics affecting the acceptability of groundwater for domestic use. However, the pH of the groundwater obtained from some of the project sites (Dakpan, Kuchitagi, Raggida Hausawa, Nakoko Siyidi, and Mashigi communities) were acidic. This was attributed to the geology of the area, thus, indicating potential corrosiveness.

Terrestrial Flora: The natural ecosystem of the Project sites was observed to have been substantially altered by human activities, mainly farming, burning, and fuelwood harvesting. From the field analysis, it was evident that the flora composition of the all the project sites were identical because of anthropogenic influences, mainly agricultural and pastoral activities. The sites had little diversity of plants since the natural vegetation has been replaced by different populations of weeds such as *Hyptis suaveolens* and *Cleome viscosa.* The plant species encountered in the study area fall under Not Evaluated, according to the IUCN (International Union of Conservation of Nature) Red List of Threatened Species. None of the recorded plant species in the study area is critically endangered or endangered. In addition, there are no known protected species on the Project site under the Nigerian legislation.

Terrestrial Fauna: The fauna species observed at the sites were generally few and mostly small invertebrates such as earthworms, insects, Grasshoppers, Butterflies, spiders. Also, vertebrates such as Lizards, birds, and rodents were sighted within the Project sites and AoI.

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Socio-economic and Health: The socioeconomic and health studies conducted for each of the beneficiary communities was based on information gathered through extensive literature reviews, focus group discussions, key informant interviews, direct observations, and questionnaire administration. The demographic profile for each of the beneficiary communities are summarized as follows:

<u>Nakoko Siyidi village</u>: is composed of people from Nupe, Hausa and Fulani ethnic groups. The prevalent religion is Islam, and about 77.50% of respondents from the community were married, while 22.5% identified as single. The village is a nucleated settlement that was established about 36 years ago when some farmers moved into the area and settled, after obtaining permission from Kao Village (a nearby community). Majority (96%) of the respondents from the community are self-employed as farmers and petty traders.

<u>Dokogi Village</u>: residents migrated from Apofu, an area in Lavun local government. They are mostly involved in rice farming, agriculture processing (rice and millet), and some are fishermen. The ethnic composition of the village comprises of Nupe, Hausa and Fulani ethnic groups, and the dominant religion is Islam. Educational attainment is low in the village, as many of the respondents during the survey had only primary education or Islamic education. 80% of the respondents were married, while 20%

were single. The religious and cultural beliefs of this village limit women, especially married women, to housekeeping and other household engagements.

Gbangba Village: was formed many years ago when some of the villagers migrated to the area. The community is composed of Nupe, Hausa and Fulani ethnic groups who are predominantly Muslims. The level of educational attainment in the village is also low, as many of the respondents had only primary education or Islamic education. All respondents during the survey were married, but it was observed that married women often spend a lot of their time in the house, and are restricted from engaging with strangers, especially males. All respondents from the community were self-employed either in farming, processing of farm produce, or trading. It was also observed that the processing of farm produce is a major activity for women in the village.

Kuchitagi Village: residents are composed of Hausa, Nupe and Fulani ethnic groups. Farming is the most common livelihood activity in the village that is practiced by men, while the women are often restricted to housekeeping activities due to the local culture, tradition and religious beliefs. Islam is the predominant religion, and a large percentage of respondents in the community have no formal education with 15% of respondents stated to have attained primary school education. Only 15% of the respondents from the community claimed to be single, and age composition among the respondents is skewed towards the economically active people. 42% of the community members are within the age range of 18 – 40 years while others are 40 years above.

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Dakpan Village: is a remote rural community that is almost exclusively inhabited by Nupe, Fulani, and a few numbers of Hausa ethnic group. Islam is the dominant religion practiced in the community, and 76% of the respondents are married while 24% are single. All the residents who were interviewed during this study were active farmers who specialize in rice, corn, and other farm produce. The level of formal education in this community is low with only 7.14% of the survey respondents had a primary school education, the 92.86% had training from Arabic school and no other formal education.

Sheshimandiko Village: the community was established by migrants who settled in the area many years ago so that they could be close to their farmlands. At present, the population of the community consists of mostlyu economically active people. All respondents stated that they were married during the survey, and 8% are above 60 years while others are within the age range of 18 – 59 years old. Educational attainment is low, as respondents have only attained either Islamic education, or primary school level of education.

Ragidda Hausawa Village: residents are mostly Nupe and Hausa. The village was established by local farmers from neighboring villages who came to settle close to their farmlands in the area. The major livelihood activities among the residents in the village is agriculture, and some residents are into commercial farming activities. Data from the survey showed that 71% of the respondents from the village were married while 29% are single, and polygamy was common among the villagers. The age distribution data shows that 94% of the village members were within the age group of 31-45 years. All the residents who were interviewed during this study were self-employed, all engaged in farming activities.

Mashigi Village: residents are involved in farming and trading as their major livelihood activities. The population is composed of Hausa, Fulani and Nupe ethnic groups. All respondents during the survey stated that they practice Islam and they are all married. The age distribution shows that 78% of the village members were within the age group of 20-45 years, which implies a high proportion of economically active people in the community.

Kpanje Village: was created through the unity of three villages: Kpanje, Warashiri and Koshifiyi villages. Within the Kpanje village, the common livelihood activities are farming and fishing. The village is also well known for rice farming and production. The age composition of the village is distributed majorly among economically active people; only 12% are above 60 years, others are within the age range of 18 – 59 years old. The ethnic composition of the village comprises of Nupe and Hausa ethnic groups. The prevalent religion in the community is Islam.

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Mayaki Village: is a remote village comprising of mostly farmers, and a few farm produce traders. Most farmers are large scale farmers. About 81% of the respondents from the village are married while 19% are single, and polygamy is common in the village. Also, about 92% of the household members were within the age group of 20-45 years.

Generally, all of the communities lack access to power supply from the national grid, and their overall level of infrastructure is poor. The communities are clustered rural settlements where families live close to each other; and their houses are surrounded by fields and farmlands. Lands are communally owned, and are usually allocated by the village heads. Access to healthcare is generally challenging as only two of the communities (Dakpan and Sheshimandiko) have healthcare centres, which were noted to be inadequate.

Gender assessment studies conducted in the villages during the baseline studies revealed that the all the villages were patriarchal societies, and women were mostly restricted to domestic roles. Women are generally underrepresented in leadership roles, and they limited in their decision making autonomy. Although some villages had women support groups, many of the women were economically inactive as their spouses do not permit them. The common Gender Based Violence (GBV) risks identified in the communities include marital rape, non-consensual sex, child marriage, and female genital mutilation. Also, there were no GBV response centers identified within the project areas.

Community Concerns and Perceptions

During the town hall meetings across the ten (10) communities, discussions were held with the men, youths, and women. The Project components and associated impacts were carefully explained during the meetings. As observed, the reactions of the communities' leaders and members were positive, and they provided positive comments about the Project. The community members believe that it would significantly improve their standard of living, and that there are impending economic advantages for them in terms of jobs as a result of the Project. Their major concerns were the pricing of the power supply, and how soon the project development would commence in their communities.

Stakeholder Engagement

Stakeholder engagement was conducted as part of the ESIA for the proposed project. This included a review of the legal and administrative framework, stakeholder identification and analysis, and initial consultation with stakeholders. Comments and issues raised by relevant stakeholders consulted during the ESIA study were provided in the report. Consultations and interactions (including virtual meetings) were held with the relevant stakeholders to the Project from October 13th to 23rd, 2020. They include:

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- Niger State Ministry of Environment
- Niger State Environmental Protection Agency
- Niger State Ministry of Works
- Niger State Renewable Energy Department
- Gbako LGA Authority
- Edati LGA Authority
- Mashegu LGA Authority

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

5.0 ASSOCIATED AND POTENTIAL RISKS AND IMPACTS

The potential environmental and social (E&S) risks and impacts associated with the proposed Project were identified and ranked across each phase of the Project development. During the pre-construction phase, the significant impacts identified are the displacement of temporary farmlands within three (3) communities, impacts to soil during site clearing and land preparation activities, and impacts on worker's safety during pre-construction phase activities.

The significant impacts identified for the construction phase include: air quality and noise impacts from construction activities, increased soil erosion potential and reduction in structural stability due to civil works, discrimination of women during employment, GBV risks, community health and safety impacts due to influx of workers and construction activities, and occupational health and safety hazards. During the commissioning phase, the proposed Project is presumed to have minor noise impact and OHS hazards such as injuries. The operational phase will have significant risks such as electric shock and injuries to workers, GBV risks, and work-related issues (poor working conditions and discrimination). The decommissioning phase will have significant impacts on the soil and road traffic of the Project area.

Some of the potential positive impacts associated with the proposed Project include: improvement in standard of living for the communities, employment opportunity, promotion of clean energy source, reduction of GHG emissions, and skill acquisition and transfer of knowledge and skills through training.

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6.0 MITIGATION MEASURES

Recommended mitigation measures required to complement those incorporated in the Project design for the identified negative impacts were proffered while enhancement measures for the positive impacts were similarly presented and documented in this report.

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

<u>Pre-construction Phase</u>

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

- The affected farmers shall be allowed to harvest their crops before site clearing activities.
- The sites shall be fenced to avoid further encroachment by farming activities before site clearing.
- Removal of vegetation and soil cover shall be restricted to the areas required for the Project.
- Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas.
- Disturbed areas will be rehabilitated as soon as possible to prevent erosion.

- The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated.
- Clearing exceeding the approved working corridor shall be prohibited.
- Site clearing shall be limited to the day time as much as possible (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr)
- Provision of adequate personal protective equipment (PPE) such as nose masks and safety boots shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.

<u>Construction Phase</u>

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

- Regular maintenance and servicing of construction equipment /machinery shall be ensured.
- Only modern and well maintained equipment and machinery shall be used for construction activities.
- Routine water sprinkling shall be carried out to minimize dust generation during construction.
- Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). In the event that noisy activities are undertaken outside of the specified working hours, all noise receptors in the Project area shall be informed of such activities in advance.
- Construction machinery shall be turned off when not in use.
- A procedure for recording all construction related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc.
- A GBV Action Plan shall be implemented for the Project
- All workers on the project shall be required sign a code of conduct (CoC) to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)
- The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site.
- Health and Safety Plan shall be developed and implemented by the EPC Contractor. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence
- Construction workers shall be sensitized and monitored on the need to be safety conscious.
- Daily toolbox talks prior to commencement of work activities shall be carried out.
- Proper safety signs and signage shall be placed at strategic locations within the site.

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- PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored.
- Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers.
- Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible.
- The local community shall be informed of the Project activities prior to commencement of work.
- An induction and sensitization programme, including a Code of Conduct, for all construction workers shall be carried out prior to construction activities. This will increase sensitivity to local norms and customs, provide awareness to construction workers of appropriate and acceptable behaviours, and will govern worker interactions with the local community.
- Procedure for receiving and addressing community concerns shall be developed and implemented.
- Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment.
- Portable spill containment and clean-up kits shall be available onsite.
- A Waste Management Plan shall be developed by the EPC Contractor and implemented
- E-wastes generated shall be stored in appropriate locations set up at the Project site prior to recycling and/or disposal.

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<u>Commissioning Phase</u>

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

- The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations.
- Strict compliance to the Standard Operating Procedures shall be ensured.
- The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.

<u>Operation Phase</u>

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

- Strict compliance to the standard operating procedures for the diesel generators shall be ensured.

- Regular maintenance of diesel generators shall be ensured as required by the manufacturer.
- A cleaning schedule shall be developed and implemented for cleaning the panels installed at the project site during operations.
- The solar panels shall be inspected regularly for dust and rain damages and maintained according to manufacturer's instructions.
- Inverters shall be maintained as per manufacturer's recommendations and operated as per original specifications.
- The diesel generators shall be operated with the sound proof covers at all times.
- Periodic maintenance of the diesel generators shall be carried out.
- Appropriate PPE shall be provided for workers.
- Training shall be provided to employees on emergency preparedness and responses.
- Appropriate safety signage shall be placed at strategic locations within the site.
- Strict compliance to the SOPs / code of conduct shall be ensured.
- A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.
- Equal treatment of workers shall be ensured.
- Continuous implementation of the GBV Action Plan shall be sustained for the Project
- All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)
- GBV sensitive channels for reporting in GRM shall be implemented for the Project
- Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained.
- All workers shall be required to undergo regular training and refreshers on GBV
- Engie Fenix shall provide separate facilities for men and women and add GBV-free signage at the project site.
- All gender-based violence incidents shall be reported and dealt with as per the law.
- General housekeeping to ensure the site is not overgrown with grasses shall be maintained
- Burning of waste shall be prohibited.
- Damaged/expired batteries, solar panels, inverters and electric components shall be returned to the manufacturer based on the Extended Producer Responsibility (EPR) model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site.

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- Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment.
- Portable spill containment and clean-up kits shall be available onsite.
- E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal
- Waste receptacles shall be provided within a secured area for collection of solid waste.
- Water management plan shall be implemented
- Manual cleaning of the PV panels with water shall be regulated as much as practicable. The frequency of cleaning of PV panels with water is dependent on the rainfall pattern in the project area. During rainy season, cleaning is estimated to occur not more than thrice; however, during dry season the interval shall depend on the rate of dust accumulation.

7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

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

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

8.0 REMEDIATION PLAN AFTER DECOMMISSIONING/CLOSURE

Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle. The average life span of the solar power plant to be provided as part of the proposed Project is 25 years (which can be extended through regular maintenance) while the training centre can last for 40 years or more. Even after the 25 years, the PV panels can still generate up to 90 % of the design capacity.

In the event of decommissioning, the management of Engie Fenix Nigeria, shall ensure that the Project site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be invoked. The tasks will include, amongst others:

- Evacuation of the dismantled PV panels and other related items (such as inverters, and control devices) to the manufacturers for recycling;
- Transportation of spent batteries to recycling facilities;
- Restoration of the Project site to baseline conditions (as much as practicable) in line with legislative and regulatory requirements.
- Assessing the residual impact, if any, the project has on the environment.
- Monitoring the abandoned project environment as necessary.

Decommissioning activities will only begin after due consultation with the relevant stakeholders including the regulatory authorities. The decommissioning activities shall be carried out in line with the relevant provisions of the National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the FMEnv.

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9.0 CONCLUSION AND RECOMMENDATIONS

The ESIA of the proposed solar mini-grid projects in Niger State has been conducted in accordance with the relevant requirements of FMEnv guidelines and the applicable World Bank Safeguard Policies, specifically the Operational Policy 4.01 triggered by the proposed Project.

The ESIA study consists of a number of key steps including: desktop review, scoping, consultations with relevant stakeholders including relevant government authorities and potentially affected community in the Project's area of influence, field data gathering, laboratory analysis of field samples, potential impact identification and evaluation, development of mitigation measures and environmental management plan, report writing and disclosure.

Based on the nature and extent of the proposed Project and the findings of this study, it is believed that the potential negative impacts associated with the proposed Project can be mitigated to as low as reasonably practicable through the implementation of the proffered mitigation measures documented in this report, while the positive impacts can also be enhanced.

The ESIA study recommends the following:

1 Engie Fenix Nigeria, through its Project Management Team (PMT), shall ensure that the proposed Project is developed and operated in an environmentally sustainable manner by properly managing the processes/activities that may bring about disturbances to the environment

through the implementation of the recommended mitigation measures and the ESIA.

2 Continuous monitoring of environmental and social performance of the Project shall be ensured, including periodic consultation with the relevant regulatory authorities, the potentially affected community, and other relevant stakeholders throughout the Project life cycle.

3 Implementation of the Project's Stakeholder Engagement Plan (including grievance redress mechanism) shall be maintained.

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CHAPTER ONE:

INTRODUCTION

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CHAPTER ONE

INTRODUCTION

1.1 Background Information

The Federal Government of Nigeria (FGN) has set a goal to increase access to electricity to 75% and 90% by 2020 and 2030 respectively and at least 10% of the renewable energy mix by 2025 as contained in the National Electric Power Policy (NEPP) of 2001 and the Rural Electrification Policy of 2005 respectively (RESIP, 2016). Improving energy access to rural areas in Nigeria will enable the provision of basic needs, which are essential indices of socio-economic development by improving agricultural methods, and businesses that are responsible for creating goods and services that sustain society (Uzoma and Amadi, 2019). The FGN, through the Rural Electrification Agency (REA), initiated the Nigeria Electrification Project (NEP) as one of the programs to achieve this goal.

The NEP is a private sector-driven initiative that seeks to provide electricity access to households, micro, small and medium enterprises in off-grid communities across the country through renewable power sources. NEP is being implemented by the Rural Electrification Agency (REA) in collaboration with the World Bank, African Development Bank (AfDB) and other partners.

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One of the major components of the NEP is the development of solar hybrid mini-grids for Rural Economic Development. This component is aimed at serving about 300,000 households, and 30,000 local enterprises, with mini-grid operators. The component will be implemented by private sector partners to provide electricity to the households on a commercial basis. Some communities within Niger State have been selected to benefit from this component. Engie Fenix Nigeria, in collaboration with the REA and World Bank, will develop and operate the projects in Niger State.

Engie Fenix Nigeria (Engie Fenix) is a subsidiary of the Engie Group, a French multinational electricity utility company which operates in the fields of energy transition, electricity generation and distribution, natural gas, nuclear, renewable energy and petroleum. Engie Fenix specializes in the design, manufacture, distribution, finance and provision of last-mile service for Solar Home Systems and Mini Grid solutions. The company intends to develop and operate solar power mini-grid projects in some selected rural communities in Niger State, Nigeria. The project will be developed as part of the Performance Based Grant sub-component of the World Bank-sponsored Nigeria Electrification Project (NEP) being implemented by the Rural Electrification Agency (REA).

In compliance with the provisions of the Nigeria Environmental Impact Assessment (EIA) Act No 86 of 1992 (now codified as the EIA Act CAP E12 Law of the Federal Republic of Nigeria, LFN, 2004) as well as the requirements of relevant international standards and guidelines such as the World Bank Safeguard Policies. Engie Fenix commissioned Environmental Accord Limited (EnvAccord), an accredited environmental and sustainability consulting firm to conduct an Environmental and Social Impact Assessment (ESIA) study for the proposed mini-grid solar power Projects. The ESIA study is also in fulfilment of commitments documented in the Environmental and Social Management Framework (ESMF) for NEP, as well as the corporate policies of Engie Group on the protection of the environment and human health.

1.2 Overview of the Project

The project will involve the construction and operation of solar photovoltaic (PV) panel systems at selected sites distributed within Niger State. The solar panels will be installed on the sites using piling foundations, and the power generated will be distributed to the local communities close to the site. A powerhouse will be constructed within each site for the inverters, batteries and associated components installed for the proposed projects. A diesel generator is planned to be installed at each site, to serve as backup source of power for the project. The power generated from the project will be distributed within the communities via overhead cables installed by Engie Fenix. The customers (i.e. households connected to the project) will be fitted with electricity meters to measure their power consumption for billing. The proposed project will ensure the provision of safe, reliable and affordable power supply to the beneficiary communities.

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The mini-grid solar power Projects will be developed at ten (10) different sites in Niger State. The list of the beneficiary communities and proposed power generation capacities of the solar plants to be installed are presented in Table 1.1 below.

Table 1.1: Beneficiary communities in Niger State

S/N	Community/Site name	Local Government Area (LGA)	*Power Capacity (kWp)
1.	Gbangba	Gbako	85
2.	Sheshimandiko	Gbako	85
3.	Kuchitagi	Gbako	85
4.	Dakpan	Gbako	85
5.	Dokogi	Edati	85
6.	Kpanje	Edati	85
7.	Nakoko-Siyidi	Mashegu	85
8.	Ragidda Hausawa	Mashegu	85
9.	Mashiyi	Mashegu	85
10.	Mayaki	Lapai	85

***The capacities of the solar power plants presented in this table are yet to finalized as at the time of this ESIA Study, as power audit and engineering designs are ongoing.**

1.3 ESIA Objectives

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

The specific objectives of the ESIA study are to:

- Establish and document the existing environmental and social conditions of the Project's Area of Influence[1] prior to construction, including any cultural resources and sensitive components of the environment.
- Assist Project design and planning by identifying those aspects of location, construction, operation and decommissioning which may cause adverse environmental and social impacts, including occupational and community health and safety issues.
- Develop appropriate and practicable mitigation measures and environmental and social management plan (ESMP) including monitoring programme, responsible parties, timeframe and cost estimates required to address the identified adverse impacts and enhance the associated Project benefits (e.g. positive climate impact).
- Conduct stakeholder consultations to capture the concerns of the various stakeholders (e.g. relevant government institutions, potentially affected persons, etc.) about the Project including gender-based violence (GBV) risks.
- Prepare a detailed report presenting clear and concise information on the findings of the ESIA study.
- Obtain FMEnv approval for the proposed Project.

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1.4 Scope of the ESIA

The scope of the ESIA covers the following:

- Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed Projects.
- Description of all actions/activities that will be carried out in the course of the Project development and implementation.

[1] Based on a consideration of potential environmental and social aspects/footprints of the Project, the area of influence (AoI) of the Project is defined as each project site and its surrounding environment up to approximately 1 km radius. The spatial boundary has been selected to ensure that all sensitive receptors that could potentially be affected by the Project are covered as well as the areas where cumulative impacts of the Project may be experienced.

- Desktop review of relevant documents pertaining to the Projects and the environment where the Project would be located.
- Field data gathering covering biophysical and socio-economic components of the Project's Area of Influence.
- Consultations with relevant stakeholders including government institutions, beneficiary communities, etc.
- Laboratory analysis of field samples and data analysis.
- Impacts identification and evaluation, and development of appropriate and practicable mitigation measures.
- Report preparation and disclosure.

1.5 ESIA Study Approach

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

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

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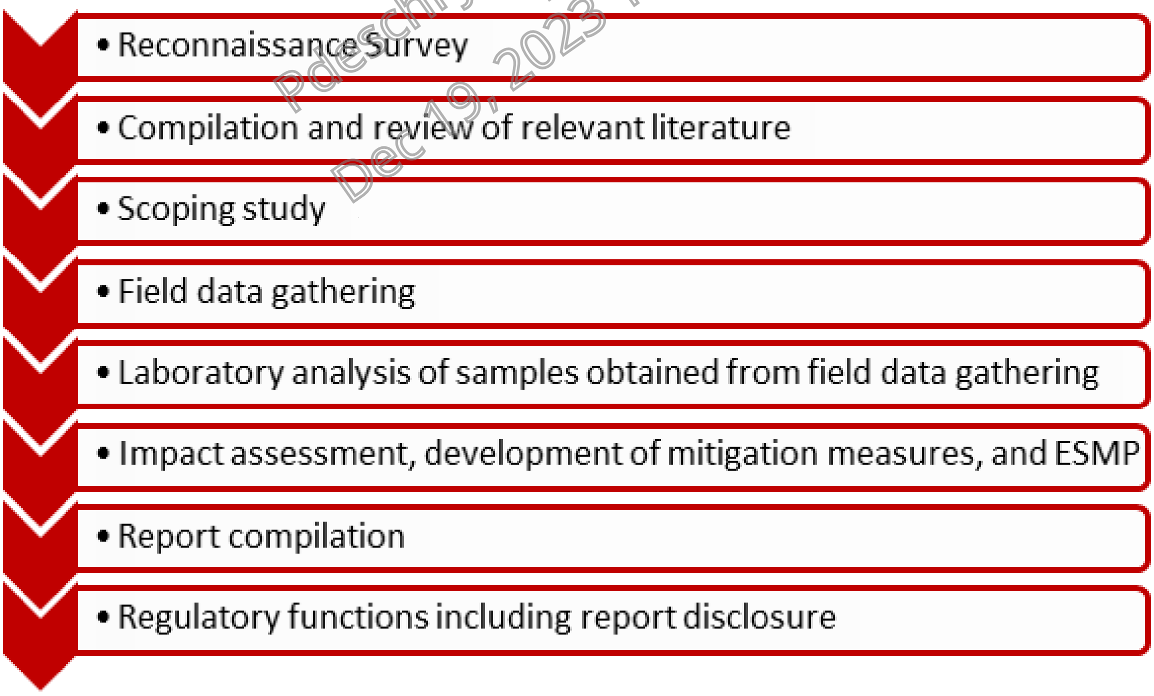

Figure 1.1: Schematic presentation of the general methodology for the ESIA

1.6 Legal and Institutional Framework

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

1.6.1 National Policy, Guidelines and Regulations

1.6.1.1 Federal Ministry of Environment (FMEnv)

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

In furtherance of her mandate, the FMEnv developed laws/guidelines on various sectors of the national economy. The specific policies, acts, guidelines enforced by FMEnv that are applicable to the Project are summarized as follows:

- *National Policy on the Environment, 2017*

The National Policy on the Environment, 2017 provides for "a viable national mechanism for cooperation, coordination and regular consultation, as well as harmonious management of the policy formulation and implementation process which requires the establishment of effective institutions and linkages within and among the various tiers of government that is, federal, state and local government". The objective of the policy is to achieve sustainable development in Nigeria pertaining to:

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

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

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

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

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

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

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

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

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

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Based on the provisions of the EIA Act, a full-scale EIA study is not required for the Project (the power generation capacity is less than 10MW). This has thus necessitated the development of this ESIA to identify and manage the potential impacts of the Project throughout its life cycle.

❖ *National Environmental Impact Assessment Procedural and Sectoral Guidelines*

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

1.6.1.2 National Environmental Standards and Regulations Enforcement Agency

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

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

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

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

This regulation highlights the permissible noise levels to which a person may be exposed; control and mitigation of noise; permits for noise emissions in excess of permissible levels; and enforcement. The NESREA's permissible noise level for ambient environment is 85 dB(A).

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

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

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

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

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Other NESREA regulations relevant to the Project are:

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

species of endangered wildlife from extinction through the prohibition of trade, importation, etc.

- *S.I. 32 National Environmental (Control of Alien and Invasive Species) Regulations, 2013*: This regulation seeks to prevent the decline, minimize the modification and destruction of ecosystem, and human health caused by alien and invasive species.
- *S.I. 64 National Environmental (Air Quality Control) Regulations, 2013*: The objective of this regulation is to ensure the control of air pollutants that may affect the ambient environment.

1.6.1.3 Federal Ministry of Power, Works and Housing

The Federal Ministry of Power, Works and Housing is the policy making arm of the Federal Government with the responsibility for the provision of power in the country. The Ministry is guided by the provisions of the Electricity Act No 28 of 1988, the National Electric Power Policy, 2001, the Electric Power Sector Reform Act, 2005, the Roadmap for Power Sector Reform, 2010, and the National Energy Policy, 2013. These policies are briefly described below:

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

In order to ensure a safe, steady, reliable and progressively improved electric power sector in Nigeria, the Electric Power Reform Implementation Committee (EPIC) was inaugurated by the Bureau of Public Enterprises (BPE) and resulted in Federal Executive Council (FEC) of Nigeria approving the National Electric Power Policy in September 2001, which recommended, amongst others: establishment of the electric power sector regulator and the privatization of the electric power sector.

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- *Electric Power Sector Reform Act 2005*

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

- *The National Energy Policy (NEP) 2013*

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

- *The National Energy Efficiency Action Plans of Nigeria*

The first version of the National Energy Efficiency Action Plans (NEEAP) for Nigeria (2015 -2030) was approved on July 14, 2016 by the National Council on Power

(NACOP). It has been formulated within the framework of United Nations' Sustainable Energy for All (SE4All) and adopted by the Inter-Ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE).

The NEEAP includes baseline data and information on energy efficiency activities and programmes in Nigeria, barriers to the development and promotion of energy efficiency in the country and suggested achievable energy efficiency targets, including gender disaggregated indicators, based on national potentials and socio-economic assessments. The implementation of the NEEAP is being monitored by the Federal Ministry of Power, Works, and Housing.

- *Rural Electrification Agency*

The Rural Electrification Agency was set up by Section 88 of the Electric Power Sector Reform Act 2005 as the Implementing Agency of the FGN tasked with electrification of rural and unserved communities. The mission is to provide access to reliable electric power supply for rural dwellers irrespective of where they live and what they do, in a way that would allow for reasonable return on investment through appropriate tariff that is economically responsive and supportive of the average rural customer. The NEP is one of the key programmes being implemented by the REA to achieve this mission. The REA has developed an Environmental and Social Management Framework (ESMF) for the NEP which is being implemented to clarify E&S management policies, processes, and mitigation principles, organizational arrangements and design criteria to be applied to subprojects, which are to be prepared during project implementation by both REA and private sector companies participating in the project. This ESIA is being developed for the proposed projects as part of the requirements of the NEP ESMF.

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1.6.1.4 <u>Nigerian Electricity Regulatory Commission (NERC)</u>

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency inaugurated on October 31, 2005. The Commission is mandated to carry out the following, amongst others:

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

1.6.1.5 <u>Acquisition of Land Access Rights for Electricity Projects Regulations, 2012</u>

This is a Nigerian Electricity Regulatory Commission Act which provide a regulatory framework for the acquisition of land and access rights for electricity projects in Nigeria. This Act also stipulates provisions for the payment of compensation and resettlement of persons affected by the acquisition of their land for the establishment of electricity projects as well as the monitoring and evaluation of project designs of licensees to ensure compliance with environmental standards. The Regulations apply to the acquisition of land access rights for electricity in Nigeria, including projects related to generation, transmission and distribution of electricity.

1.6.1.6 Renewable Energy and Efficiency Master Plan (REEMP), 2016

The REEMP is a policy being implemented by Nigeria's Federal Ministry of Environment that aims to increase the contribution of Renewable Energy to account for 10% of Nigerian total energy consumption by 2025. The initial Renewable Energy Master Plan (REMP) was produced in 2006 but was recently updated and approved in June 2016 as the Renewable Energy and Efficiency Master Plan (REEMP). The REEMP articulates Nigeria's vision and sets out a road map for increasing the role of renewable energy in achieving sustainable development. The policy primarily addresses Nigeria's need for increased electricity supply, improved grid reliability and security. The REEMP set the framework for Nigeria to be less dependent on hydrocarbons and increases energy generation from the Sun, biomass conversion, small hydro plants and wind as well as other conventional technologies that will provide opportunities to empower people and communities in meeting their energy and developmental needs.

1.6.1.7 National Policy on Occupational Safety and Health

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

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1.6.1.8 Harmful Waste (Special Criminal Provisions) Act No 42 of 1988 (amended in 2004)

The Harmful Waste (Special Criminal Provisions) Act No 42 of 1988 (amended in 2004) prohibits and declares unlawful all activities relating to the purchase, sale, importation, transit, transportation, deposit, storage of harmful wastes. Appropriate penalties for contravention are prescribed.

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

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

1.6.1.10 Labour Act of 1990 (amended by Labour Act Cap L1, LFN 2004)

Nigeria has ratified all core International Labour Organisation Conventions. The Labour Act is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers.

1.6.1.11 Public Health Law of Nigeria CAP 103 LFN 1990

In Nigeria, the Public Health Law provides justification for the execution of developmental projects under guidelines that promote health by protecting the environment and safeguarding the humans' health. Subsections 6 and 7 of 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.

1.6.1.12 Land Use Act

The Land Use Act was established in 1978 and revised in 1990 and 2004. Section 1 of the Act vests the entire land in any state in the Governor of the State. The Acts also specify the procedures the State must follow to clear the land, and define the compensatory measures the State must implement in order to compensate any affected person. The project sites will be acquired via direct purchase from the beneficiary communities by Engie Fenix.

1.6.1.13 Employees Compensation Act

The Employee's Compensation Bill 2010 was signed into Law in 2010. The Act repeals the Workmen's Compensation Act Cap W6 LFN, 2004. It is designed for an open and fair system of guaranteed and adequate comprehensive provisions for payment of compensation to employees who suffer from occupational diseases or sustain injuries arising from accident at workplace or in the course of employment.

1.6.1.14 National Guidelines for Decommissioning of Facilities in Nigeria (2017)

The purpose of this guideline is to provide clear directions and guidance on the step by step process involved in decommissioning a facility in Nigeria. The guideline is to aid in achieving an effective and environmentally sustainable decommissioning process that shall be compatible with intended future land use on health concerns and environmental impacts.

1.6.1.15 Violence Against Persons (Prohibition) Act, 2015

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

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1.6.1.16 Natural Resources Conservation Act CAP 349 LFN 1990

The Natural Resources Conservation Act CAP 268 LFN 1990 is the most direct existing piece of legislation on natural resources conservation. The Act establishes the Natural Resources Conservation Council, which is empowered to address soil, water, forestry, fisheries and wildlife conservation by formulating and implementing policies, programmes and projects on conservation of the country's natural resources.

1.6.1.17 Public Health Law Cap 103 LFN 1990
Public Health Law examines the authority of the government at various jurisdictional levels to improve the health of the general population within societal limits and norms. The State is empowered to protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria. The law prohibits the public or private sector of the economy not to undertake or embark on or authorize projects or activities without prior consideration of the effect on the environment.

1.6.1.18 Energy Commission of Nigeria Act CAP 109 LFN 1990
The Act was promulgated to create the Energy Commission of Nigeria (ECN) with responsibility for coordinating and general surveillance over the systematic development of the various energy resources of Nigeria. Subject to this Act, the ECN is charged with the responsibility for the strategic planning and co-ordination of national policies in the field of energy in all its ramifications. The mandates of ECN include statistical analysis of Electricity Generation, Transmission and Distribution.

1.6.1.19 National Gender Policy, 2006
Nigeria put together the National Gender Policy in 2006. Its overall goal is to promote the welfare and rights of Nigerian women and children in all aspects of life: political, social and economic. The policy seeks to plan, coordinate, implement, monitor and evaluate the development of women in the country. In concrete terms, the National Gender Policy in Nigeria focus on:

- Contribution towards women's empowerment and the eradication of unequal gender power relations in the workplace and economy, in trade unions and in broader society;
- Encouragement of the participation, support and co-operation of men in taking shared responsibility for the elimination of sexism and redefining of oppressive gender roles;
- Increase the participation of women in leadership and decision-making;
- Ensure that through labour legislation and collective bargaining, the particular circumstances of women are considered and that measures are promoted to eliminate discrimination on the basis of gender;
- Ensure that there is a gender perspective in all sectors of development.

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1.6.2 State Laws
The proposed Projects are to be sited in three sites located within three (3) LGAs in Niger State. The key state administrative authorities and legal instruments relevant to the proposed Project are briefly described below:

1.6.2.1 Niger State Ministry of Environment & Forestry
The Niger State Ministry of Environment & Forestry is responsible for the management and protection of the environment in Niger State. The Ministry works with other relevant agencies and authorities to ensure a conducive and sustainable

development of the environment in the state.

1.6.2.2 Niger State Environmental Protection Agency (NISEPA)

The Agency was created in 1996 by the Niger State Government through an edict (amended in May 2011). The Agency is mandated to raise environmental awareness among the people of Niger State for sustainable development as well as monitor waste management.

1.6.3 Local Government Laws on Environmental Protection

The proposed project sites fall within the jurisdiction of the following Local Government Area (LGA) authorities:

- Mashegu LGA
- Gbako LGA
- Edati LGA
- Lapai LGA

The LGAs have Environmental Health Departments which ensure compliance with environmental sanitation laws, including maintaining good housekeeping and proper management of waste, amongst others.

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1.6.4 International Guidelines and Conventions

In addition to the national regulations, this ESIA has been developed to comply with the requirements of the applicable international guidelines and standards as discussed in the sub-sections below:

1.6.4.1 International Guidelines and Standards

- *The World Bank Safeguard Policies*

The environmental and social safeguard policies of the World Bank are the fulcrum of its support towards sustainable poverty reduction, particularly in developing countries. The policies aimed at preventing and mitigating undue harm to the people and the environment in the development process. As indicated in Table 1.2, there are a total of ten (10) environmental and social safeguard policies of the World Bank, of which only Operational Policy (OP) 4.01 – Environmental Assessment- is triggered by the proposed Project, and its requirements have been taken into consideration in the ESIA study.

Table 1.2: Applicability of the World Bank Safeguard Policies to the Project

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA that address the requirements
1.	Environmental Assessment (OP/BP 4.01)	The World Bank requires Environmental Assessment (EA) of	Yes	The proposed Projects have associated	Chapter 3 – Project Description

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA that address the requirements
		projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.		environmental and social aspects which may affect the environment. Thus, this ESIA has been prepared to ensure that the potential environmental and social impacts/ footprints of the proposed Project are identified and managed appropriately.	Chapter 4 – Description of the Environment Chapter 5 – Potential and Associated Impact Chapter 6 – Mitigation Measures Chapter 7 – Environmental and Social Management Plan
2.	Forests (OP/BP 4.36)	Operational Policy on Forests (OP 4.36) is proactive in both identifying and protecting critical forest conservation areas and in supporting improved forest management in production forests outside these areas. The Forests Policy covers all projects that affect natural or planted forests, whether positively or negatively	No	There are no natural or planted forests within the Project sites or their immediate surroundings environment that would be affected by the proposed Project.	-
3.	Involuntary Resettlement (OP/BP 4.12)	The Involuntary Resettlement Policy (OP/BP 4.12) applies to projects involving either (i) the involuntary taking of land for Project purposes that leads to physical relocation, loss of assets, or loss of income sources or livelihoods for the affected persons; or (ii) the involuntary restriction of access to legally designated protected areas that leads to adverse impacts on the livelihoods of the affected persons. To address these impacts, the policy requires the preparation of (i) either a Resettlement Plan or Resettlement Policy Framework in the case of involuntary land taking; and (ii) a	Yes	During site visits, it was observed that some of the project sites had temporary farmlands (subsistence level farming). The sites with farmlands include a. Sheshimandiko b. Dakpan c. Mashigi The nature of activities, potential impacts and mitigation measures are described in the report.	Chapter 3 – Project Description Chapter 4 – Description of the Environment Chapter 5 – Potential and Associated Impact Chapter 6 – Mitigation Measures Chapter 7 – Environmental and Social Management Plan

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

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

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S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA that address the requirements
		projects proposed in geographic areas that are disputed between two or more countries.			
10.	Projects on International Waterways (OP 7.50)	This policy (OP 7.50) covers projects that could appreciably affect international waterways, or the quantity or quality of water in more than one country.	No	There are no known international waterways within the Project's Area of Influence that could be affected by the proposed Project.	-

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

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

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

- The World Bank Group EHS General Guidelines (2007); and
- The World Bank Group EHS Guidelines for Electric Power Transmission and Distribution (2007)

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

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

- Community health and safety
- Construction and decommissioning.

The EHS Guideline for Electric Power Transmission and Distribution provides guidance applicable to the power project facilities that will involve power transmission and distribution. The E&S management measures documented in the relevant World Bank EHS Guideline form part of the recommended mitigation measures to address the identified impacts of the proposed Project, as detailed in Chapters 6 and 7.

1.6.4.2 International Conventions

The Nigerian Government is an important player in the International support for the protection of the environment. As such, the country is a signatory to some International laws and conventions, which are targeted towards conservation and protection of the environment in order to ensure sustainable development. Some International conventions and regulations that are applicable to the Project include:

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

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

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- *Vienna Convention for the Protection of the Ozone Layer*

The Vienna Convention was adopted in 1985 and entered into force on September 22, 1988. It places general obligations on countries to make appropriate measures to protect the environment against adverse effects resulting from human activities which tend to modify the ozone layer.

- *The Montreal Protocol on Substances that Deplete the Ozone Layer*

The Protocol was adopted on September 16, 1987 as an international treaty to eliminate ozone depleting chemicals production and consumption.

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

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

- *The United Nations Convention on Biological Diversity*

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

- *The United Nations Framework Convention on Climate Change*

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

- *International Health Regulations (2005)*

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

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

United Nations Conference on the Human Environment proclaims that "a point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences."

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

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

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

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

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

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

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

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

At the organizational level, the guidelines encourage the integration of OSH management system elements as an important component of overall policy and management arrangements. Organizations, employers, owners, managerial staff, workers and their representatives are motivated in applying appropriate OSH management principles and methods to improve OSH performance. Nigeria ratified the guidelines in 2001.

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

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

1.6.4.3 Engineering Codes and Standards

- *International Electrochemical Commission (IEC)*

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

1.7 Institutional Arrangements for Environmental and Social Management of the proposed Project

The solar mini-grid projects initiated by REA will be executed by Engie Fenix Nigeria (Project sponsors). Engie Fenix will develop and operate the projects, and serve as the

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utility management company for the administrative, commercial and maintenance services associated with the operation phase of the projects.

Engie Fenix has constituted a project management team (PMT) for mini-grid activities at the global and national levels of the company's operations. The global level organisation, headquartered between Paris and Bruxelles, will support the company's country activities. At the national level, the project management team is led by the Head of Mini-Grid Activities. The Engie mini-grid solar projects will be deployed in clusters, which will be managed by a cluster manager and a cluster team (Field technicians, Commercial Officers, and Local Operator), all of whom make up the Engie PMT.

Furthermore, Engie Fenix will employ a Technical Manager to oversee the management of health, safety, environmental and social issues associated with the project throughout its life cycle. The Technical Manager and the PMT will be supervised by Engie Fenix Head of Mini-Grid Activities.

FMEnv, NESREA and the Niger State Ministry of Environment will monitor the implementation of this ESIA at different developmental phases of the project, as part of their statutory functions.

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1.8 Structure of the ESIA

In line with the relevant local, national and international guidelines, this ESIA is structured as follows:

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

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

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

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

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

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

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

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

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

- **Chapter Nine**: Conclusion and Recommendations

The report also includes references and appendices.

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CHAPTER TWO:

PROJECT JUSTIFICATION

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CHAPTER TWO

PROJECT JUSTIFICATION

This chapter presents the rationale for the proposed Engie Fenix Nigeria mini-grid solar power projects in Niger State. It also includes the description of the alternative development options considered for the Project.

2.1 Need for the Project

Overall consumption and supply of electricity in Nigeria has increased in the past 20 years. Between 1995 and 2015, consumption per capita grew by 3.2% per year on average, from 91kWh per year to 144kWh per year, while electricity generation increased by 4.6% per year on average, from 14TWh per year to 30TWh per year. Nigeria currently has an available grid power hovering around 4,000MW for over 190 Million people. However, power infrastructure is unevenly distributed across the country as most of the power plants, transmission and distribution lines are installed in the economic centres which are mostly urban areas. It is estimated that the Nigeria economy loses US$ 29.3 Billion annually due to the lack of adequate power supply and is estimated to have lost US$ 470 Billion in GDP since the year 2000 due to under-investment in power infrastructure (ESMAP, 2017; PSRIP, 2017).

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The Federal Government of Nigeria (FGN) has been making significant investments in the power sector to increase the existing power generation and distribution capacity. The FGN is committed to the goal of providing reliable electricity to 75 per cent of the population by 2020, and 90 per cent by 2030, with at least a 10 per cent share of renewable energy by 2025. At present, approximately 73.6 million (73.6m) people lack access to grid electricity (13.4m in urban areas and 60.2m in rural areas), with the national electrification rate at 60.6% (86.0% in urban areas and 34.1% in rural areas) (IEA, 2017). This corresponds to an urban-to-rural electricity access divide of some 450% (SE4ALL Africa Hub & African Development Bank, 2018).

It is evident that the majority of the underserved and unserved people live in rural areas, and these communities rely on candles, kerosene and torches for lighting, as well as traditional biomass (e.g. firewood) for cooking. The livelihood of most rural communities and overall national development is highly encumbered due to a lack of access to electricity. Electricity is required for effective delivery of basic services such as potable water, health care, telecommunication and education, as well as agro-industrial processes. The lack of these amenities adversely impacts on poverty reduction and quality of life in these rural communities (Uzoma and Amadi, 2019).

The Nigeria Electrification Project (NEP) is an initiative of the FGN which is being implemented by the REA, to provide energy access to the underserved and unserved communities across Nigeria. The REA in line with its mandate to increase electricity access is championing and promoting renewable and other distributed off-grid power solutions (PSRP, 2018). The proposed projects are off-grid power solutions, being implemented by Engie Fenix Nigeria to provide energy access to underserved and unserved communities in Niger State.

The beneficiary communities in Niger State are mainly rural communities with little or no access to the national grid due to their remote locations. The proposed projects will generate electricity through a renewable energy source (Solar) to serve the communities. The deployment of off-grid power solutions to these underserved and unserved communities will provide significant benefits such as enhancement in the standard of living, health, and wellbeing of people in rural communities. The proposed projects will also be part of Nigeria's contribution to Africa's renewable energy target and as well improve the carbon footprint of Nigeria as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

2.2 Value of the Project

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The envisaged capital expenditure (CAPEX) of the Project is approximately Four Hundred and sixty-six Thousand US Dollars ($466,000) which is approximately one hundred and seventy-seven million naira (₦ 177,000,000[1]) per project site. However, this cost may reduce for sites with lower power generation capacities. A percentage of the cost will be injected into the local economy through the award of contracts and subcontracts to indigenous companies. The Project has local and national economic values in terms of employment opportunities for various categories of Nigerian professionals, skilled and semi-skilled craftsmen, business opportunities and additional revenue for the government.

2.3 Project Benefits

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

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

- Provision of clean, affordable and steady power supply to selected beneficiary communities within the project AoI.

[1] Central Bank of Nigeria (CBN) November 2020 exchange rate of ₦380/1$

- Improved standard of living for the beneficiary communities as access to electricity will enable them to use domestic appliances (e.g. pressing iron, fridges, television sets, washing machines, etc.).
- Reduction of human health risk (respiratory diseases, eye strain, etc.) associated with CO_2 emission from generators and use of Kerosene lamps, typically used indoors by the rural communities.
- Improved health characteristics and improved lifespan. The project will result in many families replacing kerosene lamps and generators for lighting with electricity there-by reducing disease burden at the family level and on the government.
- Multiplier effects from the availability of affordable power supply. These include the reduction in lightening costs to households, an increase in disposable income, more savings, and engendering inclusive growth, etc.
- Improved communications through electricity access for mass media and information sources such as televisions, radios, and mobile phones. This will be useful for informed decision making with regards to various aspects of their lives.
- Alleviating the daily household burdens of women, reducing women's drudgery, saving their time, improving their health and enhancing their livelihoods through the uptake of electrical appliances to enable them to perform domestic tasks and livelihood activities more efficiently and productively.
- Promoting gender equality, women's empowerment, and women's and girls' access to education, health care, and employment.
- Technology transfer and acquisition of new skills during construction and operation.
- Increase in local and regional business/commerce in the communities during and after construction through local material sourcing and sale of materials for use in the project.
- Development of cleaner power project with minimal Greenhouse Gas (GHG) emissions compared to petrol or diesel-fueled power projects.
- Provision of support to the Government's Renewable Energy Policy through the use of PV panels power generation rather than the use of gasoline and diesel generators.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to the acquisition of new skills and the introduction of all manners of income-generating spill-over effects.
- Increase in the local and regional economy through the award of contracts and purchase of supplies for Project development.

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2.4 Envisaged Sustainability

2.4.1 Technical Sustainability

The Project development shall be handled by qualified and experienced personnel according to the pre-established standards and procedures. The construction phase of the Projects shall be overseen by qualified engineers from Engie Fenix. However, an Engineering, Procurement and Construction (EPC contractor) has been selected for the project – GreenElec Integrated Power Solutions (GreenElec). GreenElec is a leading energy efficiency & power engineering company in Nigeria, with a wide portfolio of projects and commendable track record of excellence. Dedicated Project Managers shall also be assigned to monitor the Project operations.

In addition, standard operating manuals and appropriate documentation regarding the operation and maintenance of the Projects shall be put in place. These documents will be used as the basis for providing facility-specific training to relevant personnel prior to start-up to further ensure technical sustainability of the Projects.

2.4.2 Environmental Sustainability

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The environmental sustainability measures for the Projects include the use of renewable source of energy (solar) for electricity generation (with negligible GHG emissions compared to fossil fuel-burning power projects). Moreover, this ESIA study is being undertaken at the early stage of the Project development phase (and the commitment to implement the recommended mitigation measures and the ESIA) is geared towards ensuring the environmental sustainability of the Project. The following measures shall also ensure the environmental sustainability of the Project:

- The Project facilities shall be designed and constructed to keep environmental impacts at the minimum and acceptable levels.
- The Project development activities shall be carried out to conform to all relevant international and national environmental regulations and standards, including the mitigation and management measures documented in this report.
- A comprehensive Health, Safety and Environment (HSE) system shall be maintained.
- Handling, storage and disposal of wastes shall be in accordance with the applicable local, national and international requirements.

The project is also in line with the FGN's efforts to keep GHG emissions at the barest minimum, as part of efforts towards climate change mitigation and adaptation. According to WRI CAIT, Nigeria's GHG emissions increased by 25% between 1990 and 2014, averaging 1% annually, while GDP grew 245%, averaging 5.5% annually. Although GDP grew faster than GHG emissions, in 2014, Nigeria's emissions relative to GDP were 1.6 times the world average, indicating the potential for improvement

(USAID, 2019). Thus, the adoption of renewable energy for power generation – a critical need for Nigeria's development, is a key policy direction of the FGN.

2.4.3 Economic Sustainability

The proposed solar mini-grid projects will be owned and operated by Engie Fenix. A cost-reflective service charge (to be determined based on consultation with beneficiary communities and relevant stakeholders) shall be implemented for all households connected to the project. All connected users will be metered and billed based on their power consumption. The generated income from the project shall be used to recover the construction costs and sustain the operational expenses. The procurement of project components that may need replacement (e.g. spent batteries, panels, etc.) during operations will be from income generated from the project.

Furthermore, Engie Fenix has signed exclusivity agreements with the beneficiary communities. This will further enhance the economic sustainability of the project, as Engie Fenix will be the sole energy provider in the beneficiary communities.

2.4.4 Social Sustainability

Stakeholder consultation has been carried out as part of the ESIA study, to assist in ensuring that all relevant stakeholders are presented with the opportunity to provide input into the Project. This has also assisted in laying a good foundation for building relationship with the stakeholders. Stakeholder participation/involvement will be sustained throughout the Project life cycle. A Stakeholder Engagement Plan (SEP) shall be developed to ensure continuous engagement with relevant stakeholders throughout the Project life cycle. Details of stakeholder engagement carried out till date for the Project are provided in Chapter Four of this report.

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2.5 Alternatives Considered within the Context of the proposed Mini-Grid Power Plant

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

2.5.1 Overview

Many emerging economies (e.g. Nigeria) have an excellent solar resource, and have adopted policies (e.g. PRSP, NEP, etc.) to encourage the development of the solar industry to realize the benefits that expanded use of PV technology can have on their economies and on improving energy security, as well as on the local and global environmental (IFC, 2015).

Compared to alternative renewable generation technologies such as wind turbines or biofuel generators, solar energy is produced by conducting the sun's radiation – a process void of any smoke, gas, or other chemical by-product, which makes this technology to meet the clean development mechanism of the Kyoto protocol. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions. Furthermore, solar power projects can be deployed quickly, compared hydro and fossil fuel projects that require more than 4–5 years to complete. This presents a major incentive in rapidly-growing, emerging markets with a high unmet demand and urgent need for power supply, especially to remote and underserved areas (IFC, 2015).

The use of solar energy for the Project will significantly avoid the generation of GHG emissions associated with fossil-fuelled power projects. Based on review of similar projects, it is estimated that each 100 kWp mini-grid has the potential of saving about 180 tons of CO_2 emissions annually (IED, 2013). Thus, the Project will help reduce Nigeria's carbon emission footprints and contribute to the country NDC on climate change. In addition, the high solar irradiation in Niger State (Figure 2.1) will be able to support the Project.

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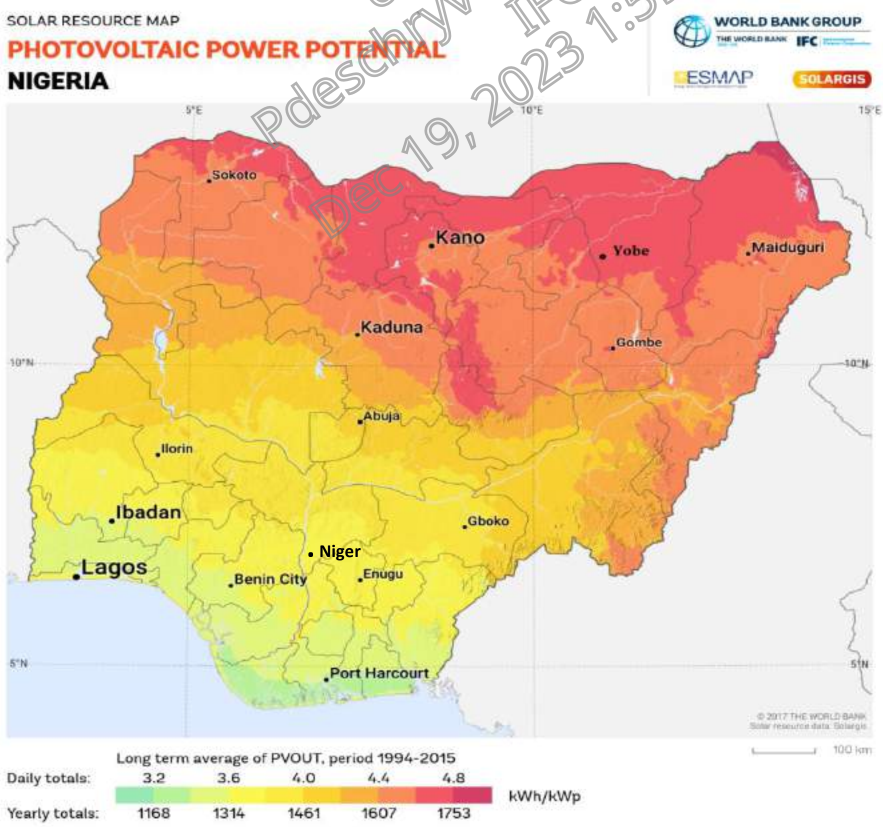

Figure 2.1: Photovoltaic power potential of Nigeria
Source: © 2017 The World Bank, Solar resource data: Solargis

2.5.2 Solar Power Technology Alternative

Improved materials, better yields, lower installation and operational costs, and a more favourable socio-political environment are some of the reasons why solar technology has gained wider acceptance globally. Furthermore, the increasing awareness on the issues associated with GHG emissions and global warming are diverting attention away from fossil fuel generated power. The solar technologies considered for the Project are:

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

The analysis of the two (2) technologies is described in the following paragraphs:

- ***Concentrated Solar Power (CSP)***

CSP is a solar power generation system that relies on use of mirrors or lenses to concentrate a large area of sunlight or solar thermal energy onto a small surface (Garcı´a *et al*, 2011). The concentrated radiation is then used as heat or heat source for a conventional power project. CSP technology generates alternating current (AC) which can be easily distributed on the power network. In addition, CSP systems often use solar trackers and a cooling system to further increase their efficiency (IEA, 2014).

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The three (3) main types of CSP systems are:

- Linear concentrator,
- Dish/engine, and
- Power tower systems.

Linear concentrator systems collect the sun's energy using long rectangular, curved (U-shaped) mirrors. The mirrors are tilted toward the sun, focusing sunlight on tubes (or receivers) that run the length of the mirrors. The reflected sunlight heats a fluid flowing through the tubes. The hot fluid is then used to boil water in a boiler; the steam is passed through a conventional steam-turbine generator to produce electricity. There are two major types of linear concentrator systems: parabolic trough systems, where receiver tubes are positioned along the focal line of each parabolic mirror; and linear Fresnel reflector systems, where one receiver tube is positioned above several mirrors to allow the mirrors greater mobility in tracking the sun.

A dish/engine system uses a mirrored dish similar to a very large satellite dish, although to minimize costs, the mirrored dish is usually composed of many smaller flat mirrors formed into a dish shape. The dish-shaped surface directs and concentrates sunlight onto a thermal receiver, which absorbs and collects the heat and transfers it to the engine generator. The most common type of heat engine used today in dish/engine systems is the Stirling engine. This system uses the fluid heated by the receiver to move pistons and create mechanical power. The mechanical power is then used to run a generator or alternator to produce electricity.

A power tower system uses a large field of flat, sun-tracking mirrors known as heliostats to focus and concentrate sunlight onto a receiver on the top of a tower. A heat-transfer fluid heated in the receiver is used to generate steam, which, in turn, is used in a conventional turbine generator to produce electricity. Some power towers use water/steam as the heat-transfer fluid.

The CSP system is not considered as the preferred option for the Project due to its significant environmental footprints such as large amount of water consumption, high cost of installation and maintenance, and low level of flexibility when compared with PV system as summarized in Table 2.1.

❖ ***Photovoltaic (PV) Solar Panels***

PV is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the PV effect. Materials presently used for PV include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium selenide/Sulphide.

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PV technology is made as a system designed to capture electron released by an array of semiconductors that exhibit PV effect on exposure to light. The direct current (DC) generated is then converted to alternating current (AC), usually with the use of inverters, in order to be distributed on the power network.

It is widely believed that two factors have contributed the most for the dominance of PV over CSP. These factors are:

- **Market size:** PV can be installed almost everywhere but CSP cannot. Current commercial CSP technology needs higher levels of irradiance, access to water (just like a coal plant) and large-scale deployments (typically more than 20 MW, compared with the few Kw of a residential PV system).

- **Technological simplicity:** A PV system is like a quartz watch, whereas a CSP system is like a mechanical watch. The former revolves around the solar cell, while the latter is a combination of equally critical components.

Table 2.1 shows the comparison between CPS and PV Solar technologies considered for the Project.

Table 2.1: Comparison between CSP and PV Solar Technology

Features	CSP Technology	PV Technology
Description	CSP technology uses concentrated radiation from the sun, to heat a liquid substance which is used to generate steam which in turn passes through a steam-turbine to generate electricity. CSP Technology produces electricity through indirect means. Energy output with CSP technology is of AC type.	PV technology uses sunlight through the 'photovoltaic effect' to generate direct electric current (DC). PV Technology produces electricity through direct means. Energy output with PV technology is of DC type but commonly converted to AC through an inverter.
Applications/Scale	CSP is used for utility scale power generation, mostly for Grid Connections, and also supporting conventional thermal power and desalination plants.	PV technology is suitable for off grid small and medium-sized applications, and for utility scale applications
Land requirement	CSP technology is best suited for areas of high direct normal solar radiation. CSP technology requires about 5 to 10 acres of land per MW of capacity	PV technology has a wider geographical area of application.
Cost	CSP technology has a high installation and maintenance cost compared to PV	PV technology has a low installation and maintenance cost in comparison to CSP
Construction Time	CSP plant construction is technical more complex than PV	Utility scale PV plants are easier to install and require less time than CSP for Plant construction
Water Requirement	Water requirement is variable depending on the CSP technology option adopted. CSP may utilize wet, dry, and hybrid cooling techniques	Typically requires less water than CSP technology. Water is occasionally required for cleaning of dust from the panels.
Design Options	Less flexible in comparison to PV technology. Can be hybridized with fossil fuels like natural gas.	Highly flexible and adaptable to the project specific requirement
Life Span	> 20 years	> 20 years
Efficiency	Power production efficiency of CSP technology are as high as 45%	Power production fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or AC, through the use of inverters.
Environmental Risks	CSP systems have been recorded to pose environmental risks to bird species, which may be killed by the intense heat generated by the concentrated solar radiation which is reflected off the mirrors.	PV systems are considered to be generally benign.

Culled from different sources online

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The preferred option for the Project is PV technology (consisting of PV cell and PV module or panel) since it is highly flexible and requires low installation and maintenance cost in comparison to CSP technology. Water requirement for PV system is also low when compared to CSP system.

2.5.3 PV Panel Alternatives

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

- Mono-crystalline silicon
- Poly-crystalline silicon
- Thin-film

Each of these types is further discussed in the following paragraphs:

❖ ***Mono-Crystalline Silicon***

Mono-crystalline silicon (mono-Si) PV cells are made out of cylindrical silicon ingots. They 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. It 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 mono-crystalline cell, four sides are cut out of the cylindrical ingot, which is then sliced into wafers. This gives mono-crystalline solar panels their characteristic appearance (Tatau, 2015).

Mono-crystalline 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 panels. They are however slightly more expensive to produce. Figure 2.2 shows the typical appearance of mono-crystalline silicon PV panels.

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Figure 2.2: Typical appearance of mono-crystalline silicon PV panels
Source:https://www.solarreviews.com/blog/pros-and-cons-of-monocrystalline-vs-polycrystalline-solar-panels

❖ ***Poly-Crystalline Silicon***

Panels based on polycrystalline silicon, also known as poly-silicon (poly-Si) or multi-crystalline, have been in the market since 1981, in which time the technology has been developed and improved. Raw silicon is melted and poured into square moulds, which are cooled and then cut into square wafers. This process is simpler and cheaper compared to mono-Si PV cell production. Although the poly-Si has a slightly lower efficiency, the panels generally have similar operating power density as mono-Si panels since the wafers are truly square and can be packed together in a panel with less wasted space.

Poly-Si panels are recognizable due to their light or dark-blue colouring, which may vary across the panel. However, non-reflective coating means that less light is reflected and the panels themselves appear less varied in appearance. Poly-Si cells tend to be slightly more sensitive to higher temperatures than mono-Si. However, their lower pricing in comparison to mono-Si panels and higher efficiency in comparison to thin-film technology make them the most commonly used solar panel technology in the market today. Figure 2.3 shows the typical appearance of poly-crystalline silicon PV panels.

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Figure 2.3: Typical Appearance of Polycrystalline Silicon PV panels
Source:https://www.solarreviews.com/blog/pros-and-cons-of-monocrystalline-vs-polycrystalline-solar-panels

❖ ***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 PV 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. CdTe panels utilize 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 products being produced by the solar PV panel during its lifecycle (IEA, 2014).

Due to difference in physical properties, CdTe TFSC performs slightly better than crystalline silicon PV technologies when subjected to higher temperatures and shading impacts. However, CdTe and most other commercially available TFSC panels have a lower efficiency than poly-Si and mono-Si panels currently on the market. This lower efficiency means that the costs of associated equipment and infrastructure (e.g. support structures, cables etc.) will also increase, since more exposure surface and materials for the installation will be required for a similar performance. The typical appearance of thin film CdTe PV panels is shown in Figure 2.4.

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Figure 2.4: Typical appearance of Thin-Film CdTe panels
Source:https://www.solarreviews.com/blog/pros-and-cons-of-monocrystalline-vs-polycrystalline-solar-panels

For the proposed Project, monocrystalline silicon PV panels are envisaged to be used based on considerations of cost and efficiency.

2.5.4 Battery Types Alternative

The Project is an off-grid system, which will involve the storage of power. Storage allows the PV array to continue providing power even when the demand is down, instead of having to disconnect and refrain from generating power. The batteries for the Project have to meet the demands of heavy cycling (charging and discharging) and irregular full recharging.

There are a variety of battery types fitted for these requirements; however, five (5) of these batteries are the best available technology for solar power projects. These are: lead-acid; lithium-ion; lithium iron phosphate; flow; and nickel-cadmium batteries.

Considerations for choosing a battery include cost, cycle life and installation, and maintenance.

- Lithium-ion Batteries

These are the most common storage technology, regardless of application. There are three types: pouches such as in smartphones and tablets, cylindrical such as in power tools, and prismatic. The prismatic types often have corrugated sides, which create air gaps between adjacent cells and can aid in cooling. The prismatic have been applied in several solar power projects and are more expensive than the lead-acid batteries (Liang *et al.,* 2017).

Lithium-ion batteries can deliver more cycles in their lifetime than lead-acid. They can be lighter and more self-contained than lead-acid batteries. They are solid, and do not require refills or maintenance. The most important benefit lithium-ion provides for solar is its high charge and discharge efficiencies, which help harvest more energy. Lithium-ion batteries also lose less capacity when idle, which is useful in solar installations where energy is only used occasionally. However, a typical lithium-ion battery has a life span of 2-3 years (Liang *et al.,* 2017).

Lithium-ion batteries can use organic or inorganic cells. Organic-based batteries are free from any toxins. Inorganic-based cells are much more difficult to dispose of. Inorganic lithium-ion is toxic so it must be disposed of properly. Unlike lead-acid batteries, spent lithium-ion cells have little commercial value. This is because lithium-ion manufacturing involves lengthy preparation and purification of the raw material. In recycling, the metal must go through a similar process again, so it is often cheaper to mine virgin material than retrieve it from recycling (Liang *et al.,* 2017).

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- Flow Batteries

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

The VRFB has no cycling limitations, and batteries can be charged and discharged completely without impact on their lifespan. They can last up to 20 years. The recycled vanadium in flow batteries is not toxic and can be reused repeatedly for other purposes, such as in making steel (Whitehead *et al.,* 2017).

- Nickel-Cadmium Batteries

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

NiCd batteries are vented to allow gases to dissipate. They traditionally require some watering, but new designs allow the gases to recombine to form water which makes the battery nearly maintenance free. This, along with the ability to tolerate extreme temperatures, makes these batteries ideal for off-grid applications in harsh environments. NiCd batteries are rugged batteries with a high life span of up to 20 years (Shukla and Hariprakash, 2009). Cadmium is a hazardous material. Toxic materials must be removed before the battery is disposed of. NiCd batteries can be recycled, however. The cadmium can be extracted and reused in new batteries. The nickel can be recovered and used to make stainless steel (Espinosa and Tenorio, 2006).

- Lithium Iron Phosphate Batteries

Lithium Iron Phosphate ($LiFePO_4$) batteries are widely used in electrical mobility and stand-alone PV applications, due to their advantages over other kinds of battery types: one key feature is their superior thermal and chemical stability, which provides better safety characteristics than lithium-ion batteries with other cathode materials (Wang *et al*., 2011).

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$LiFePO_4$ batteries have high output performance, good performance at high temperatures, and excellent life cycles (between 7 to 10 years). They also charge quickly; can handle excessive charge without damage; cost effective; and they are an environmentally friendly option that does not produce any waste (Oswat *et al*., 2010).

- Lead-Acid Batteries

These are the oldest and cheapest form of batteries used in solar systems. There are currently three models: flooded lead-acid, absorbed glass mat (AGM), and gel. Flooded lead-acid batteries have to be refilled regularly because the electrolyte that fully submerges the battery plates evaporates during charging. The battery enclosure needs ventilation to keep hydrogen gas from accumulating to dangerous levels. AGM and gel technologies, however, are recombinant; they internally convert hydrogen and oxygen into water and do not require maintenance (Zhang *et al.,* 2016). Proper disposal of lead-acid batteries is important because they are toxic. The life span of a typical lead-acid battery is 3-10 years (Sun *et al.,* 2017).

Lead-Acid batteries have been selected to be adopted for the proposed Project based on considerations of cost, availability and maintenance.

CHAPTER THREE:

PROJECT DESCRIPTION

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CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

This chapter presents the technical description of the solar mini-grid power projects in Niger State including their associated components, power generation and distribution systems, and development activities. Waste streams associated with the Project over its life cycle, and the proposed handling techniques are also discussed.

3.2 Project Location

3.2.1 Description of the Project sites

The proposed Engie Fenix solar mini-grid projects are planned to be located in ten (10) beneficiary communities which are distributed in Niger State. Niger State is one of the thirty-six states (Figure 3.1), located in the north-central geopolitical zone of Nigeria. The State shares boundaries with Kebbi and Zamfara States to the north, the Federal Capital Territory (FCT) and Kaduna State to the east, Kwara and Kogi States to the south, and the Republic of Benin to the west.

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Administratively, the project sites fall within four (4) LGAs in Niger State. The spatial details of the proposed project site are presented in Table 3.1, while Figure 3.2 shows the geographical distribution of the project sites within the LGAs.

Table 3.1: Spatial details of the proposed Project sites in in Niger State

S/N	Community/Site name	Local Government Area (LGA)	*Power Capacity (kWp)	Land Size (ha)	GPS Coordinates	
					Latitude	Longitude
1.	Gbangba	Gbako	85	0.26	09.40947	006.12894
2.	Sheshimandiko	Gbako	85	0.26	09.34511	005.98636
3.	Kuchitagi	Gbako	85	0.26	09.01478	005.83961
4.	Dakpan	Gbako	85	0.26	08.82163	006.03348
5.	Dokogi	Edati	85	0.26	08.81859	006.02942
6.	Kpanje	Edati	85	0.26	08.82543	005.98729
7.	Nakoko-Siyidi	Mashegu	85	0.26	09.77054	005.65259
8.	Ragidda Hausawa	Mashegu	85	0.26	09.68762	005.53708
9.	Mashigi	Mashegu	85	0.26	09.64870	005.57530
10.	Mayaki	Lapai	85	0.26	08.85117	006.69817

***The capacities of the solar power plants presented in this table are yet to finalized as at the time of this ESIA Study, as power audit and engineering designs are ongoing.**

The sites allocated for the proposed project are within rural communities with no access to electricity from the national grid. All sites for the proposed project will be purchased by Engie Fenix Nigeria from through the state and local government authorities. The topographies of the sites are relatively flat and there are no surface water bodies within 1km radius of each site. The vegetation within the sites are mostly grasses, shrubs and a few trees as majority of the sites are abandoned farmlands. However, some of the proposed sites had active farming activities as observed during the site visits. The communities that have active farmlands within the project sites include:

A. Sheshimandiko community
B. Dakpan community
C. Mashigi community

It was established during the site visits that the farmlands are all temporary subsistence farms cultivated by villagers living close to the sites. The crops cultivated on these farmlands are maize, okro, and groundnut. The farms are not the major source of livelihood for the affected persons, and there are alternative sites for them to continue their farming outside the allocated land. Also, there are no commercial structures or residential buildings within any of the proposed sites. The aerial imageries of the proposed sites are presented in Figure 3.3 – 3.12 while cross sectional views of the sites are shown in Plates 3.1 – 3.10.

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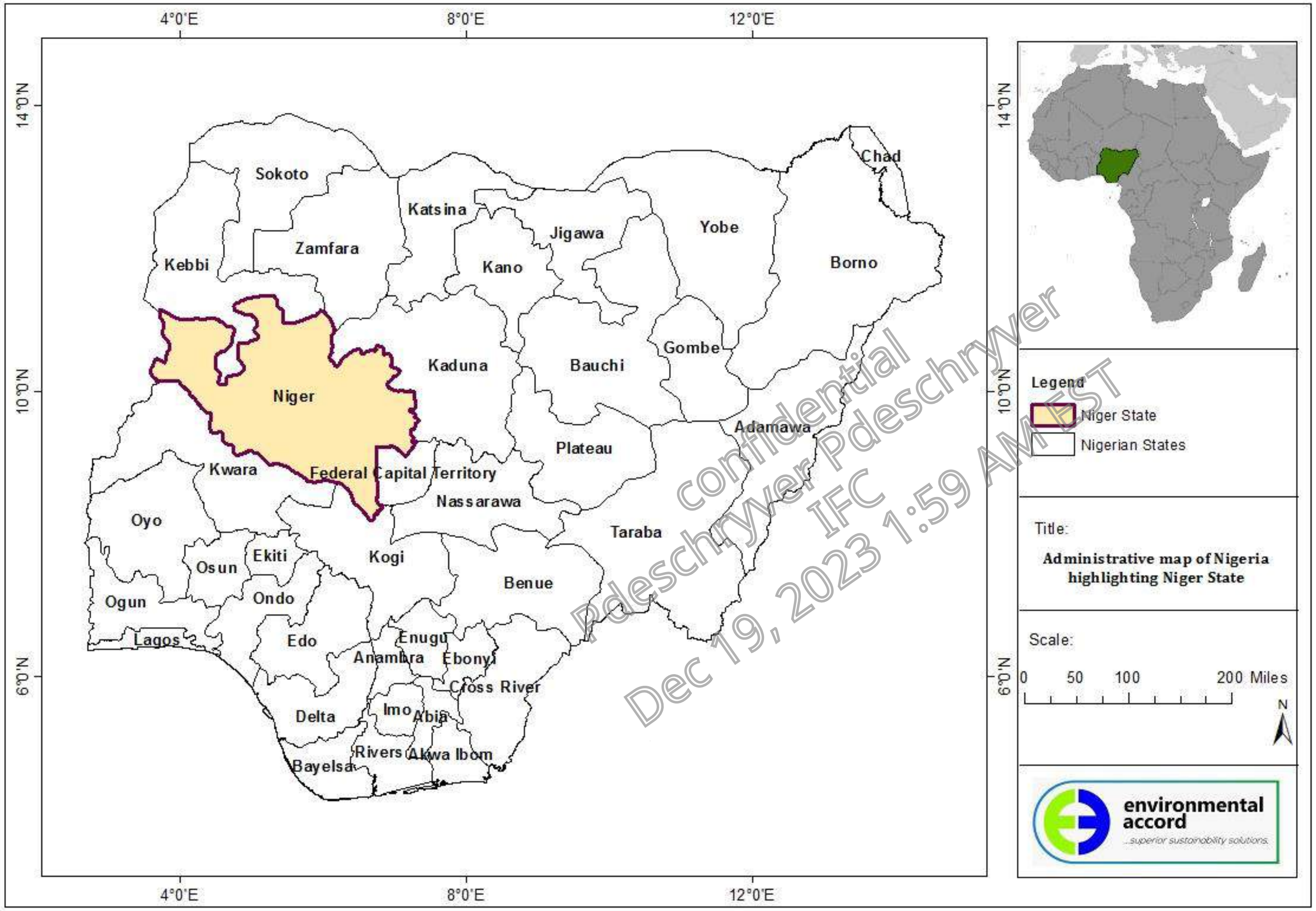

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Figure 3.1: Administrative Map of Nigeria highlighting Niger State
Source: EnvAccord GIS, 2020

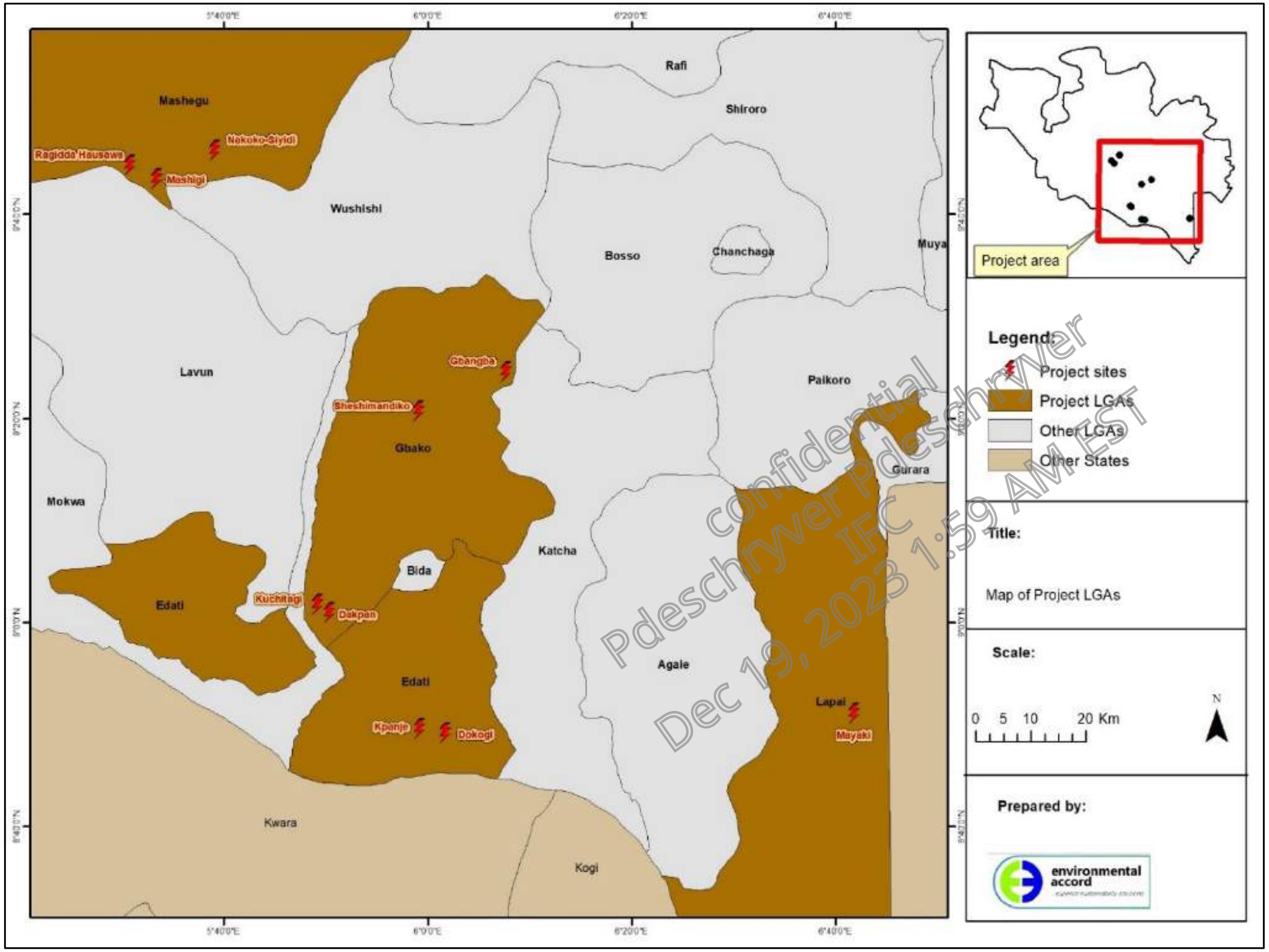

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Figure 3.2: Map of the LGAs in Niger State showing distribution of the proposed Project sites
Source: EnvAccord GIS, 2020

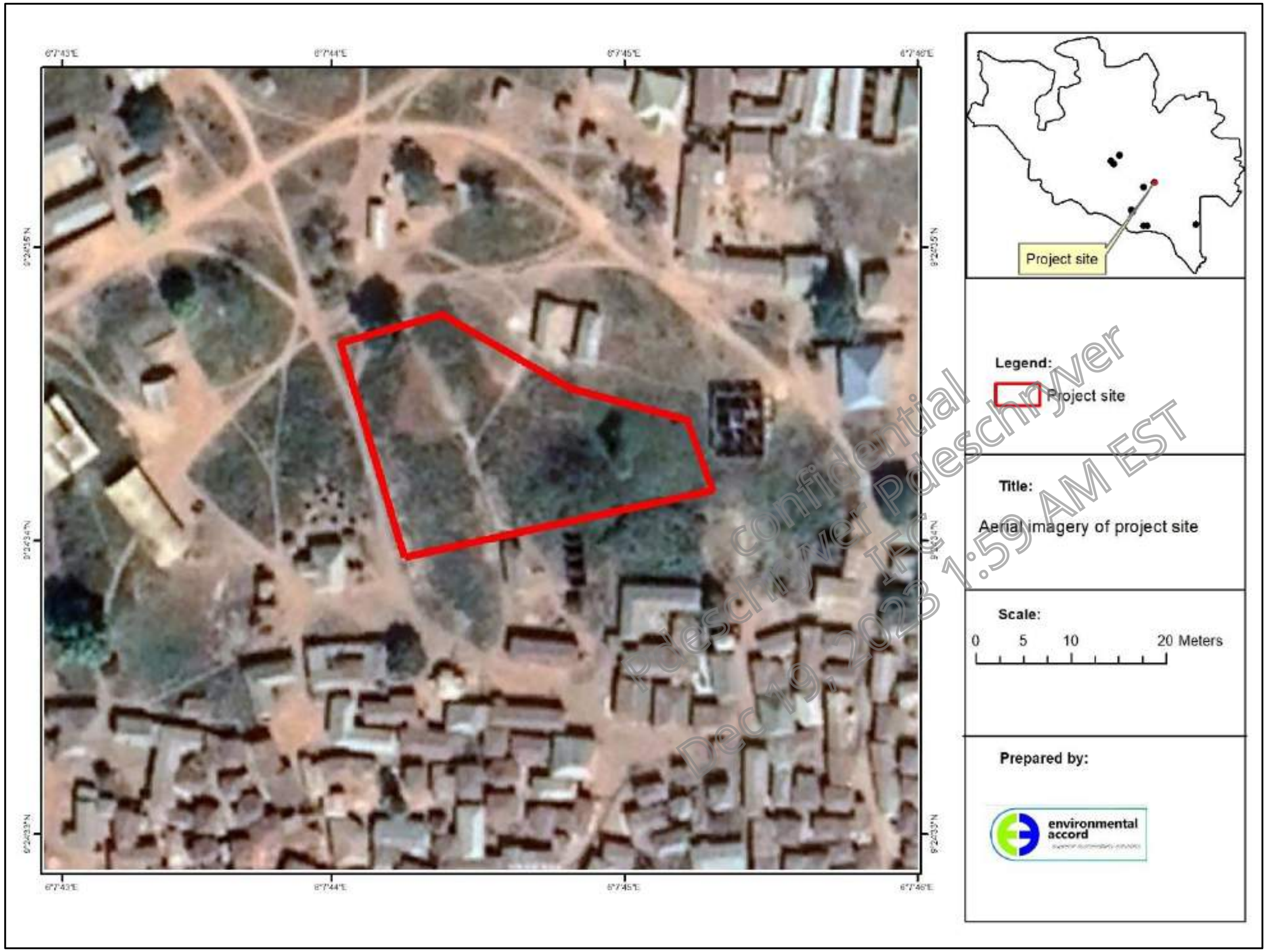

Figure 3.3: Aerial imagery of Gbangba community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

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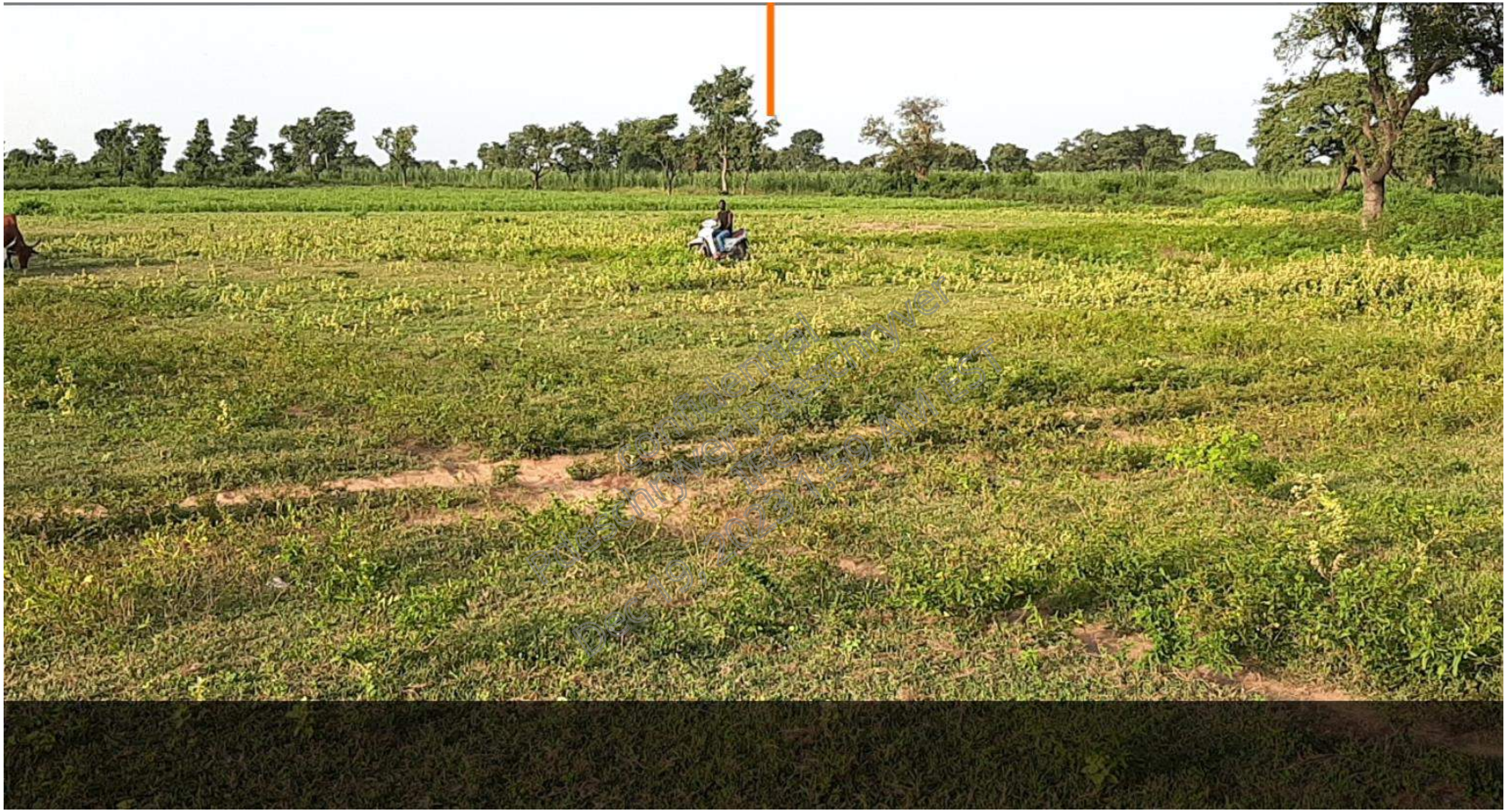

Plate 3.1: Cross sectional image of Gbangba community proposed project site
Source: EnvAccord Field Survey, 2020

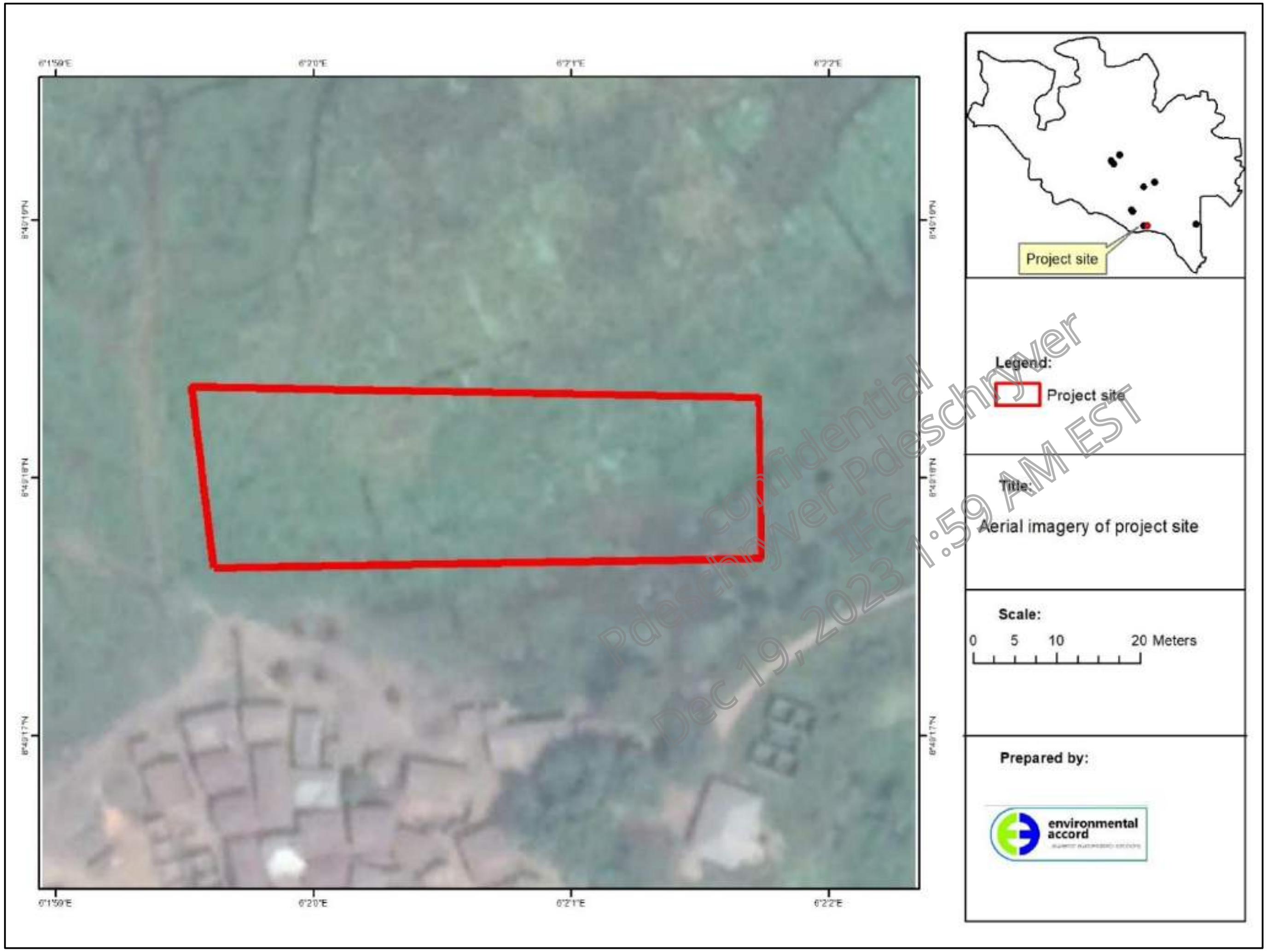

Figure 3.4: Aerial imagery of Dokogi community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

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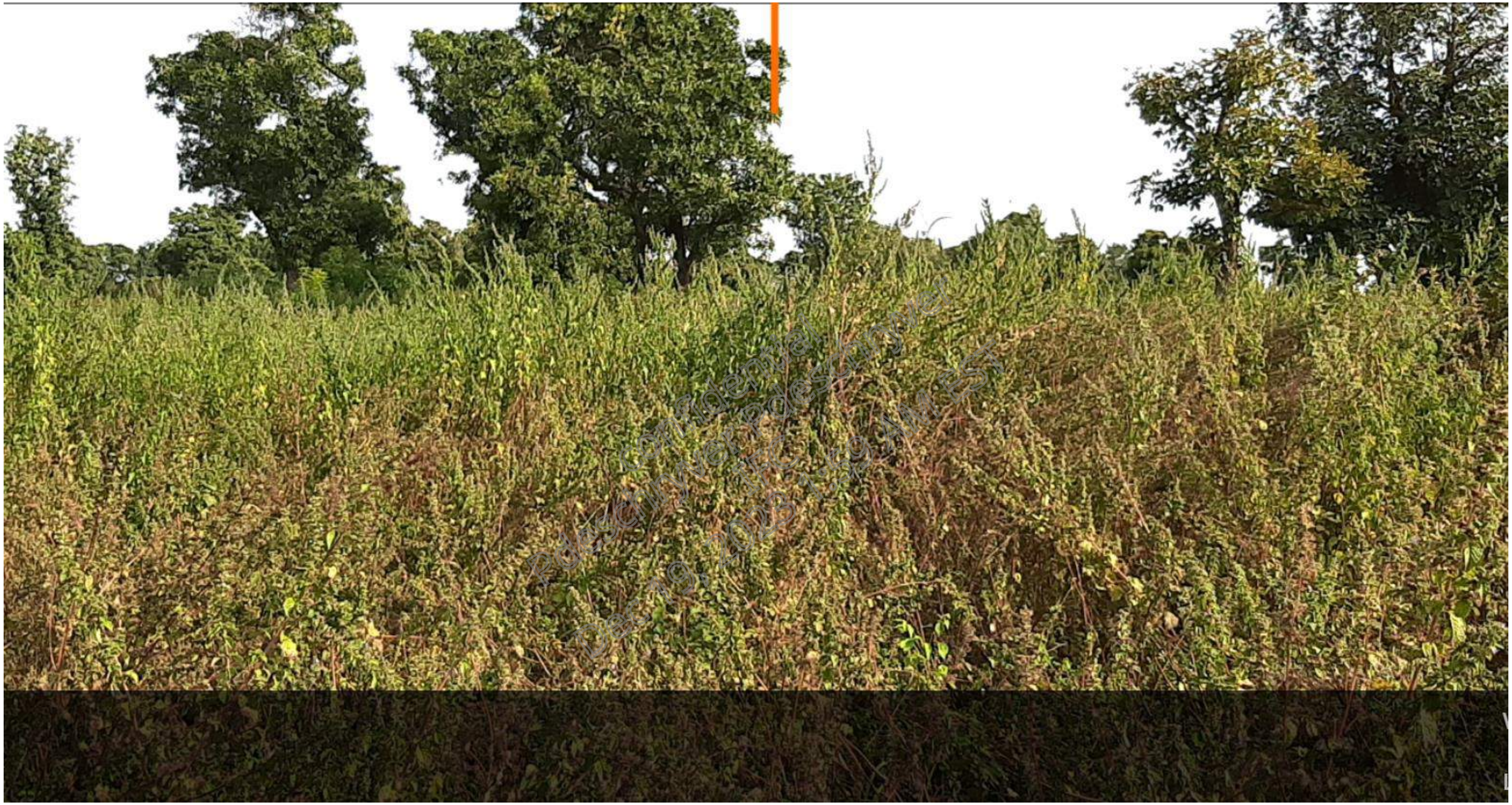

Plate 3.2: Cross sectional image of Dokogi community proposed project site
Source: EnvAccord Field Survey, 2020

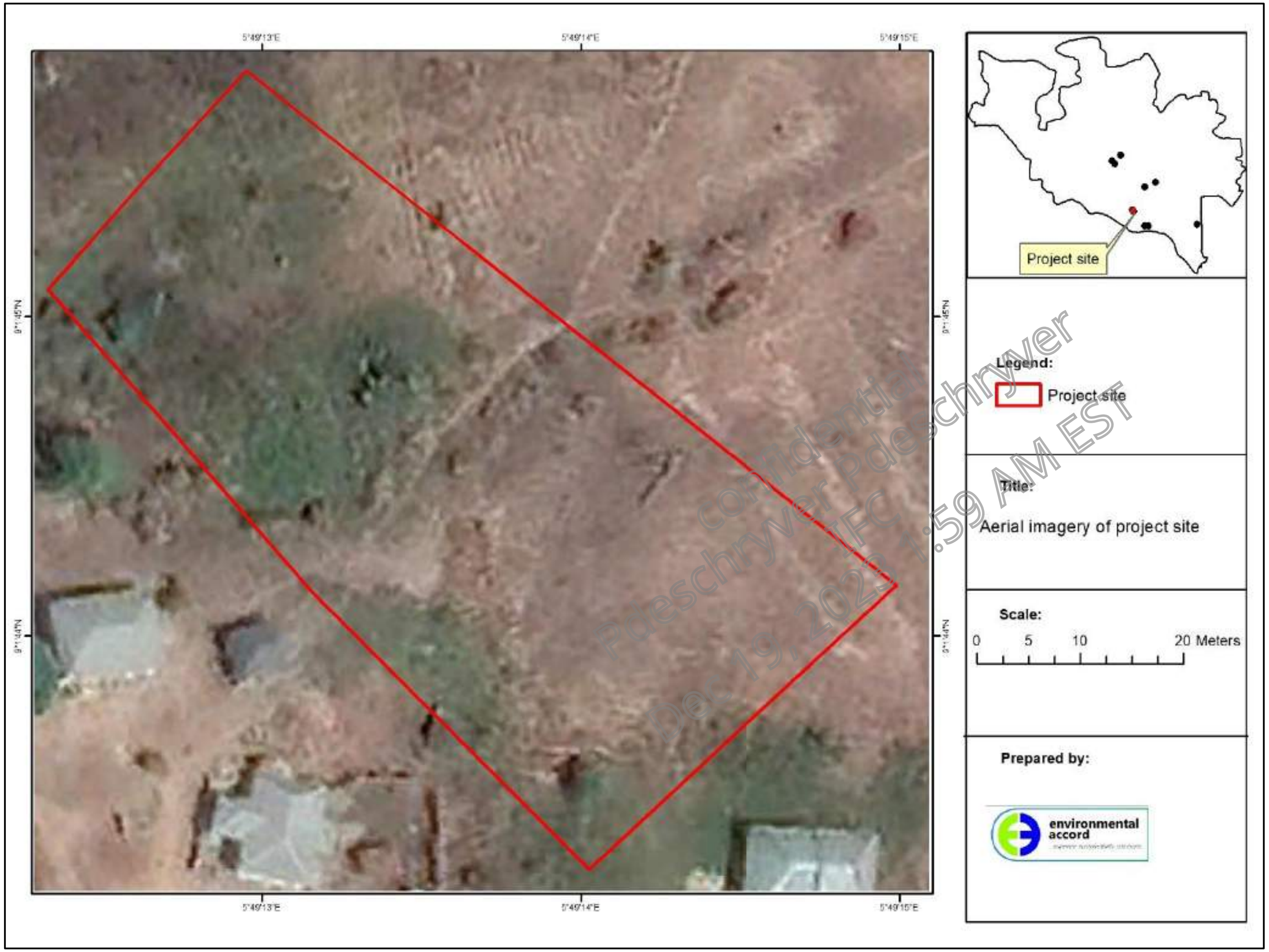

Figure 3.5: Aerial imagery of Dakpan community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

Plate 3.3: Cross sectional image of Dakpan community proposed project site
Source: EnvAccord Field Survey, 2020

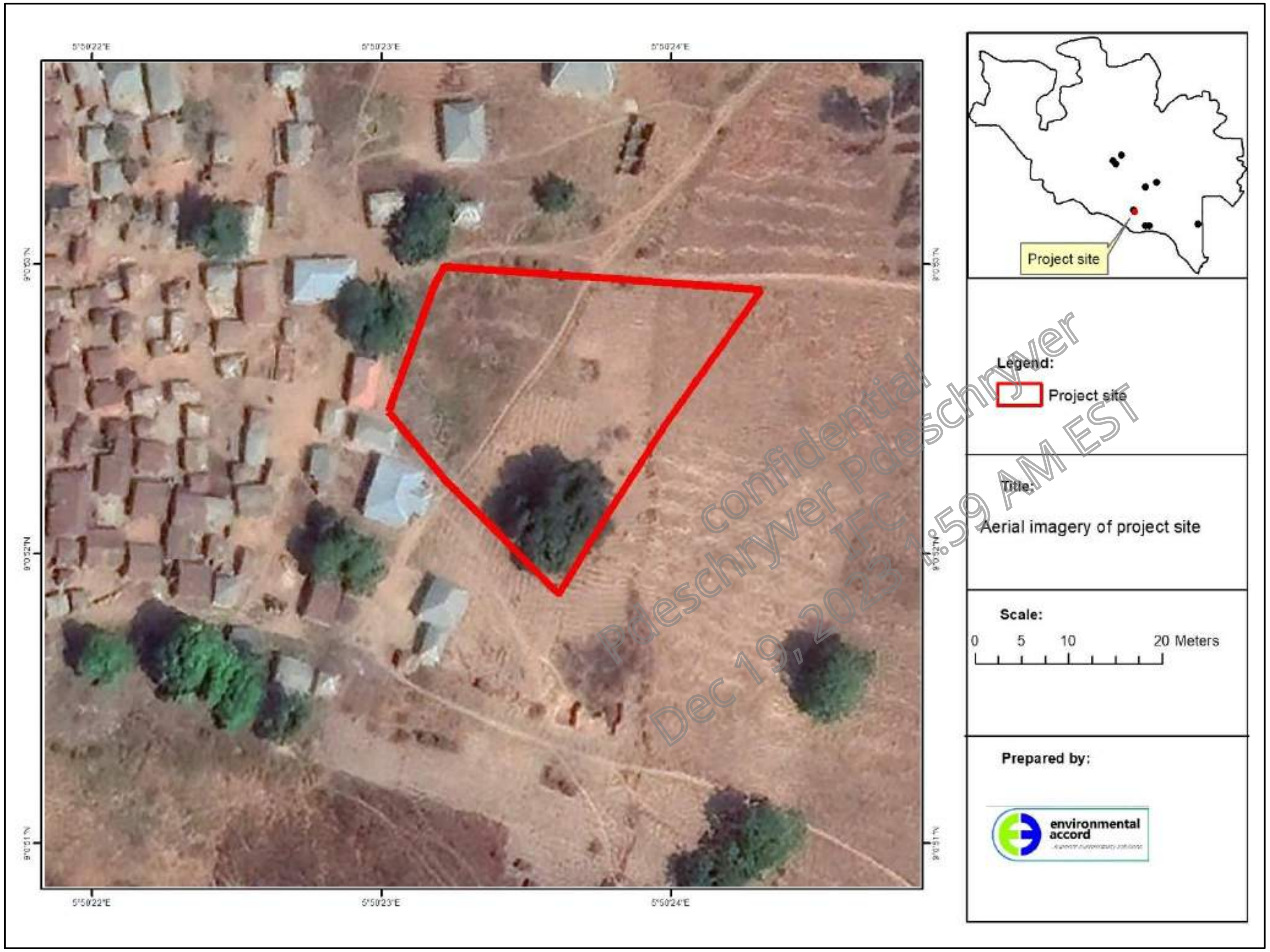

Figure 3.6: Aerial imagery of Kuchitagi community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

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Plate 3.4: Cross sectional image of Kuchitagi community proposed project site
Source: EnvAccord Field Survey, 2020

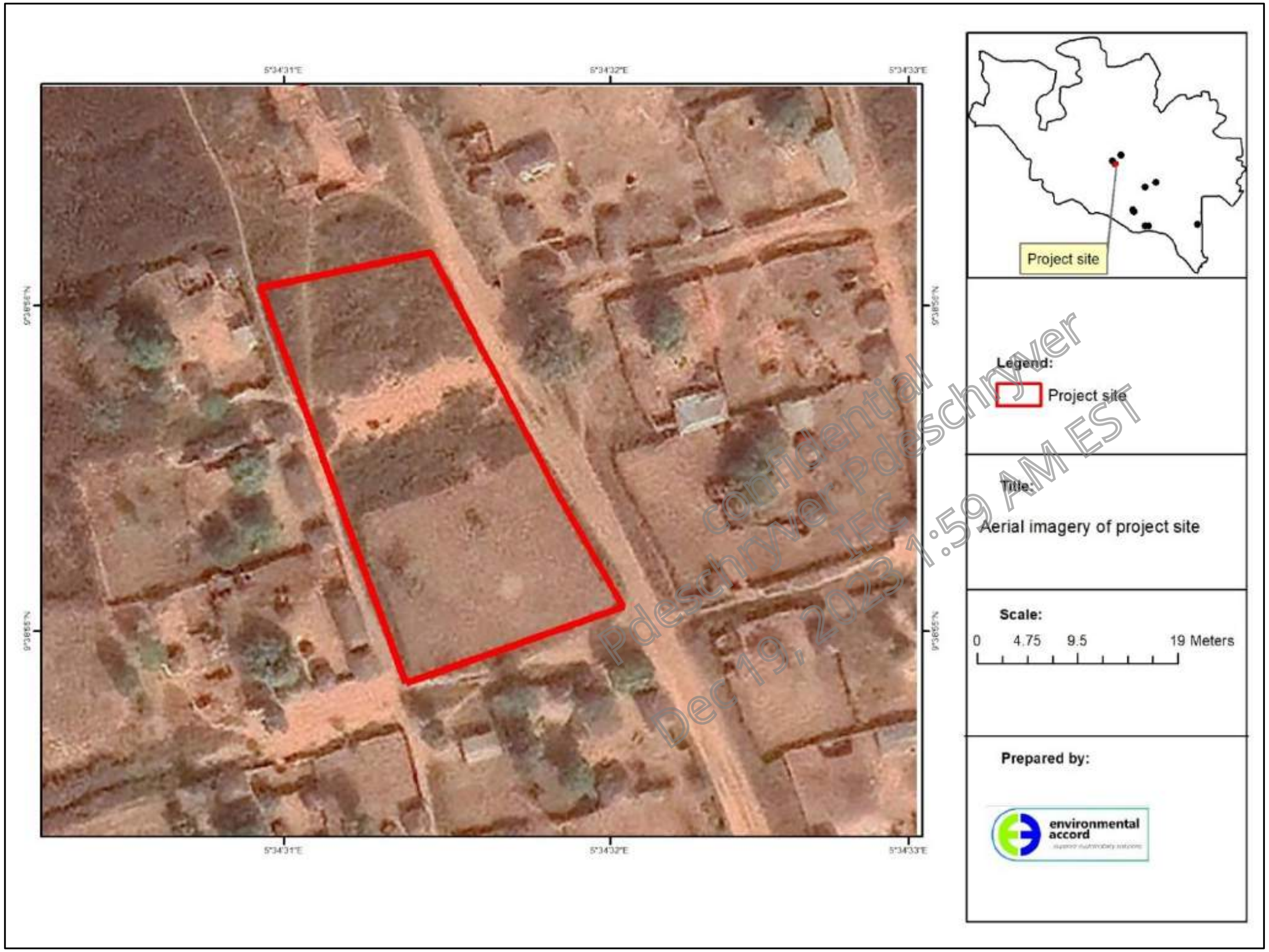

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Figure 3.7: Aerial imagery of Mashigi community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

Plate 3.5: Cross sectional image of Mashigi community proposed project site
Source: EnvAccord Field Survey, 2020

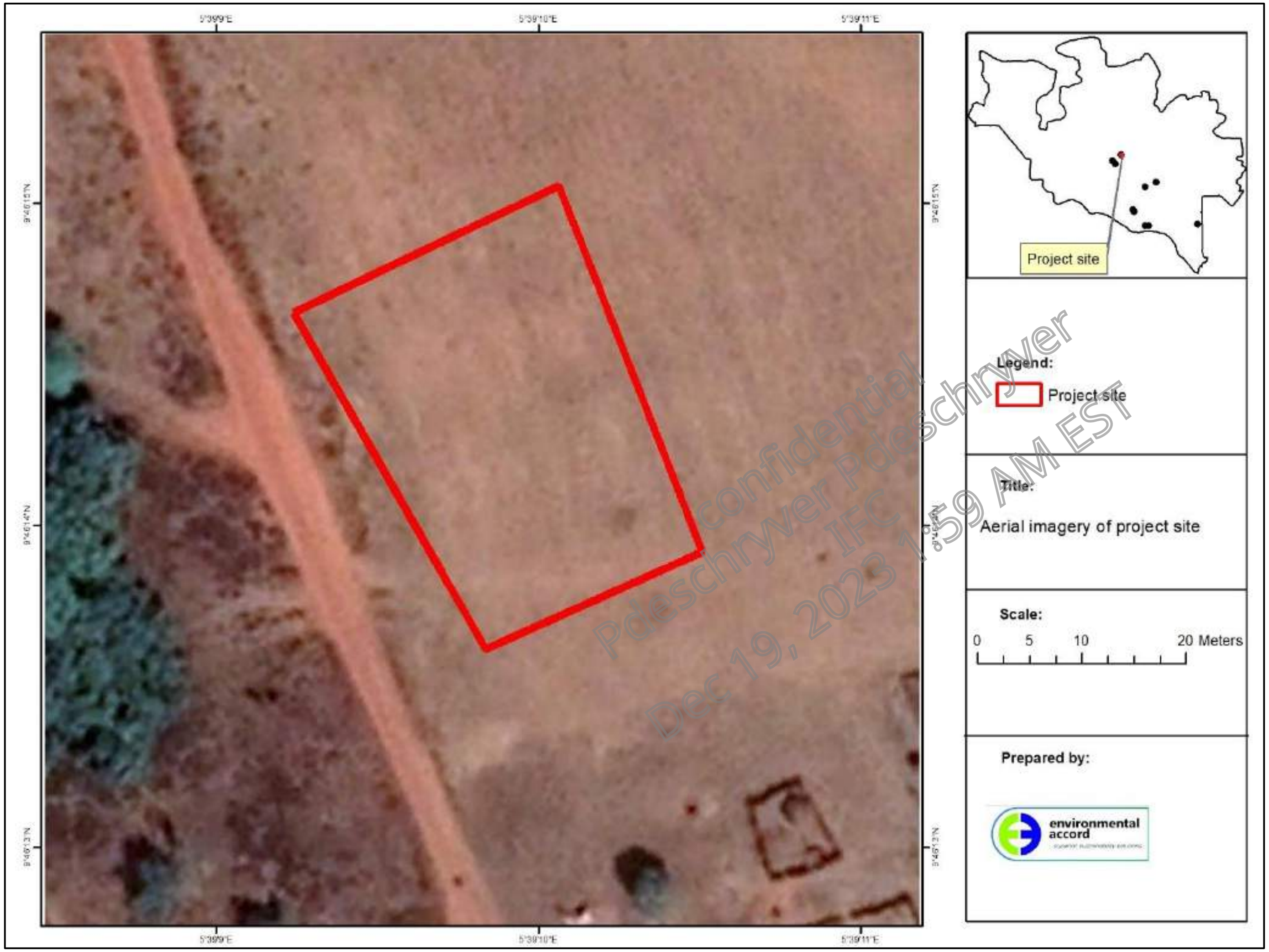

Figure 3.8: Aerial imagery of Nakoko-Siyidi community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

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Plate 3.6: Cross sectional image of Nakoko-Siyidi community proposed project site
Source: EnvAccord Field Survey, 2020

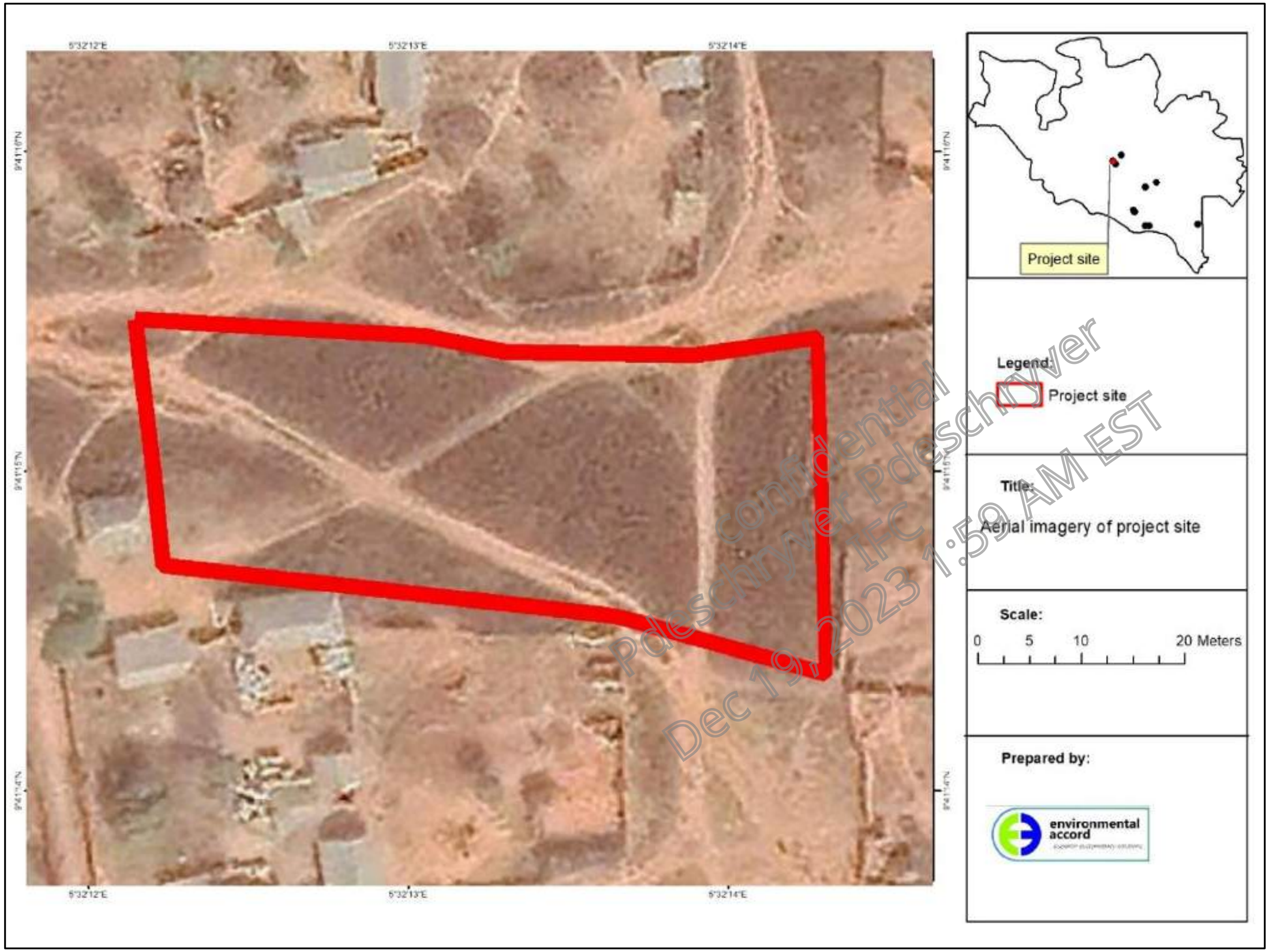

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Figure 3.9: Aerial imagery of Ragidda Hausawa community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

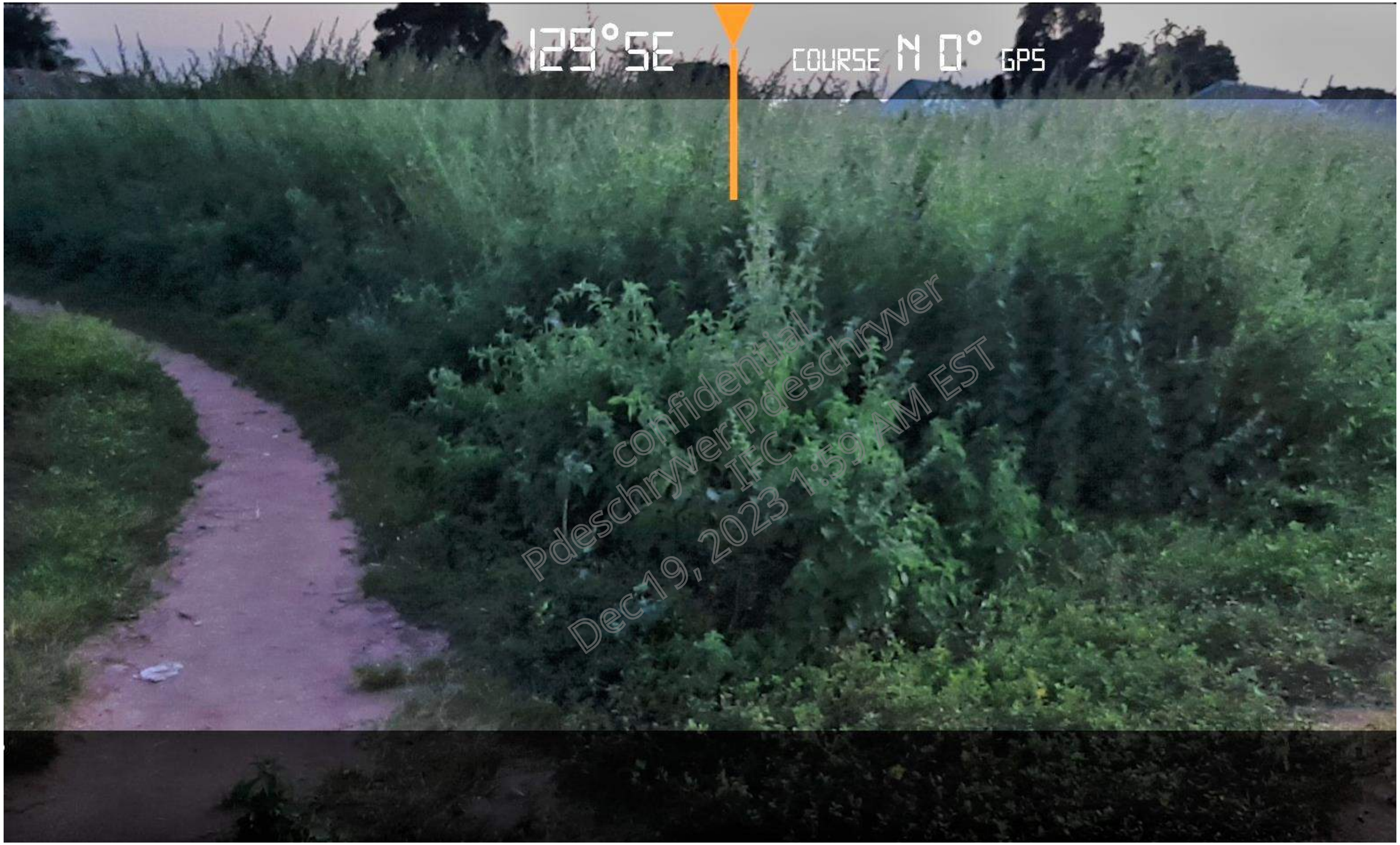

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Plate 3.7: Cross sectional image of Ragidda Hausawa community proposed project site
Source: EnvAccord Field Survey, 2020

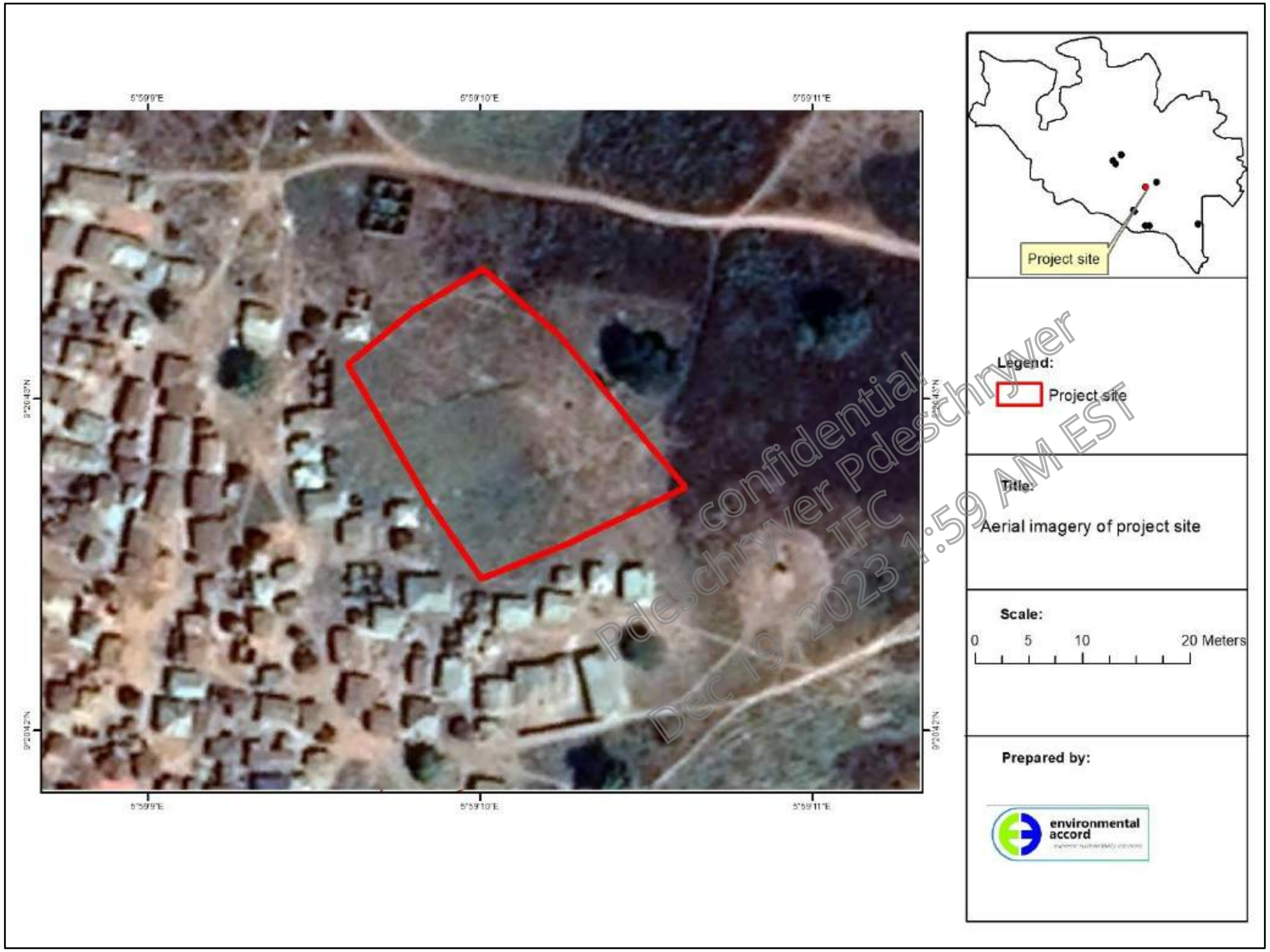

Figure 3.10: Aerial imagery of Sheshimandiko community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

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Plate 3.8: Cross sectional image of Sheshimandiko community proposed project site
Source: EnvAccord Field Survey, 2020

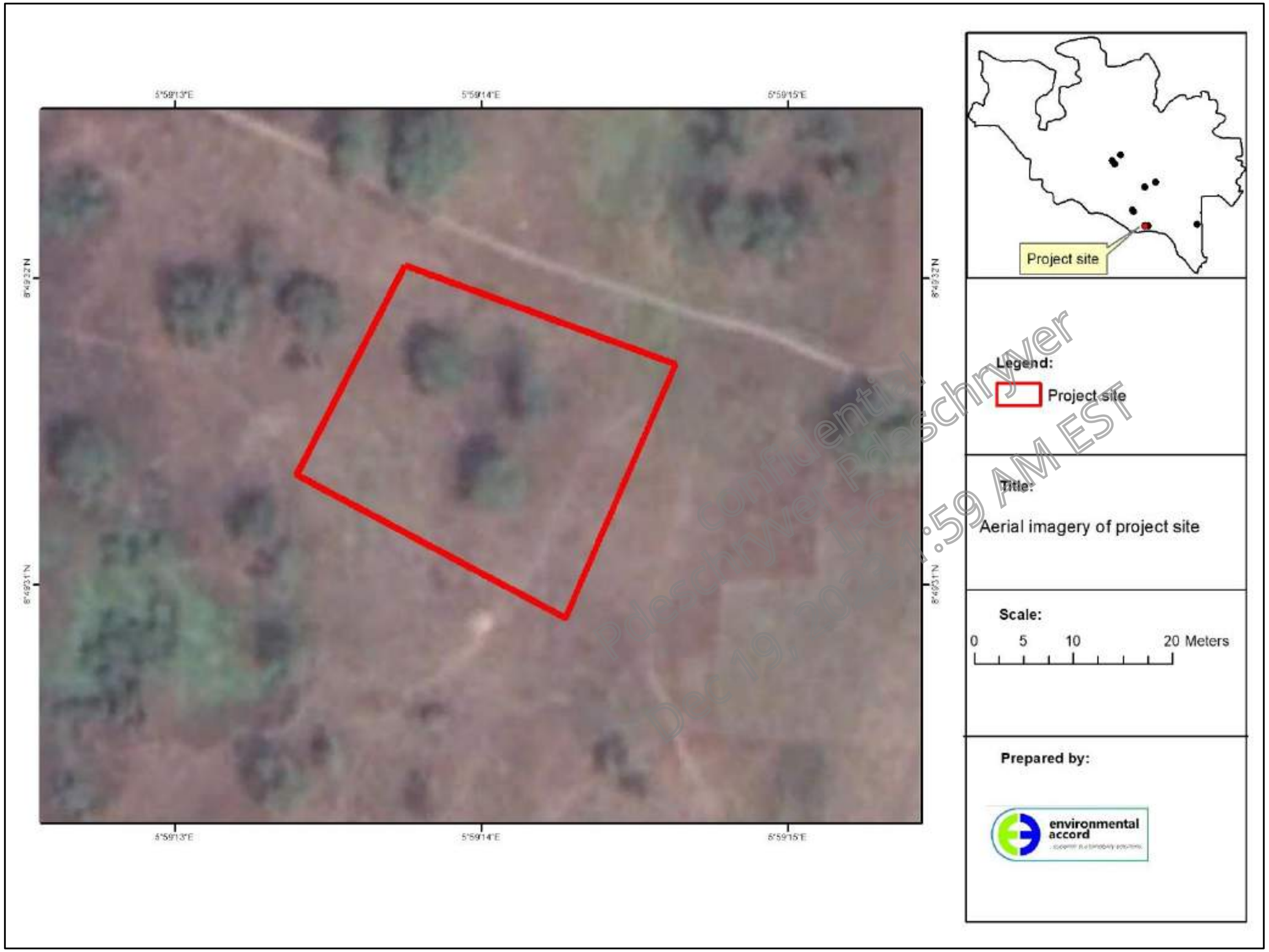

Figure 3.11: Aerial imagery of Kpanje community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

Plate 3.9: Cross sectional image of Kpanje community proposed project site
Source: EnvAccord Field Survey, 2020

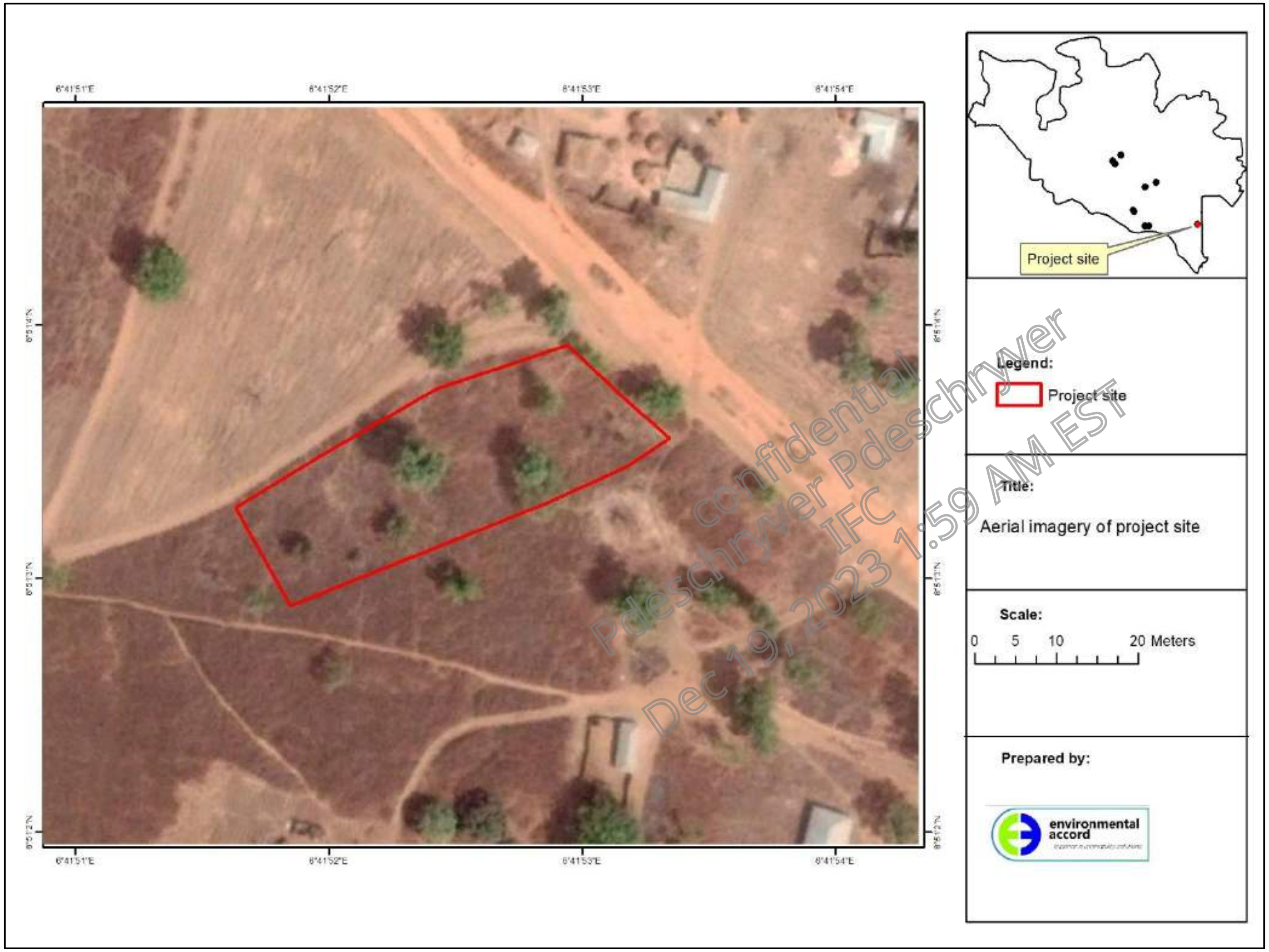

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Figure 3.12: Aerial imagery of Mayaki community showing the proposed Project site (outlined in red)
Source: EnvAccord GIS, 2020

Plate 3.10: Cross sectional image of Mayaki community proposed project site
Source: EnvAccord Field Survey, 2020

3.3 Description of the Project

As previously stated, the proposed Project involves the installation and operation of Solar Photovoltaic (PV) panels and ancillary components for generation of renewable energy within the propose project sites. All the proposed project sites will have similar layout, equipment, and facilities for power generation and distribution. However, there may be minor modifications based on the power demand of the beneficiary communities as the energy audits, engineering design and procurement of components are still ongoing as at the time of this ESIA study. Thus, the description of the project components and activities in the following sections is for a typical site.

3.3.1 Components of the Project

The major components of the proposed Project include PV panels/modules, mounting structures, inverters, electrical meters, cables, hubs, backup generator, etc. These components which will be set up in project sites are discussed below.

3.3.1.1 PV Technology

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

PV technology is basically comprised of:

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

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

JA Solar JAM72S09 375-395/PR Series (380W & 390W PERC Modules): these are high performance PV modules powered by PERCIUM cells and can be used for large- or small-scale PV systems. The key features and specification are listed in Table 3.2 while a sample picture of the panel is presented in Plate 3.11.

Table 3.2: Key features and specification of the JA Solar JAM72S09 375-395/PR Series PV modules

S/N	Specification	Data			
Electrical Data		***380 W at Standard Test Conditions***	***390W at Standard Test Conditions***	***380 W at Normal Operating Conditions***	***390W at Normal Operating Conditions***
1.	Rated Maximum Power (Pmax)	380W	390W	281W	289W
2.	Open Circuit Voltage (Voc)	48.75V	49.35V	46.15V	46.78V
3.	Maximum Power Voltage (Vmp)	39.59V	40.21V	37.34V	37.92V
4.	Short Circuit Current (Isc)	10.12A	10.22A	7.99A	8.07A
5.	Maximum Power Current (Imp)	9.60A	9.70A	7.53A	7.61A
6.	Module Efficiency [%]	19.3	19.8	19.3	19.8
7.	Power Tolerance	0~+5W			
8.	Temperature Coefficient of Isc (α_Isc)	+0.060%/℃			
9.	Temperature Coefficient of Voc (β_Voc)	-0.300%/℃			
10.	Temperature Coefficient of Pmax (γ_Pmp)	-0.380%/℃			
11.	STC	Irradiance 1000W/m², cell temperature 25℃, AM1.5G			
12.	Nominal Operating Cell Temperature (NOCT)	Irradiance 800W/m², ambient temperature 20℃, wind speed 1m/s, AM1.5G			
Specifications/Mechanical Data					
13.	Cell type	Mono			
14.	Weight	22.3kg±3%			
15.	Dimensions	1979±2mm×996±2mm×40±1mm			
16.	Cable Cross Section Size	4mm²			
17.	No. of cells	72(6x12)			
18.	Junction Box	IP67, 3 diodes			
19.	Connector	MC4 Compatible(1000V), QC 4.10-35(1500V)			
Operating conditions					
20.	Maximum System Voltage	1000V/1500V DC(IEC)			
21.	Operating Temperature	-40℃~+85℃			
22.	Maximum Series Fuse	20A			
23.	Maximum Static Load, Front*	5400Pa			
24.	Maximum Static Load, Back*	2400Pa			
25.	NOCT	45±2℃			
26.	Application Class	Class A			

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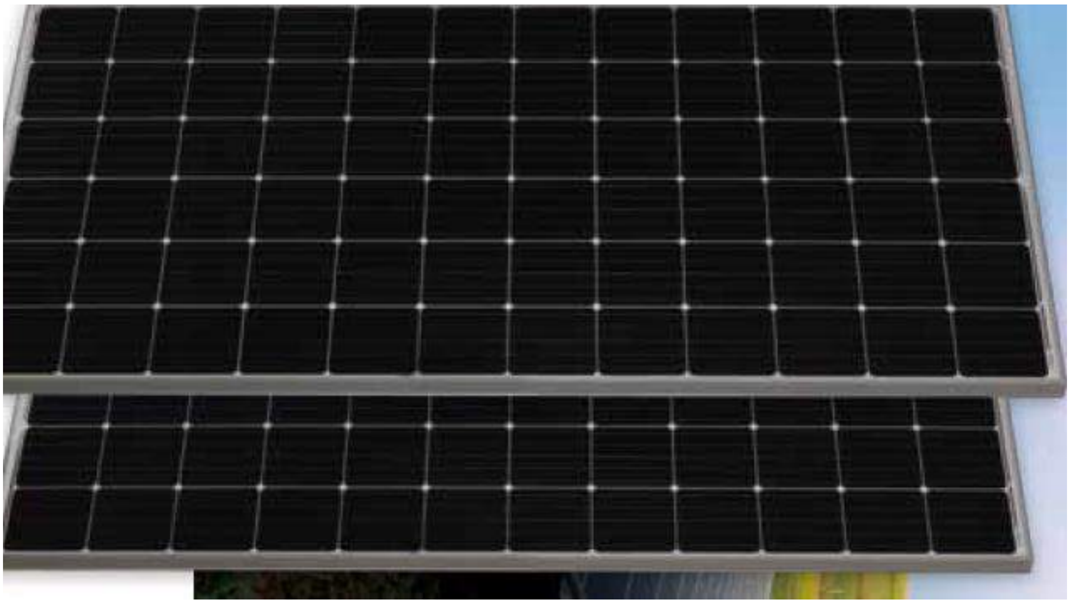

Plate 3.11: A typical JA Solar JAM72S09 375-395/PR Series module
Source: JASOLAR JAM72S09 375-395/PR series product datasheet, 2018

Considering the 390Wp size of the PV modules, the number of panels (which will be dependent on the system capacity for each site) will be between 128 and 256 per project site. In general, the PV panels to be installed will have following characteristics:

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

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3.3.1.2 Mounting structure

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

3.3.1.3 Inverter

An inverter converts the variable DC output of a photovoltaic solar module into a utility frequency alternating current (AC) that can be used by a local, off-grid electrical network or fed into a commercial electrical grid. 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.

The inverters to be installed for the proposed project are the described below:

1. **FRONIUS Symo 3.7-3-S and 3.7-3-M three phase inverters**: These inverters have standard interface to the internet via WLAN or Ethernet, and can communicate wirelessly with third party components. Furthermore, the meter interface permits dynamic feed-in management and a clear visualisation of the consumption overview. The technical specifications of the inverters are presented in Table 3.3.

Table 3.3: Technical specifications of the inverter to be installed for the proposed Project

S/N	Specification	3.7-3-S	3.7-3-M
	Efficiency		
1.	Max. efficiency	98.0%	
2.	European efficiency	96.7%	96.9%
3.	MPP adaptation efficiency	> 99.9%	
	Input Data		
4.	Number MPP trackers		
5.	Max. input current ($I_{dc\ max\ 1}$ / $I_{dc\ max\ 21}$)	1	2
6.	Max. array short circuit current (MPP1/MPP21)	16.0 A	16.0 A / 16.0 A
7.	DC input voltage range ($U_{dc\ min}$ - $U_{dc\ max}$)	150 - 1000 V	
8.	Feed-in start voltage ($U_{dc\ start}$)	200 V	
9.	Usable MPP voltage range	150 - 800 V	
10.	Number of DC connections	3	2+2
11.	Max. PV generator output ($P_{dc\ max}$)	7.4 kW_{peak}	7.4 kW_{peak}
	Output Data		
12.	AC nominal output ($P_{ac,r}$)	3,700 W	3,700 W
13.	Max. output power	3,700 VA	3,700 VA
14.	AC output current ($I_{ac\ nom}$)	5.3 A	5.3 A
15.	Grid connection (voltage range)	3~NPE 400 V / 230 V or 3~NPE 380 V / 220 V (+20 % / -30 %)	
16.	Frequency (Frequency range)	50 Hz / 60 Hz (45 - 65 Hz)	
17.	Total harmonic distortion	< 3 %	
18.	Power factor (cos $\varphi_{ac,r}$)	0.70 - 1 ind. / cap.	0.85 – 1 ind. / cap.
	General Data		
19.	Dimensions (height x width x depth)	645 x 431 x 204 mm	
20.	Weight	16.0 kg	19.9 kg
21.	Degree of protection	IP 65	
22.	Protection class	1	
23.	Overvoltage category (DC / AC) [2)]	2 / 3	
24.	Night time consumption	< 1 W	
25.	Inverter design	Transformerless	
26.	Cooling	Regulated air cooling	
27.	Installation	Indoor and outdoor installation	
28.	Ambient temperature range	-25 - +60 °C	
29.	Permitted humidity	0 - 100 %	
30.	Max. altitude	2,000 m / 3,400 m (unrestricted / restricted voltage range)	

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S/N	Specification	3.7-3-S	3.7-3-M
31.	DC connection technology	3x DC+ and 3x DC- screw terminals 2.5 - 16 mm^2	4x DC+ and 4x DC- screw terminals 2.5 - 16mm2
32.	AC connection technology	5-pole AC screw terminals 2.5 - 16 mm^2	5-pole AC screw terminals 2.5 - 16mm2
33.	Certificates and compliance with standards	ÖVE / ÖNORM E 8001-4-712, DIN V VDE 0126-1-1/A1, VDE AR N 4105, IEC 62109-1/-2, IEC 62116, IEC 61727, AS 3100,	
Protective Devices			
34.	DC insulation measurement	Yes	
35.	Overload behaviour	Operating point shift. power limitation	
36.	DC disconnector	Yes	
37.	Reverse polarity protection	Yes	
Interfaces			
38.	WLAN / Ethernet LAN	Fronius Solar.web, Modbus TCP SunSpec, Fronius Solar API (JSON)	
39.	6 inputs and 4 digital in/out	Interface to ripple control receiver	
40.	USB (A socket)	Datalogging, inverter update via USB flash drive	
41.	2x RS422 (RJ45 socket)	Fronius Solar Net	
42.	Signalling output	Energy management (potential-free relay output)	
43.	Datalogger and Webserver	Included	
44.	External input	S0-Meter Interface / Input for overvoltage protection	
45.	RS485	Modbus RTU SunSpec or meter connection	

Source: Fronious-Symo Inverter Technical Specifications Sheet, 2011

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The inverters will be set up in a building to be constructed within the proposed project sites. The number of inverters to be installed will be based on the power generated from the PV panels. Plate 3.12 is a sample picture of the inverter to be installed for the proposed Project.

Plate 3.12: Typical FRONIUS Symo 3.7-3-S and 3.7-3-M inverter

Source: Fronious-Symo Inverter Technical Specifications Sheet, 2011

2. **Quattro Inverter/Charger**: This is a combined inverter and charger. It can accept two AC inputs and automatically connect to the active source. Its many features include a true sine wave inverter, adaptive charging, hybrid PowerAssist technology plus multiple system integration features such as three or split phase operation and parallel operation. The technical specifications of the inverter are presented in Table 3.4, while a sample picture of the inverter is presented in Plate 3.13.

Table 3.4: Technical specifications of the Quattro inverter/charger.

S/N	Specification	24/8000/200-100/100 48/8000/110-100/100	48/10000/140-100/100
1.	PowerControl / PowerAssist	Yes	
2.	Integrated Transfer switch	Yes	
3.	AC inputs (2x)	Input voltage range: 187-265 VAC Input frequency: 45 – 65 Hz Power factor: 1	
4.	Maximum feed through current (A)	2x100	2x100
5.	Input voltage range (V DC)	9.5 – 17V 19 – 33V 38 – 66V	
6.	Output	Output voltage: 230 VAC ± 2% Frequency: 50 Hz ± 0.1%	
7.	Cont. output power at 25 °C (VA)	8000	10000
8.	Cont. output power at 25 °C (W)	7000	9000
9.	Cont. output power at 40 °C (W)	6300	8000
10.	Peak Power (W)	16000	20000
11.	Maximum efficiency (%)	94 / 96	96
12.	Zero-load power (W)	30 / 35	35
13.	Zero load power in AES mode (W)	25 / 30	30
14.	Zero load power in Search mode (W)	8 / 10	10
15.	Charge voltage 'absorption' (V DC)	28.8 / 57.6	57.6
16.	Charge voltage 'float' (V DC)	27.6 / 55.2	55.2
17.	Storage mode (V DC)	26.4 / 52.8	52.8
18.	Charge current house battery (A)	200 / 110	140
19.	Charge current starter battery (A)	4 (12V and 24V models only)	
20.	Battery temperature sensor	Yes	
21.	Auxiliary output (A)	50	50
22.	Programmable relay	3x	3x
23.	VE.Bus communication port	For parallel and three phase operation, remote monitoring and system integration	
24.	General purpose com. Port	2x	2x
25.	Remote on-off	Yes	
26.	Operating Environment	Operating temp.: -40 to +50 °C Humidity (non condensing): max. 95%	
27.	Housing	Material & Colour: aluminium (blue RAL 5012) Protection category: IP 21	
28.	Battery-connection	Four M8 bolts (2 positive and 2 negative)	
29.	230 V AC-connection	Bolts M6	Bolts M6
30.	Weight (kg)	45/41	45
31.	Dimensions (hxwxd in mm)	470 x 350 x 280	470 x 350 x 280
32.	Safety	EN 60335-1. EN 60335-2-29	
33.	Emission, Immunity	EN55014-1. EN 55014-2. EN 61000-3-3. EN 61000-6-3. EN 61000-6-2. EN 61000-6-1	

Source: Quattro Inverter/Charger Technical Specifications Sheet, 2020

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Plate 3.13: Sample picture of the Quattro inverter
Source: Quattro Inverter/Charger Technical Specifications Sheet, 2020

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The inverters will also be fitted with SmartSolar Charge Controllers, which will be used to manage the power going into the battery bank from the solar array. They will also ensure that the deep cycle batteries are not overcharged during the day, and that the power doesn't run backwards to the solar panels overnight and drain the batteries. The specifications of the solar charge controllers are provided in Table 3.5 while a sample picture is shown in Plate 3.14.

Table 3.5: Technical specifications of the solar charge controllers

S/N	Specification	250/85	250/100
1.	Battery voltage	12/24/48V Auto Select (36V: manual)	
2.	Rated charge current	85A	100A
3.	Nominal PV power, 12V 1a,b)	1200W	1450W
4.	Nominal PV power, 24V 1a,b)	2400W	2900W
5.	Nominal PV power, 36V 1a,b)	3600W	4350W
6.	Nominal PV power, 48V 1a,b)	4600W	5800W
7.	Max. PV short circuit current 2)	70A (max 30A per MC4 conn.)	
8.	Maximum PV open circuit voltage	250V absolute maximum coldest conditions 245V start-up and operating maximum	
9.	Maximum efficiency	99%	
10.	Self-consumption	Less than 35mA @ 12V / 20mA @ 48V	
11.	Charge voltage 'absorption'	Default setting: 14,4 / 28,8 / 43,2 / 57,6V (adjustable with: rotary switch, display, VE.Direct or Bluetooth)	
12.	Charge voltage 'float'	Default setting: 13,8 / 27,6 / 41,4 / 55,2V (adjustable: rotary switch, display, VE.Direct or Bluetooth)	

S/N	Specification	250/85	250/100
13.	Charge voltage 'equalization'	Default setting: 16,2V / 32,4V / 48,6V / 64,8V (adjustable)	
14.	Charge algorithm	multi-stage adaptive (eight preprogrammed algorithms) or user defined algorithm	
15.	Temperature compensation	-16 mV / -32 mV / -64 mV / °C	
16.	Protection	PV reverse polarity / Output short circuit / Over temperature	
17.	Operating temperature	-30 to +60°C (full rated output up to 40°C)	
18.	Humidity	95%, non-condensing	
19.	Maximum altitude	5000m (full rated output up to 2000m)	
20.	Environmental condition	Indoor, unconditioned	
21.	Pollution degree	PD3	
22.	Data communication	VE.Can, VE.Direct and Bluetooth	
23.	Remote on/off	Yes (2 pole connector)	
24.	Programmable relay	DPST AC rating: 240VAC / 4A DC rating: 4A up to 35VDC, 1A up to 60VDC	
25.	Parallel operation	Yes, parallel synchronised operation with VE.Can or Bluetooth	
Enclosure			
26.	Colour	Blue (RAL 5012)	
27.	PV terminals 3)	35 mm² / AWG2 (Tr models) Three pairs of MC4 connectors (MC4 models)	
28.	Battery terminals	35mm² / AWG2	
29.	Protection category	IP43 (electronic components), IP22 (connection area)	
30.	Weight	4.5kg	
31.	Dimensions (h x w x d) in mm	Tr models: 216 x 295 x 103 MC4 models: 246 x 295 x 103	
32.	Safety	EN/IEC 62109-1, UL 1741, CSA C22.2	

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Plate 3.14: Sample picture of the SmartSolar Charge Controllers
Source: SmartSolar Charge Controllers Technical Specifications Sheet, 2020

3.3.1.4 Monitoring and Control System

A monitoring system will also be installed within the project sites along with the solar PV panels, inverters, and battery inverters. The Victron Color Control GX remote control and monitoring panel with internet monitoring and control capability will be installed at each project site as it provides intuitive control and monitoring for all products connected to it. The technical specifications of the monitoring and control system is presented in Table 3.6 while samples pictures are shown in Plate 3.15.

Table 3.6: Technical specifications of the Victron Color Control GX

S/N	Specifications			
1.	Power supply voltage range	8 – 70V DC		
2.	Current draw	12V DC	24V DC	48V DC
3.	Display off	140mA	80mA	40mA
4.	Display at minimum intensity	160mA	90mA	45mA
5.	Display at maximum intensity	245mA	125mA	65mA
6.	Potential free contact	3A / 30V DC / 250V AC (Normally open)		
	Communication ports			
7.	VE.Direct	2 separate VE.Direct ports – isolated		
8.	VE.Can	2 paralleled RJ45 sockets – isolated		
9.	VE.Bus	2 paralleled RJ45 sockets – isolated		
10.	USB	2 USB Host ports – not isolated		
11.	Ethernet	10/100/1000MB RJ45 socket – isolated except shield		
	3rd party interfacing			
12.	Modbus-TCP	Use Modbus-TCP to monitor and control all products connected to the Color Control GX		
13.	JSON	Use the VRM JSON API to retrieve data from the VRM Portal		
	Other			
14.	Outer dimensions (h x w x d)	130 x 120 x 28mm		
15.	Operating temperature range	-20 to +50°C		
16.	Safety	EN 60950-1:2005+A1:2009+A2:2013		
17.	EMC	EN 61000-6-3, EN 55014-1, EN 61000-6-2, EN 61000-6-1, EN 55014-2		
18.	Automotive	E4-10R-053535		

Source: Victron Energy Color Control GX, 2020

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Plate 3.15: A typical Color Control GX monitoring system

Source: Victron Energy Color Control GX, 2020

3.3.1.5 Electric Meters

In order to monitor the power consumption of the prospective customers, electric meters will be installed at each household. All customers will be given a smart prepaid meter through which they will be able to track their power consumptions, and also make mobile payments to subscribe for electricity credit units based on various tariff options.

3.3.1.6 Batteries

Lead acid batteries are planned to be installed for the project. The number of Lead acid batteries to be installed as part of the power plant is yet to be finalized. The model of the batteries to be installed is the Narada REXC Series 1500, which is designed for energy storage systems and hybrid systems. The battery is waterproof, anti-salt treated, and shockproof with a design life of 20 years. Also, it is a high power battery with rapid charge and discharge cycles. The batteries would be stored and operated under optimum conditions as specified by the manufacturers. The technical specification for the battery is presented in Table 3.7 while a sample picture of the battery is shown in Plate 3.16.

Table 3.7: Technical specifications of the Narada REXC-1500 lead acid battery

S/N	Specification	
1.	Nominal Voltage	2V
2.	Capacity	1500 Ah (10hr to 1.80V/cell @25℃) 1800Ah (120hr to 1.85V/cell @25℃)
3.	Typical Weight	110kg
4.	Internal Resistance	Approximately 0.12mΩ
5.	Short-Circuit Current	16882A
6.	Self-Discharge	The residual capacity is above 90% after 90 days storage (25℃)
7.	Temperature Ranges	Operation (recommended):15℃~25℃ Operation(maximum): -40℃~50℃
8.	Max. charging current	450A
9.	Max. constant charging current	300A
10.	Charge Voltage	Floating:2.25V (25℃) Equalizing/Cycle: 2. 30V(25℃)
11.	Terminal	M8 embedded copper
12.	Terminal Hardware Torque	> 10N·m

Source: Narada REXC-1500 -01-N-EN Technical Specifications sheet, 2015

Plate 3.16: Sample picture of the Narada REXC-1500 battery

Source: Narada REXC-1500 -01-N-EN Technical Specifications sheet, 2015

3.3.1.7 Backup Generator

A 60 kVA Diesel-fueled generating set would be installed at each project site to serve as a backup to the solar power system. It would be used for providing power during periods of low solar irradiance (e.g. cloudy days at the peak of raining season), as well as during maintenance. The Marapco MP60-MP66E diesel generators with a tank capacity of 100 litres will be installed for the proposed projects (Plate 3.17).

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Plate 3.17: Typical Marapco MP60-MP66E diesel generator

Source: https://www.pmgjsc.com/en/mp60-mp66e / (accessed on September 4, 2020)

3.3.1.8 Distribution Poles and Cables

Utility poles will be erected within the communities to support the overhead cables for the proposed project. Insulated cables will be installed within the communities for distribution of power to the households connected to the project. The sizes of cables to be installed will be determined based on the power needs of the households at each site. Households that use more power will require larger cables for connection.

3.3.2 Power generation and Distribution

The solar PV panels will be installed within the project site in arrays and power generated from the panels will be transmitted to the building to be constructed within the site. The building will house the batteries, inverters and other associated electronic equipment for the proposed project. Also, another building will be constructed within the site to serve as the security post. Figure 3.13 shows a typical layout of the proposed project sites showing the buildings and facilities.

The power generated by the project components is planned to be distributed to the households within the communities where the project is sited using a single-phase system for household consumers, and three-phase system for productive power consumers. The transmission lines will emanate from the main distribution board at the project site and be distributed via overhead poles to the households. These lines will T-off as distribution lines in strategic points. The distribution lines will run through the households to power them, and electric meters shall be installed for monitoring power consumption for billing. The models and single line diagrams of the typical power generation and distribution system to be installed at the project sites is presented in Figure 3.14 to 3.16.

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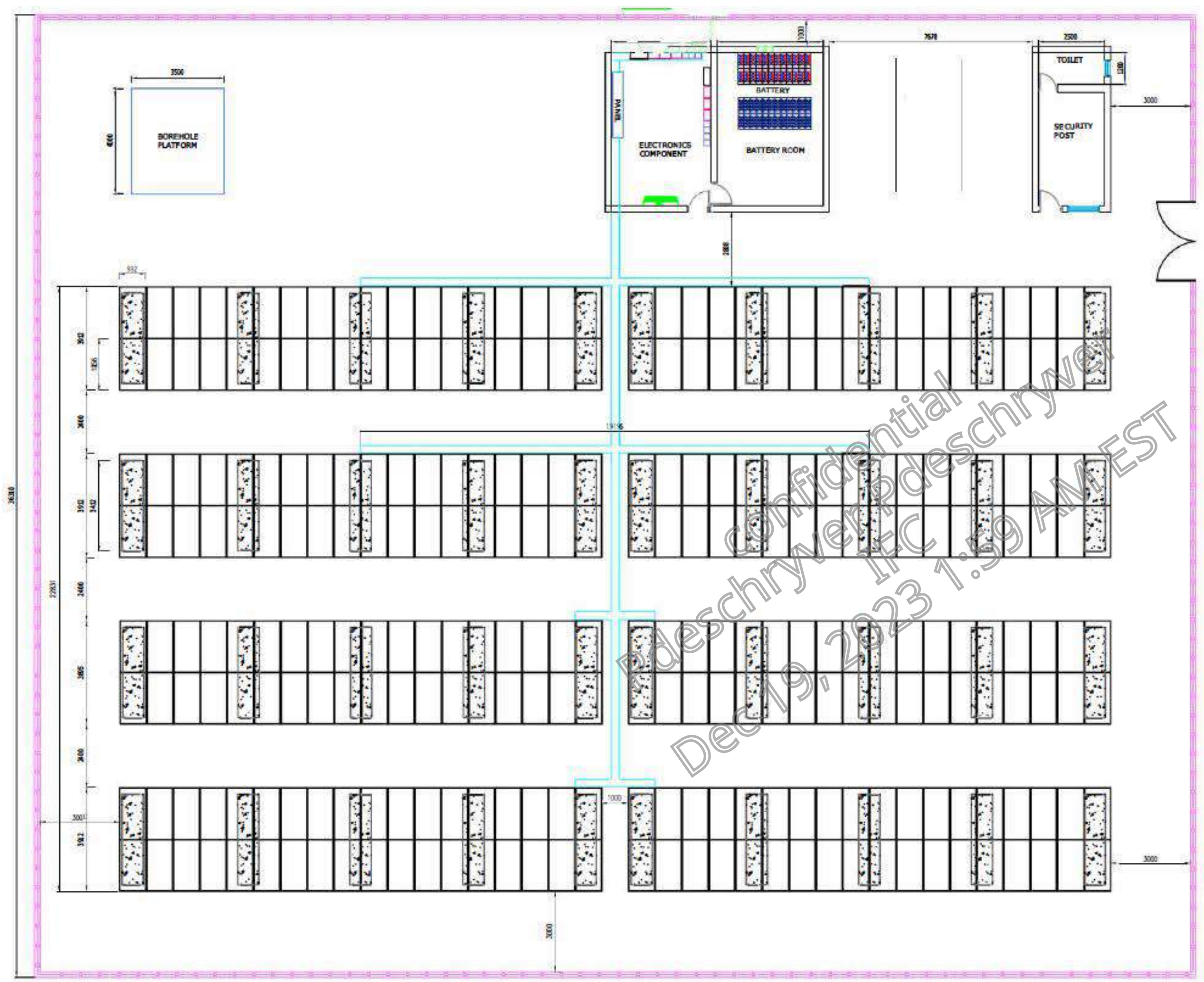

Figure 3.13: Typical layout of the proposed project sites

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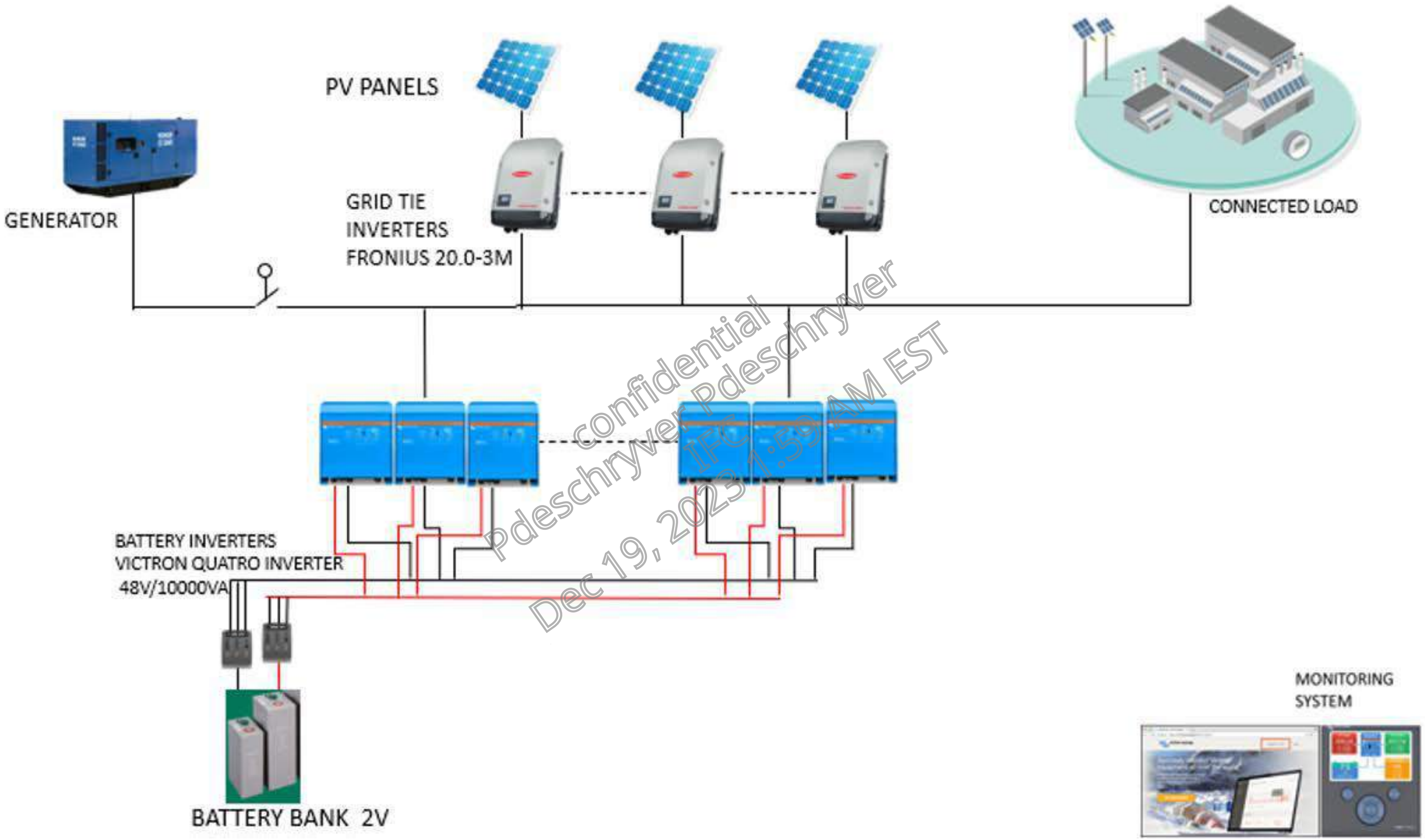

Figure 3.14: Power generation and distribution model for the proposed projects

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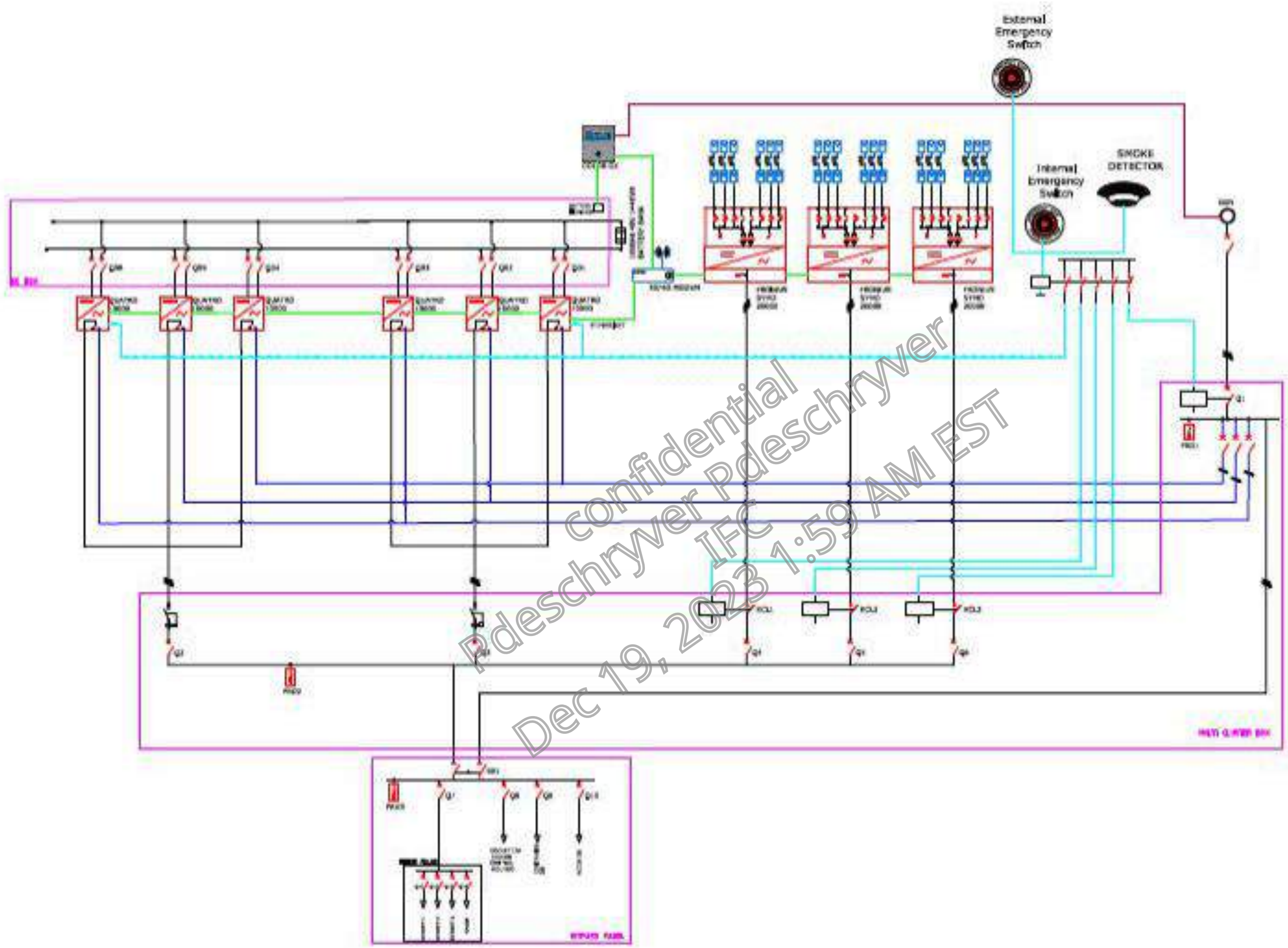

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Figure 3.15: Single line diagram showing power generation and distribution system for the proposed projects

Figure 3.16: Typical layout for power distribution within the households in the beneficiary communities

3.3.3 Safety and Emergency Systems

Each project site will have protection systems such as breakers and fuses in place, installed on the power generation components and within the power distribution network. Earthing design for the power generation units at each project site shall be by means of earth mat. There will be also ready board installed for the customers which will include 30 mA circuit breaker to protect from surges.

3.3.4 Associated Facilities/Third-Party Structures

The proposed project sites are located in rural communities with low level of infrastructural development, and there are no associated facilities or third-party structures on the proposed project sites. The communities are mostly into farming activities and food processing, but there are no industrial activities within the area of influence of the project sites.

3.4 Project Implementation Phases

3.4.1 Pre-construction Phase Activities

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

3.4.2 Construction Phase Activities

The construction phase of the Project will include civil, mechanical and electrical works; installation of PV panels and associated plant facilities; installation of distribution systems, cables and power meters to the households.

The number of workers to be engaged for the project will be determined by the engineering procurements and construction contractor (GreenElec) to be engaged for the projects. The workers required are divided into low skilled workers (e.g. construction labour who will form majority of the workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and expatriates). Most of the unskilled and semi-skilled workers would be drawn from the nearby local community to enhance the job opportunities associated with the proposed Project. The local labour force will be recruited from the communities with particular priority to the youths and the female gender. No workers camp is planned to be established onsite during construction.

3.4.3 Commissioning Phase Activities

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

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3.4.4 Operational Phase Activities

The operational phase of the Project will involve power generation and distribution to the households in the host communities as well as the preventative, corrective and predictive maintenance of the power plant and associated facilities. All the project sites in the State will be overseen by the Cluster Manger, while local operators will be engaged to manage all day-to-day activities at each project site (Figure 3.17). Field Technicians and commercial officers will also be engaged for the proposed Projects.

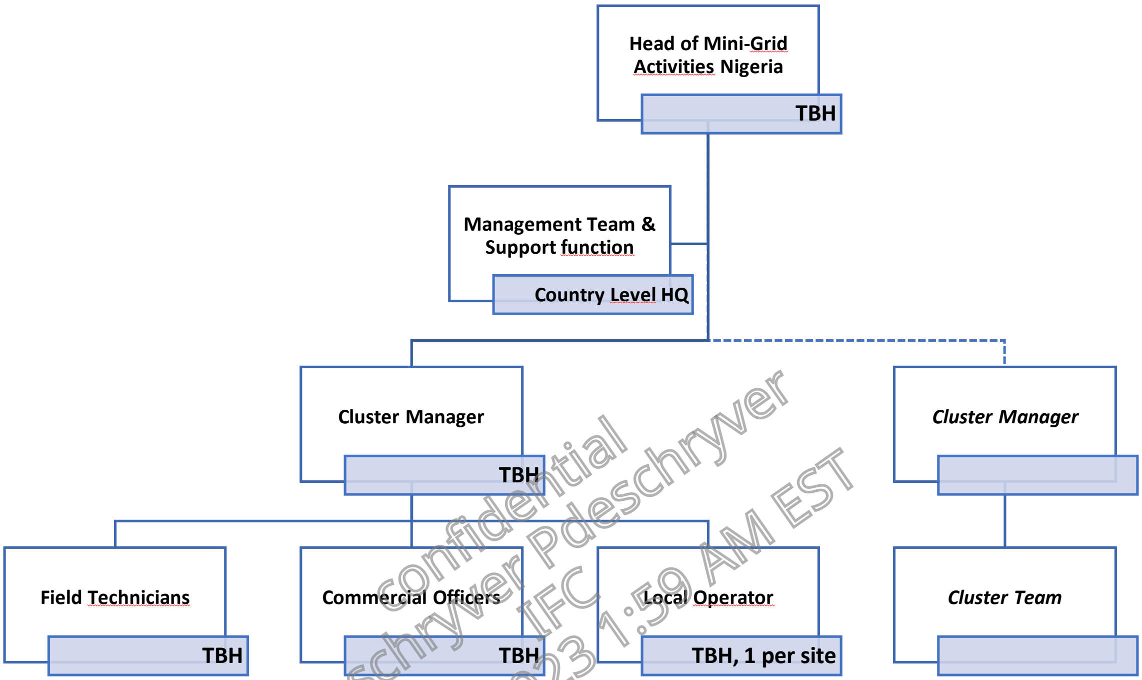

Figure 3.17: Organogram for project operations team (TBH – To be hired)

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

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

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

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

3.5 Water Use and Supply

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

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

Manual cleaning of the PV panels with water shall be regulated as much as practicable. During the periods of rainy season (usually from April to October in Niger State), direct cleaning of the PV panels is estimated to occur not more than three times. However, during the dry season (November to March), the frequency of cleaning is planned to be on a bi-weekly basis, but may increase due to high dust generation usually experienced in the Northern parts of the country.

Based on the review of similar solar power projects, each PV panel would require approximately 5 litres of water per cleaning cycle. Depending on the final power capacity, it is planned that between 128 to 256 panels will be installed for each site. Thus, it is estimated that between 640 to 1,280 litres of water will be required per cleaning cycle for each site, depending on the number of panels installed. The water required for the cleaning purpose would be obtained from the borehole that will be installed within the Project site. While sites with existing water facilities (nearby boreholes) will simply be channeled to the power plant site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have significant effect on the existing groundwater aquifer of the Project area as well as the local water use. The recharge of the existing boreholes in the study area is largely due to direct precipitation. During the rainy season, the water reserve of the aquifer in the study area increases; thus, hand dug wells and boreholes yields improve significantly.

3.6 Health, Safety and Security

The Technical manager selected by Engie Fenix shall manage and oversee the Health, Safety and Environment (HSE) aspects of the Project. The HSE personnel shall ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans; and also monitor implementation of environmental and social protection measures.

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

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

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

All staff, workmen, supplier and sub-contractor working on site shall be informed on the need to ensure their safety and the safety of the people working around them. Every worker will be instructed to always put on PPE whilst on site. Appropriate warning signs will be erected and checked each day. Daily health and safety tool-box meetings among workforce will be ensured. The safety briefings will be led by the onsite HSE officers. Smoking, use of alcohol or hard drugs will be strictly forbidden. Engie Fenix security officers have assessed the security level of the region and mapped out specific areas with high security risk. Thus, during travels and site works Police officers and local security officers will be on standby to ensure safety of both life and properties.

3.7 Waste Management

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

3.7.1 Overview

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

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

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

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

3.7.2 Associated Waste Streams

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

Pre-construction Phase

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

Construction Phase

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

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

All electronic equipment shall be supplied by credible manufacturers to reduce the risk of generating wastes from faulty equipment. All damaged PV panels generated during the installation activities shall be collected in a dedicated container and returned to the manufacturer outside the country for proper recycling since there is currently no recycling facility in Nigeria that handles PV panels. Also, Engie Fenix plans to engage EnviroServe (an international waste management company), for all e-waste collection and recycling associated with the proposed project. Off-cut cables and wire cuttings shall not be disposed with general wastes but be collected and stored for reuse and recycling.

Litter collection facilities shall be provided and all solid waste materials that are not identified for reuse or recycling will be placed in appropriate on-site storage containers (black-coloured waste receptacles for food waste, blue-coded bins for paper, and yellow-coded bins for general rubbish) and periodically disposed of (at least once a week throughout the construction period or on the need basis depending on the volume of the waste) at a government-approved dumpsite through a third party waste contractor approved by NISEPA. It is estimated that approximately 0.10 m^3 of construction debris will be produced per week.

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

<u>Operational Phase</u>

Solid wastes generated during the operational phase of the Project will be disposed by third party waste collection companies accredited by NISEPA. Approximately 1.00 cm^3 of solid waste is estimated to be generated per week during the operational phase.

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The Extended Producer Responsibility (EPR) program will be implemented for solar panels, inverters, batteries and other electrical components to be installed for the Project. Damaged or discarded PV panels and inverters will be collected and sent to the manufacturer for recycling in line with the EPR model. Spent, damaged or expired batteries will also be returned to the manufacturer for recycling. In addition, Enviroserve will also be engaged for all e-waste collection and recycling associated with the proposed project during the operational phase. Alternatively, the spent batteries are planned to be recycled by local and accredited battery recycling companies in Nigeria. These batteries shall be stored in red coloured waste receptacles before they are transported to the accredited battery recycling companies. The quantity of waste batteries generated typically depends on a number of factors such as type, capacity and number of batteries installed and depth of discharge.

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

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

Decommissioning

The waste streams associated with the decommissioning phase of the Project would be similar to the construction waste. These will include refuse, e-waste, general rubbish and demolition debris. Wastes will be segregated onsite, and non-reusable/recyclable wastes will be disposed of through an accredited third-party waste contractor.

The summary of wastes stream associated with the Project is provided in Table 3.8.

Table 3.8: Summary of Wastes Stream associated with the proposed Project and Handling Techniques

Waste Stream	Sources	Project Phase Construction (C), Operation (O), Decommissioning (D)	Handling Techniques
General rubbish, refuse, and putrescible wastes (food wastes)	Wood splinter, domestic waste, food packs, used bottles	C, O, D	On-site waste segregation; disposal of non-reusable waste through a third-party waste contractor approved by Niger State Environmental Protection Agency (NISEPA).
Cleared vegetation	During site clearing and preparation	C	Composting, collection for biomass fuel
Scrap metals	Used tubular and casings, used iron rods	C, O, D	Scrap metals will be collected for recycling
Excavated materials	Foundation works	C, D	Excavated materials generated during foundation works will be used for back-filling. Excess excavated spoil will be stockpiled and reused as part of materials for construction of plant buildings.
Damaged/expired PV panels	PV modules	C, O, D	Disposal by certified contractor, return to the manufacturer for recycling using the EPR model
Expired inverters	Electrical installation	O, D	Disposal by certified contractor, return to the manufacturer for recycling using the EPR model
Damaged/expired Batteries	Power generation	O, D	Recycle locally by engaging indigenous and accredited battery recycling contractors
Electrical components (cables, fuses, meters, etc.)	Power generation and distribution	C, O, D	Strictly prohibit burning and disposal with general wastes. Encourage repair/reuse and recycle alternatives as much as possible.
Sanitary waste	Training centre	C, O, D	Periodic evacuation of content of the septic tank by NISEPA accredited third party waste contractor.

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3.8 Project Schedule

The proposed Project is planned to be operational by the fourth quarter (Q4) of 2021. The tentative Project schedule is provided in Table 3.9.

Table 3.9: Tentative Project Schedule

Project Schedule	Timeline							
	2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site allocation								
Energy demand audit								
ESIA study and Approval								
Civil, electrical, and mechanical design								
Procurement(manufacturing and transportation)								
Preconstruction and construction Phase Activities								
Commissioning								
Commencement of operation								

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CHAPTER FOUR:

DESCRIPTION OF THE ENVIRONMENT

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CHAPTER FOUR

DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

This chapter provides a description of the existing environmental and socio-economic conditions of the Project's area of influence, which covers the Project sites and their beneficiary communities, including the area where the cumulative impacts of the Projects may be experienced. The stakeholder engagement activities conducted as part of the ESIA are also described in this Chapter.

Data and information for the environmental description of the study area were based on field data gathering (primary data) as well as review of relevant literature (secondary data). The field sampling was carried out at all the project sites by a team of environmental and social specialists. Based on the consideration of the potential environmental and social footprints of the proposed Project, as well as the need to ensure that all the sensitive receptors that could be potentially affected by the proposed Project have been captured, a 1 km radius from the centre of the Project site was selected as the spatial boundary for biophysical and socio-economic survey for each site.

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

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

4.2 Baseline Data Collection

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

The study approach includes the following:

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

4.2.1 Desktop Studies/Literature Review

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

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4.2.2 Field Sampling and Laboratory Analysis

4.2.2.1 <u>Field Sampling</u>

In order to effectively characterise the environment of the study area, field sampling was conducted at the project sites and AoI from October 12 to 19, 2020. The objective of the field exercise was to obtain the baseline data of the Project's AoI and describe its environmental and social context. Sampling locations were identified using recent satellite imagery of the Project area. The basis of the sampling design was informed by a preliminary characterization of the Project area through desktop research and identification of nearby sensitive receptors.

Sampling locations for biophysical components were randomly selected to cover as much as possible the land area for the proposed Project as well as the surrounding environment, while the socio-economic survey focused on the potentially affected community (also the beneficiary communities) identified within the Project's area of influence. All sampling locations were geo-referenced using Garmin Map-62 series Global Positioning System (GPS) handsets. The sampling maps showing the distribution of samples collected from each site during the baseline data gathering activities are presented in Figures 4.1 to 4.10.

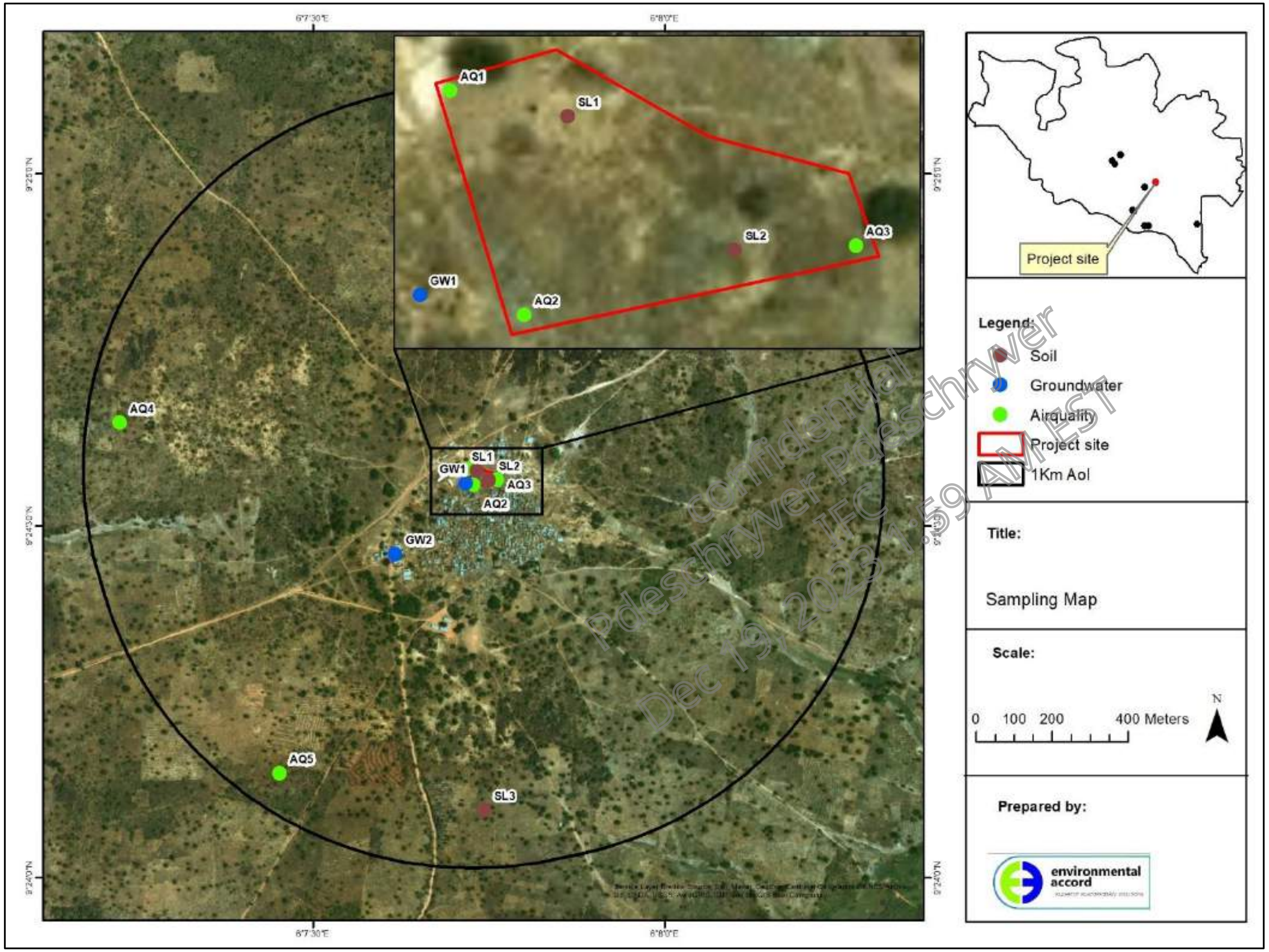

Figure 4.1: Biophysical sampling map for Gbangba community project site and AoI
Source: EnvAccord GIS, 2020

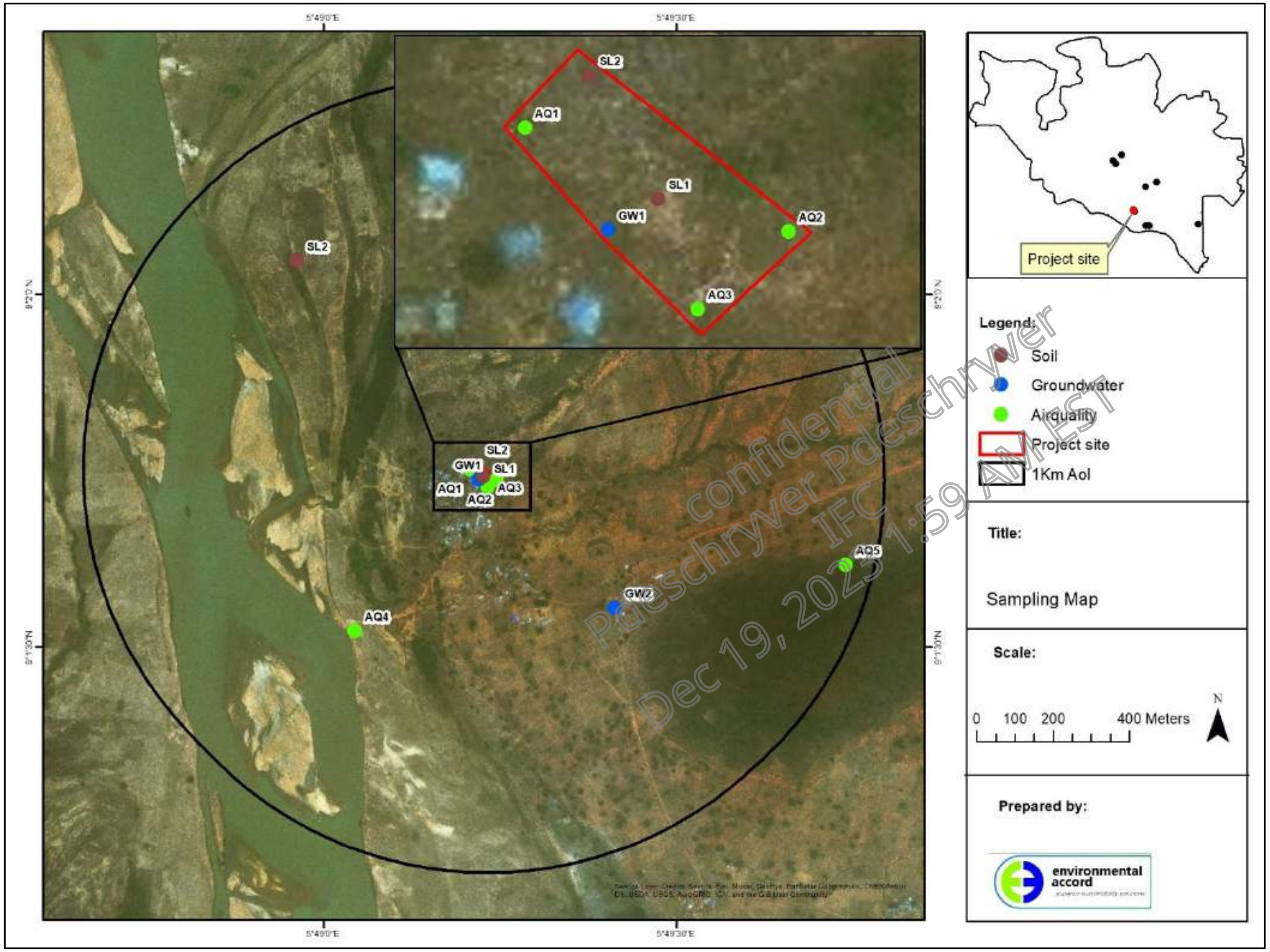

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Figure 4.2: Biophysical sampling map for Dakpan community project site and AoI
Source: EnvAccord GIS, 2020

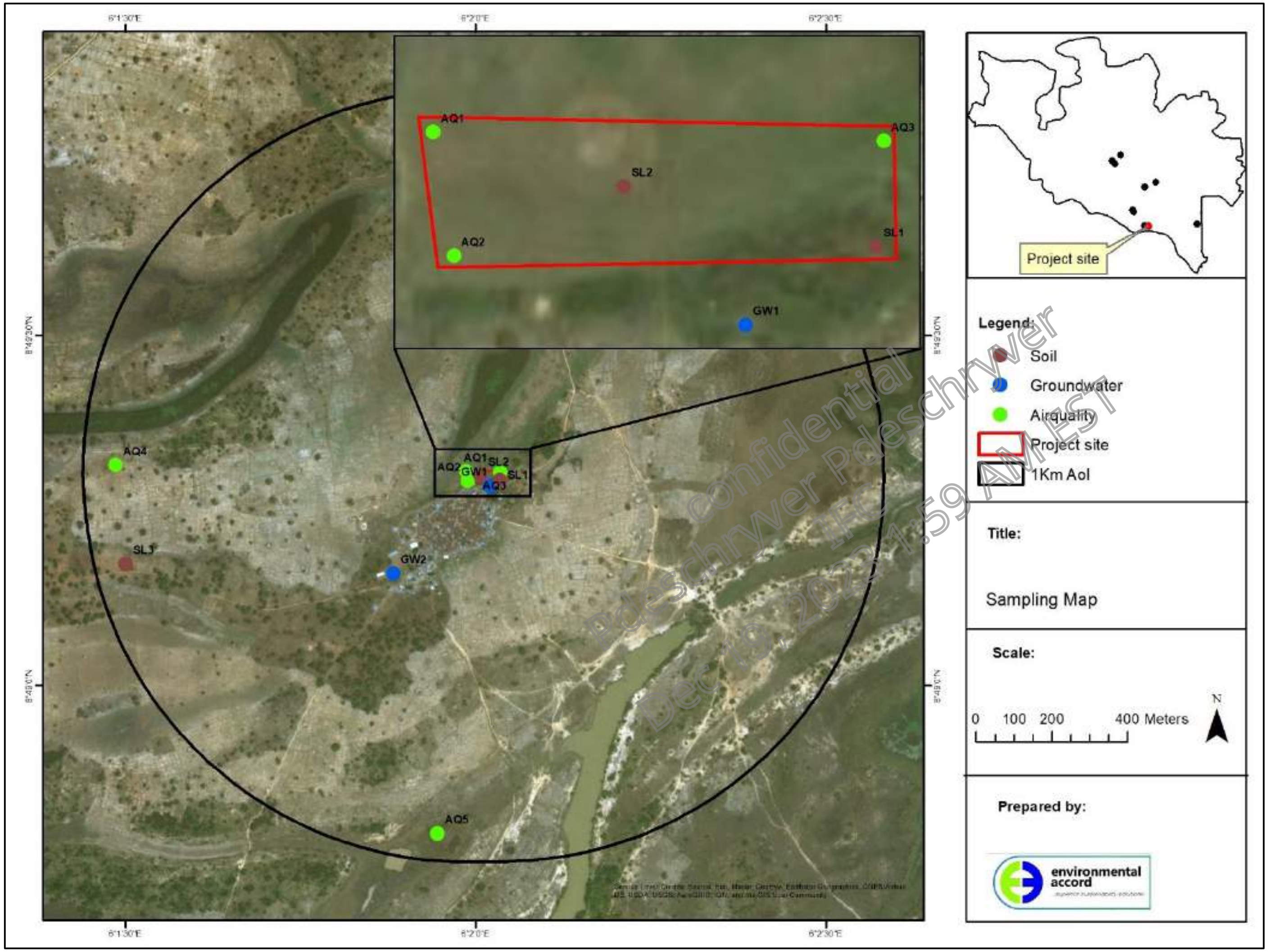

Figure 4.3: Biophysical sampling map for Dokogi community project site and AoI
Source: EnvAccord GIS, 2020

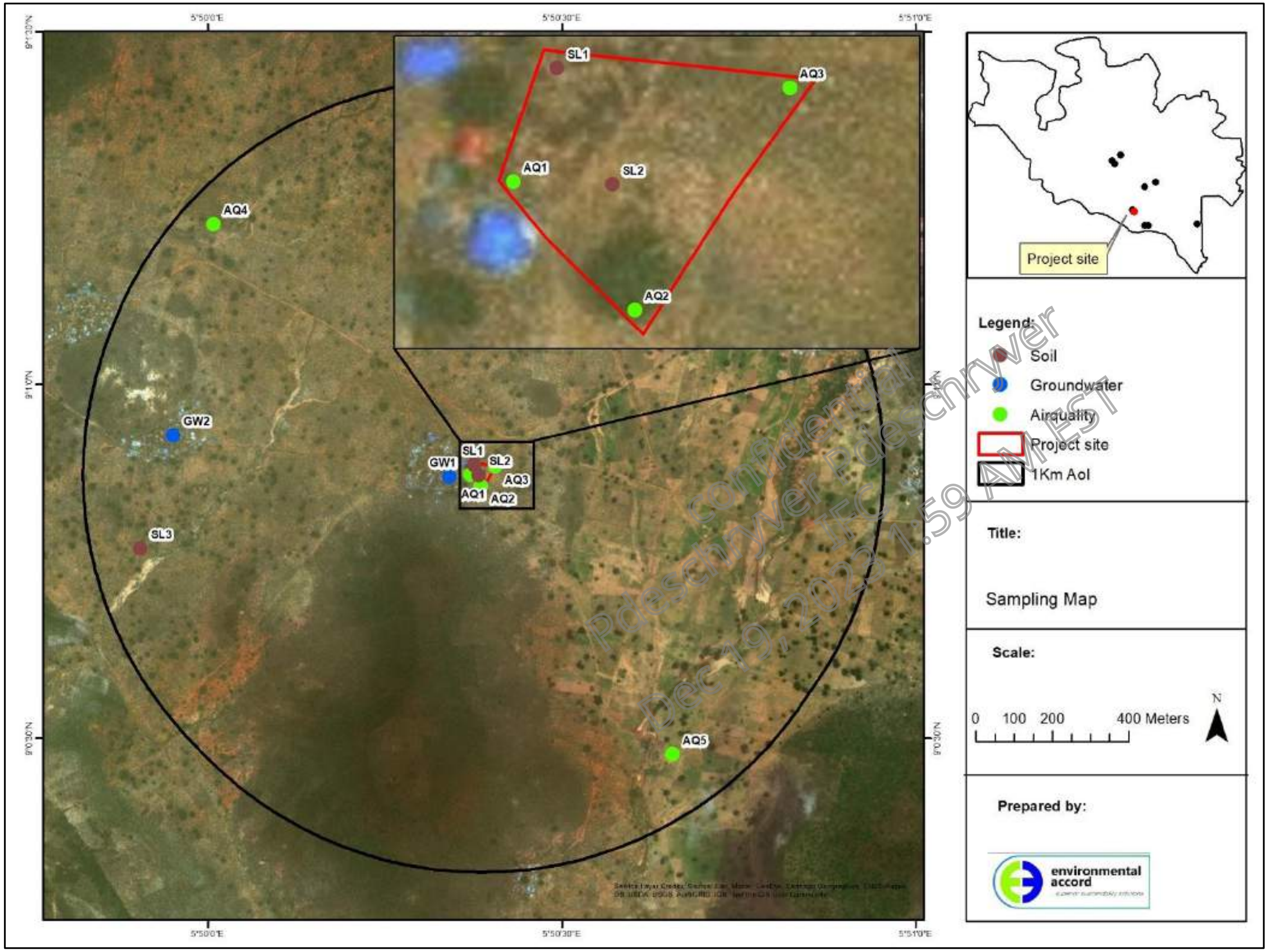

Figure 4.4: Biophysical sampling map for Kuchitagi community project site and AoI
Source: EnvAccord GIS, 2020

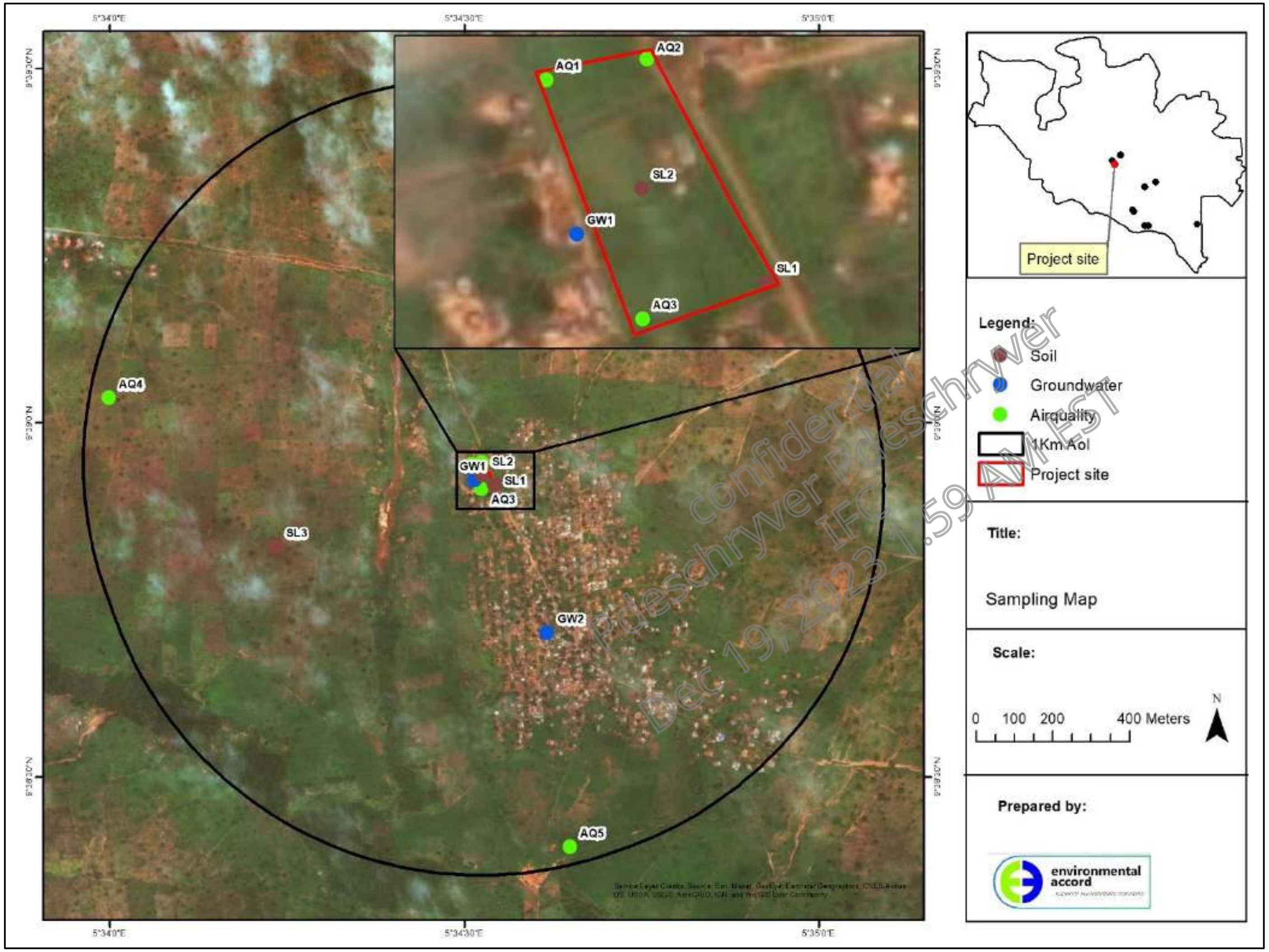

Figure 4.5: Biophysical sampling map for Mashigi community project site and AoI
Source: EnvAccord GIS, 2020

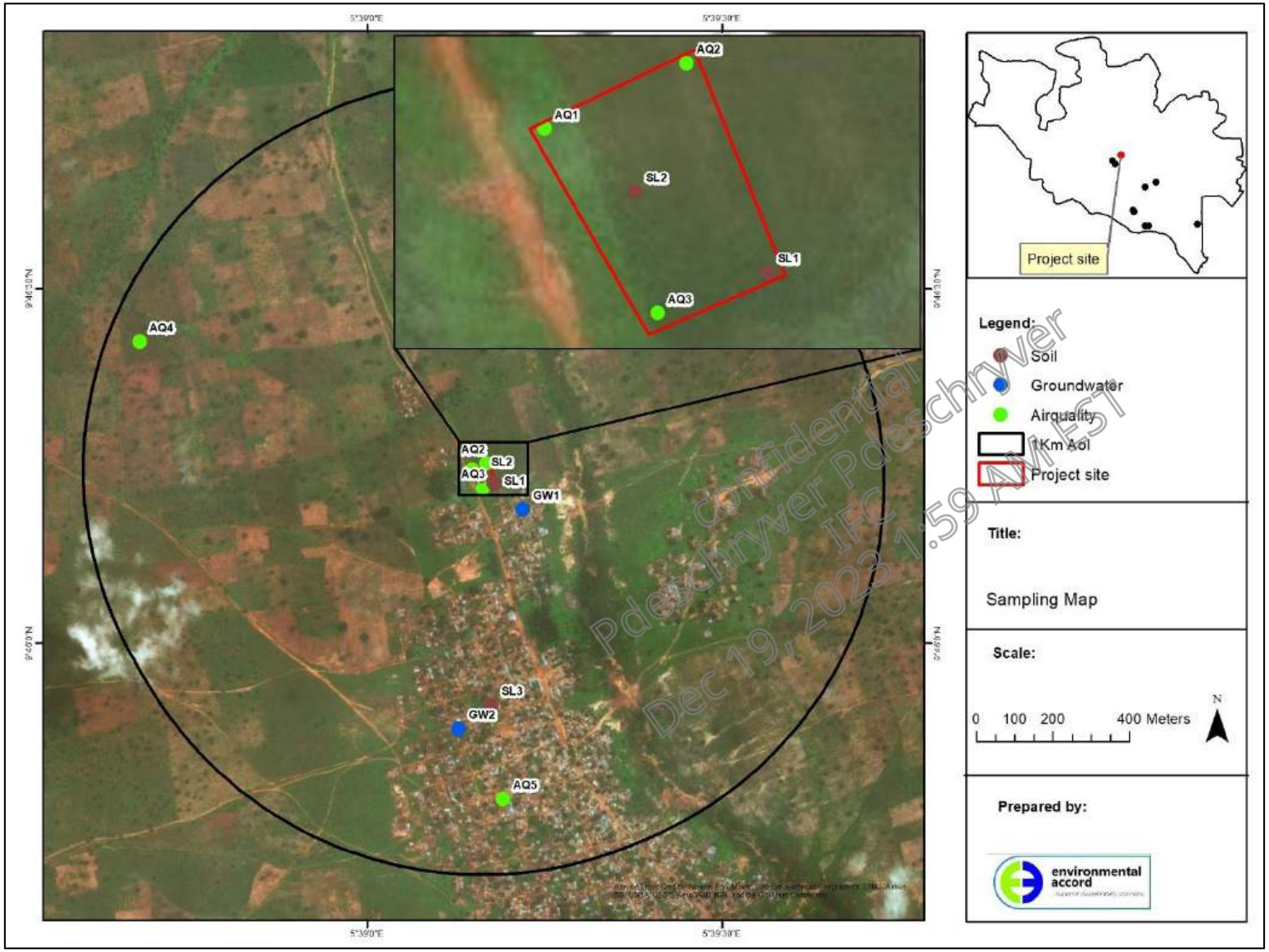

Figure 4.6: Biophysical sampling map for Nakoko Siyidi community project site and AoI
Source: EnvAccord GIS, 2020

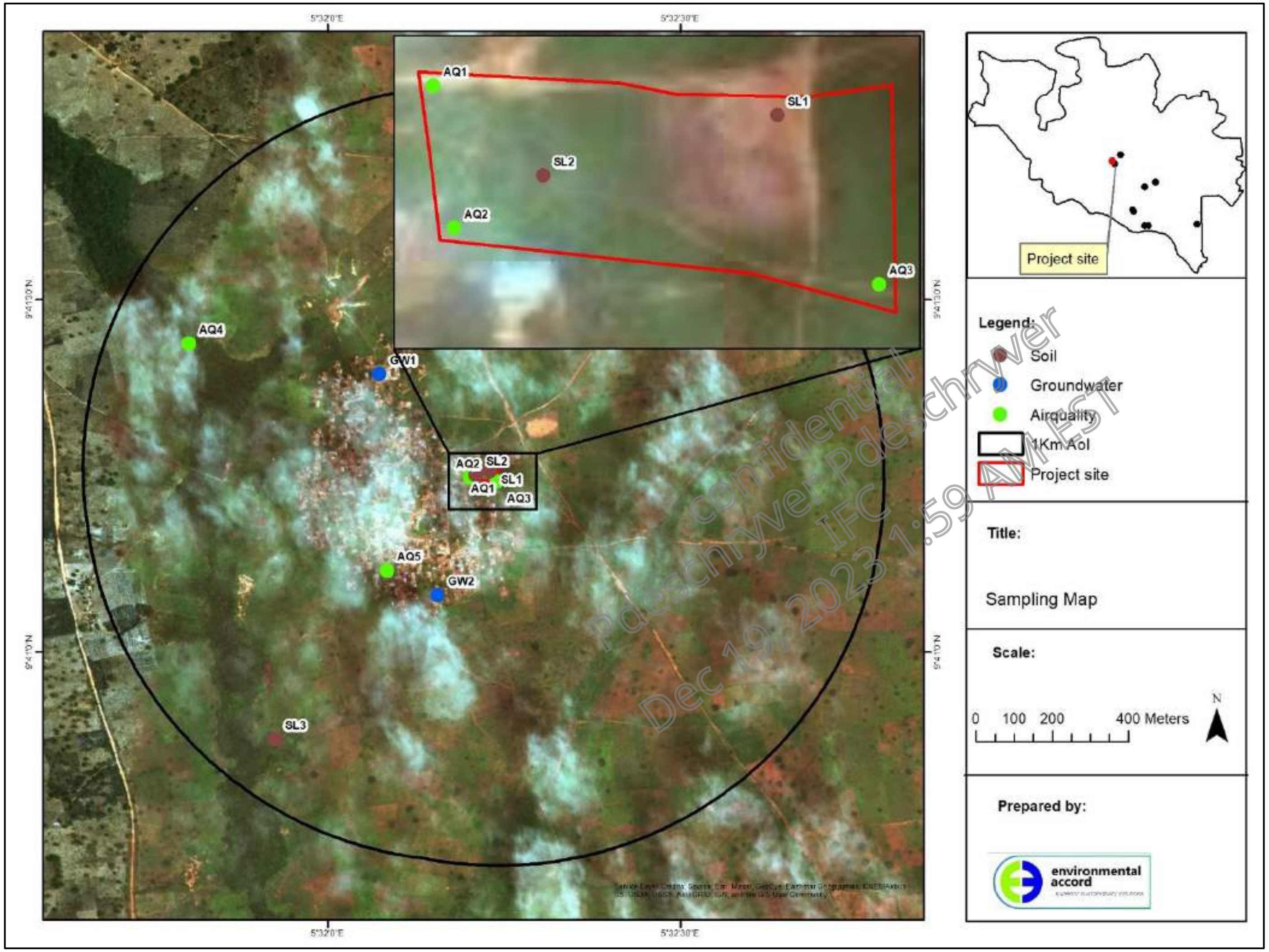

Figure 4.7: Biophysical sampling map for Ragidda Hausawa community project site and AoI
Source: EnvAccord GIS, 2020

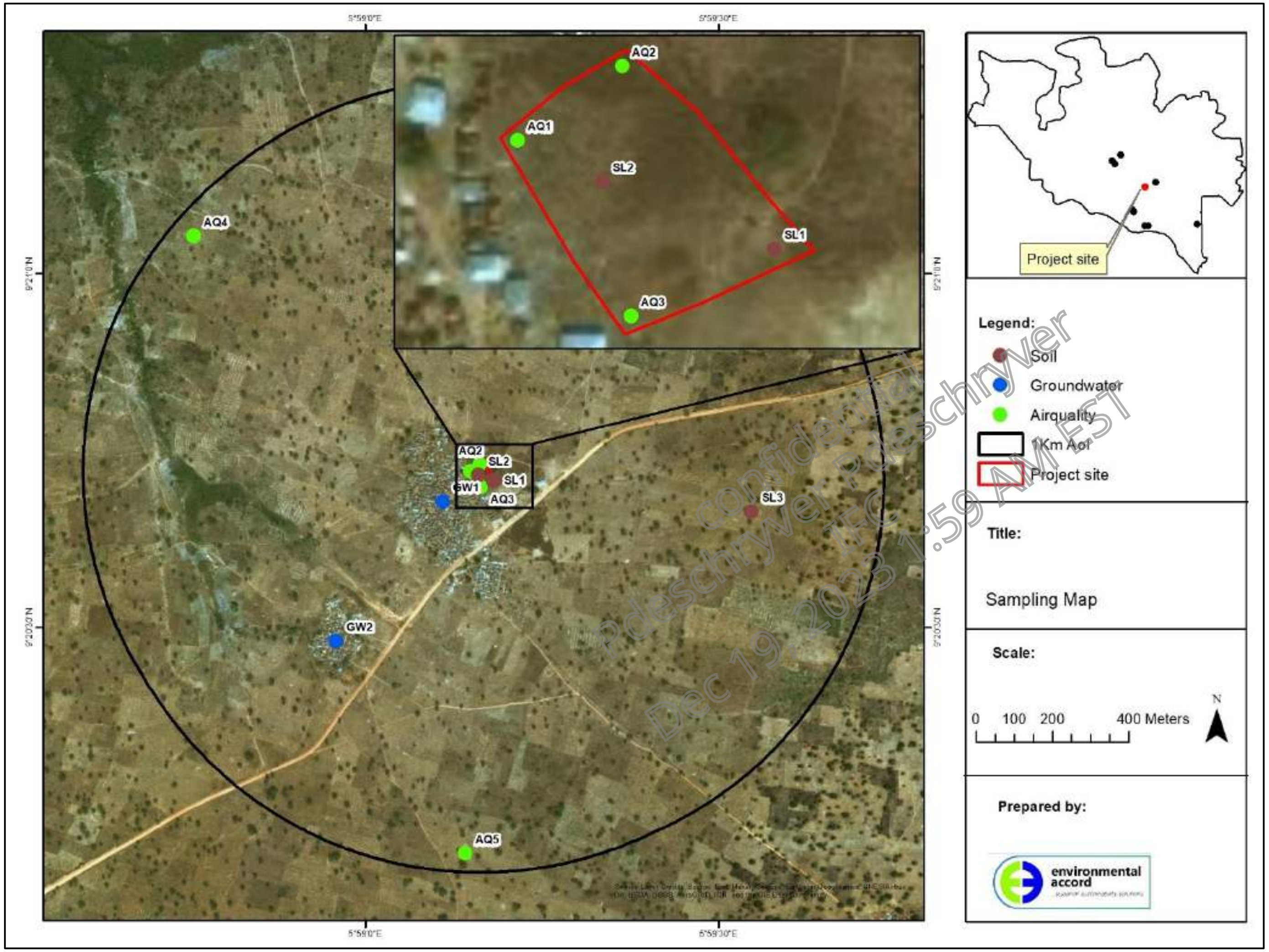

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Figure 4.8: Biophysical sampling map for Sheshimandiko community project site and AoI
Source: EnvAccord GIS, 2020

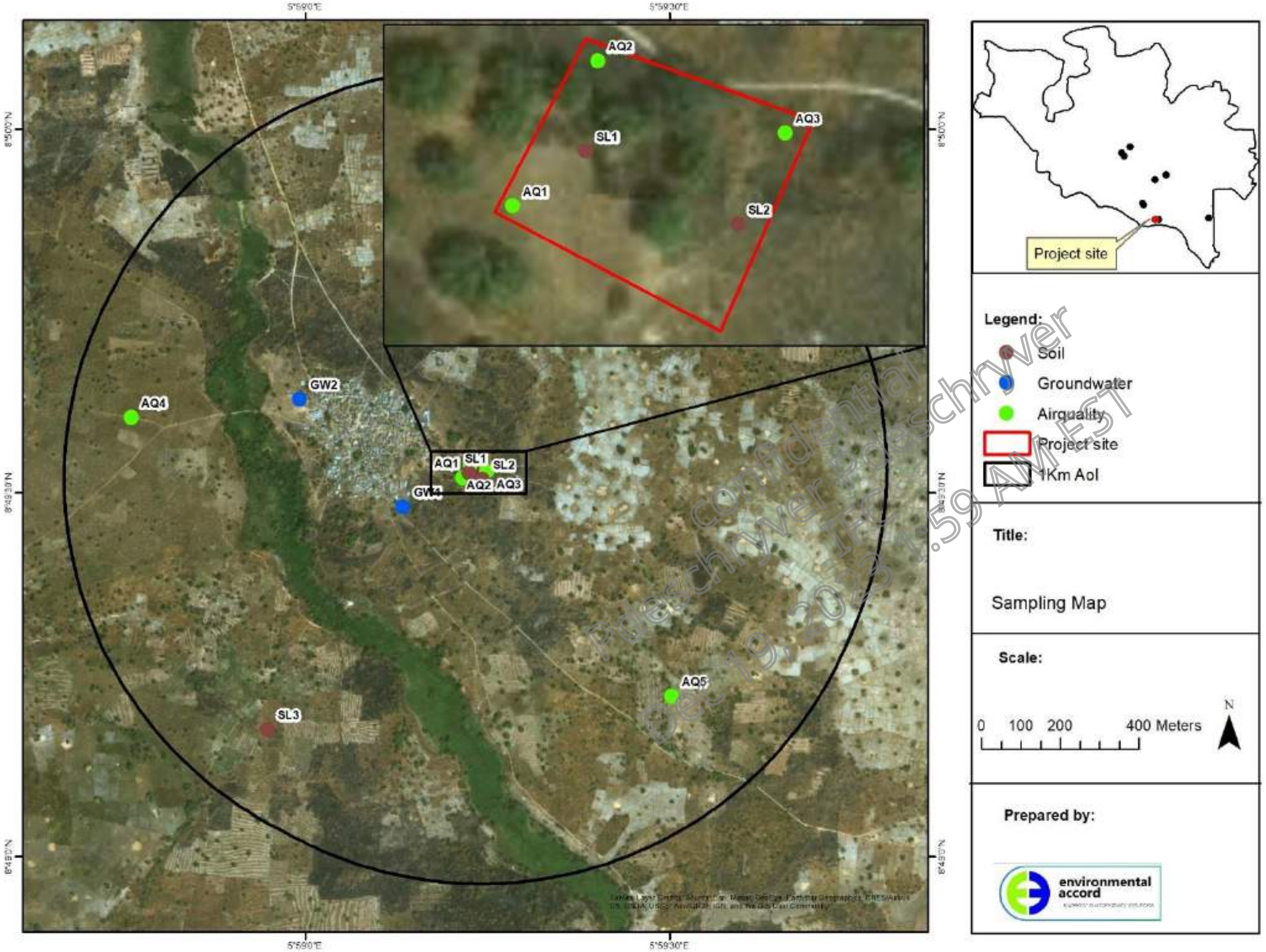

Figure 4.9: Biophysical sampling map for Kpanje community project site and AoI
Source: EnvAccord GIS, 2020

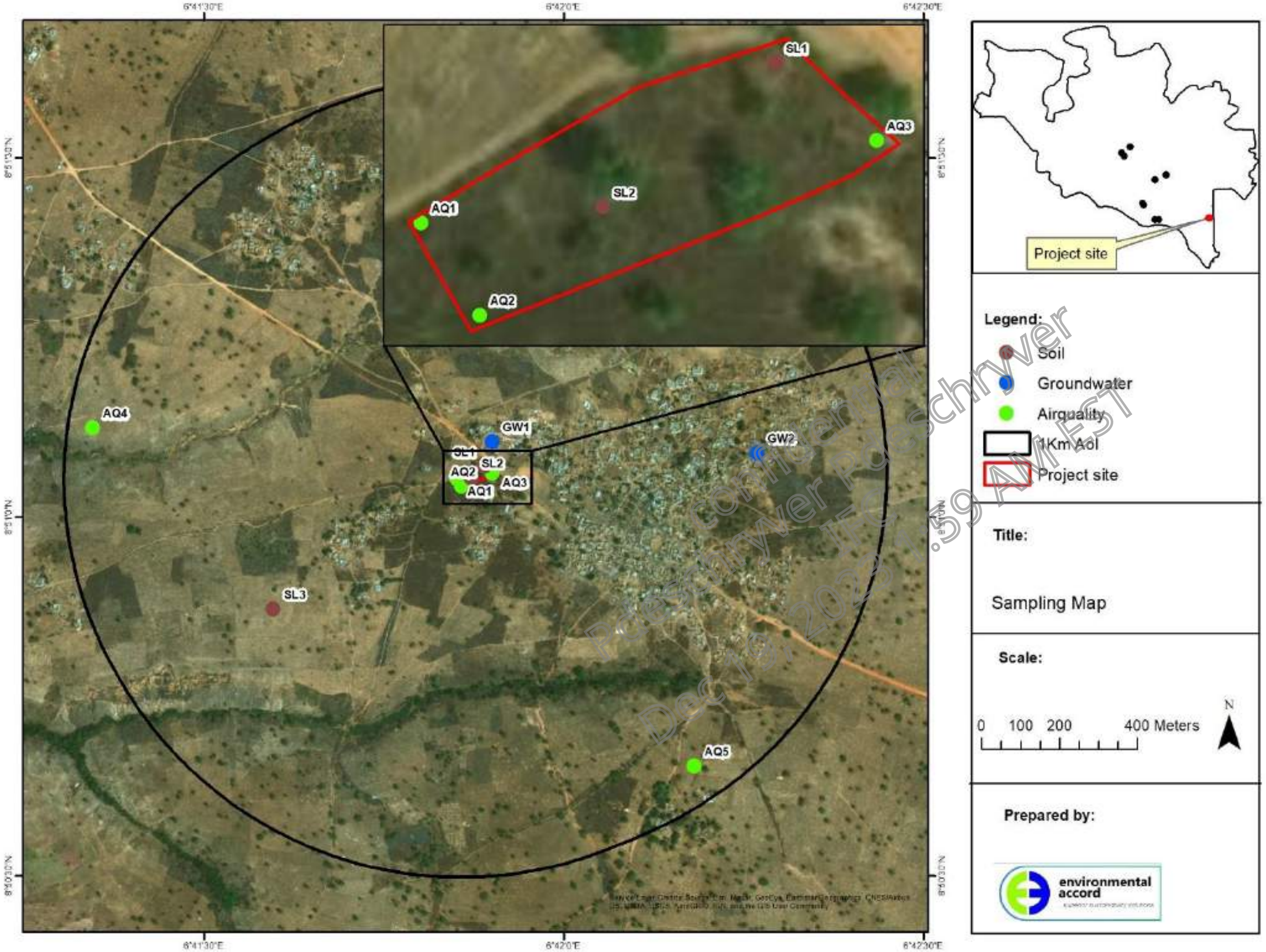

Figure 4.10: Biophysical sampling map for Mayaki community project site and AoI
Source: EnvAccord GIS, 2020

Plate 4.1 sample photographs of field sampling activities in the Project's AoI during the baseline data gathering exercise. A photo log of sampling activities at each community is presented in Appendix 4.1.

Plate 4.1: Sample Photographs of Field Sampling Activities at the Study Area: A- Noise/Air sampling, B- Soil sampling, C- Town hall meeting within of the beneficiary communities (Sheshimandiko), D- Focus Group Discussion with women.
Source: EnvAccord Field Survey, 2020

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

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

The summary of sample management program put in place to safeguard the integrity of the field samples collected during the baseline data gathering is provided in Figure 4.11.

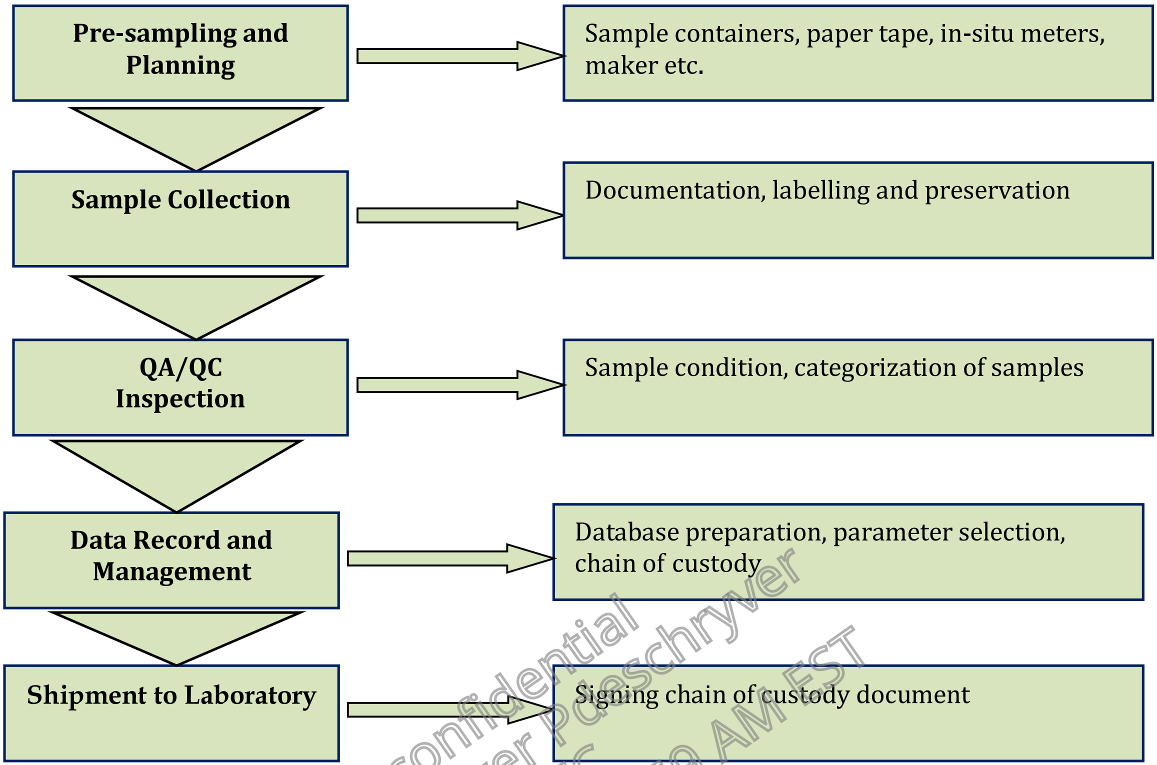

Figure 4.11: Management program employed for field sampling
Source: EnvAccord Field Survey, 2020

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4.2.2.2 <u>Laboratory Analysis of Field Samples</u>

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

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

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

Table 4.1: Analytical methods employed for field sample analysis

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

Source: EnvAccord Field Survey, 2020

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4.3 Environmental Setting of the Study Area

4.3.1 Climate and Meteorology

Niger State is characterized as a sub humid zone with derived savannah vegetation, patches of rainforest and harsh tolerance plant species. The climate of the study area is tropical and it is under the influence of the Inter-Tropical Convergence Zone (ITCZ) or Inter-Tropical Discontinuity Zone (ITDZ).

Movement of these air masses results in two main seasons; a wet season from April to October, and a dry season from November to March. During the dry season, there are periods when the harmattan (a period characterized by dry dusty winds and relatively low temperatures) is experienced. This typically occurs during the months of December and January. Table 4.2 below presents the summary of long term (1996 - 2019) climatic data of the study area, sourced from the NIMET.

Table 4.2: Summary of Climatic Data of the Study Area (1996-2019)

Month	Temperature (^{0}C)			Rainfall (mm)	Average Sunshine hours	Humidity (%)	Wind Speed (m/s)
	Min.	Max.	Mean	Mean		Mean	Mean
January	20.4	38.5	29.41	1.36	124	20	5.5
February	22.7	40.9	31.79	2.20	113	27	4.5
March	25.3	41.2	33.24	11.84	123	34	4.5
April	27.0	39.7	33.38	62.30	119	48	5.1
May	26.3	36.8	31.55	149.18	119	62	5.1

Month	Temperature (^{0}C)			Rainfall (mm)	Average Sunshine hours	Humidity (%)	Wind Speed (m/s)
	Min.	Max.	Mean	Mean		Mean	Mean
June	24.8	34.5	29.67	131.96	106	72	5.0
July	23.7	31.2	27.45	326.64	85	81	4.7
August	23.2	29.9	26.53	426.87	74	85	4.5
September	24.1	31.7	27.89	274.01	94	80	3.8
October	25.0	34.5	29.71	93.94	118	66	3.7
November	23.9	37.5	30.67	0.83	120	37	3.8
December	21.5	38.1	29.78	0.00	124	21	5.7

Source: Nigerian Meteorological Agency, Oshodi 2020

The dominant climatic elements and factors within the study area are discussed in the following paragraphs.

(a) Rainfall

The study area is influenced by two seasonal periods: the dry season, which lasts from November to March, and the wet season, which is the dominant season, lasting from April to October. In November, December, January and February there is little or no rainfall. Rainfall generally occurs from April to October with peak periods (highest rainfall values) from July to September as shown in Figure 4.12.

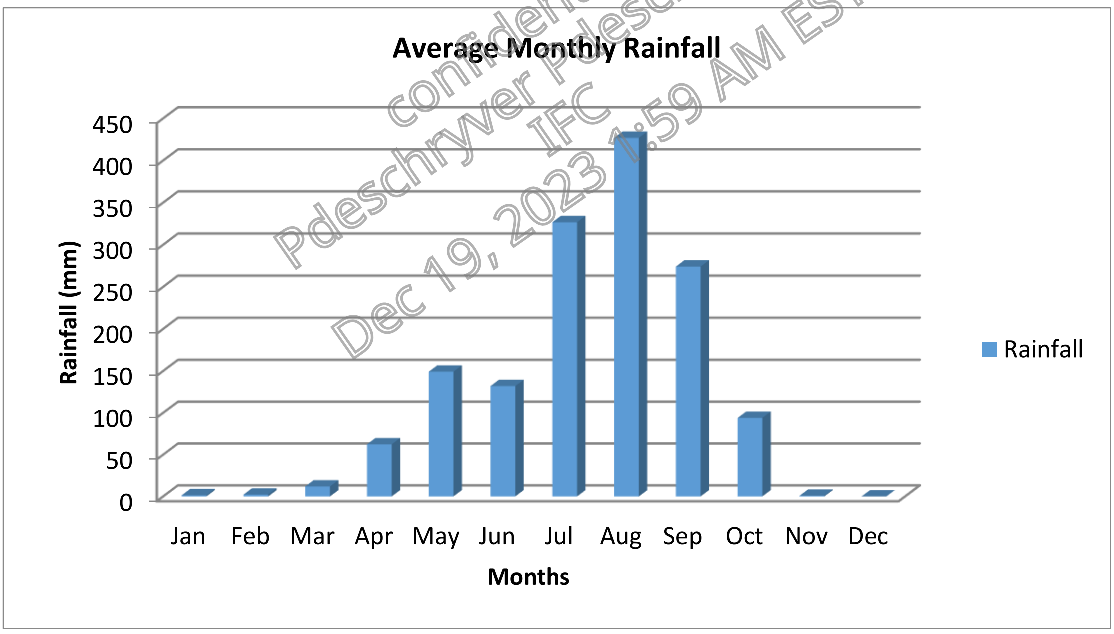

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Figure 4.12: Average Monthly Rainfall of the study area (1996-2019)
Source: NIMET, 2020

(b) Temperature

The mean monthly temperature in the study area is generally high all year round, with the maximum value of about 41.2^{0}C in the month of March and the minimum value of about 20.4^{0}C in January. Figure 4.13 shows the comparison of maximum and minimum temperature in the area. Generally, low temperature values are recorded at the peak periods of the rainy season (July to September).

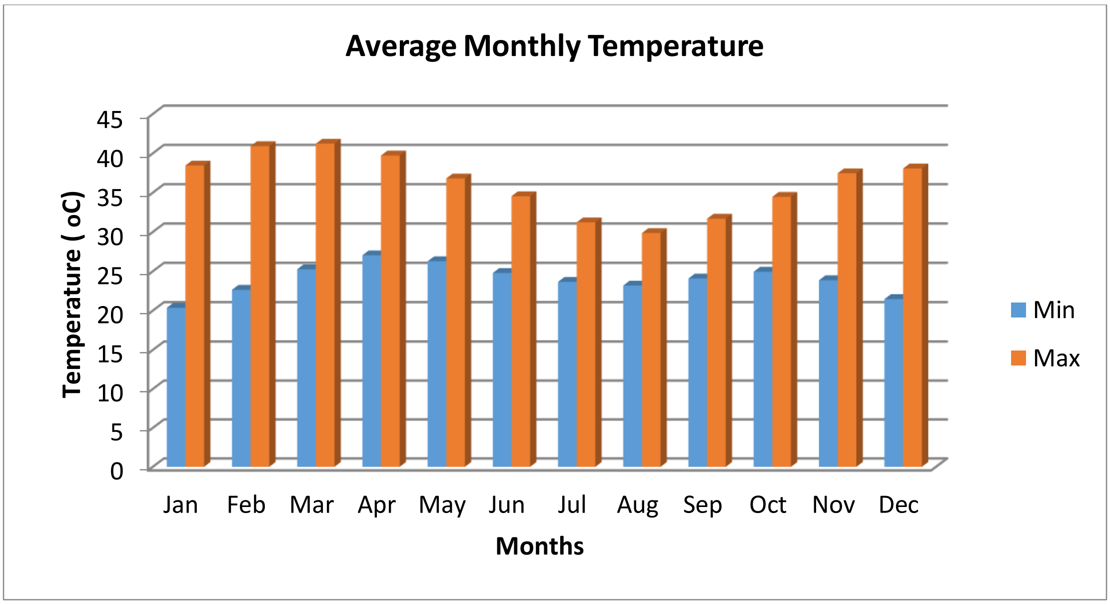

Figure 4.13: Average Monthly Temperature of the study area (1996-2019)
Source: NIMET, 2020

(c) Relative Humidity

Niger State experiences high humidity as a result of the prevailing Tropical Maritime (TM) air mass that blows over the area almost all the year round. Generally, low relative humidity values are recorded in the dry season (as indicated in Figure 4.14) as a result of prevalent dry Tropical Continent air mass during the period.

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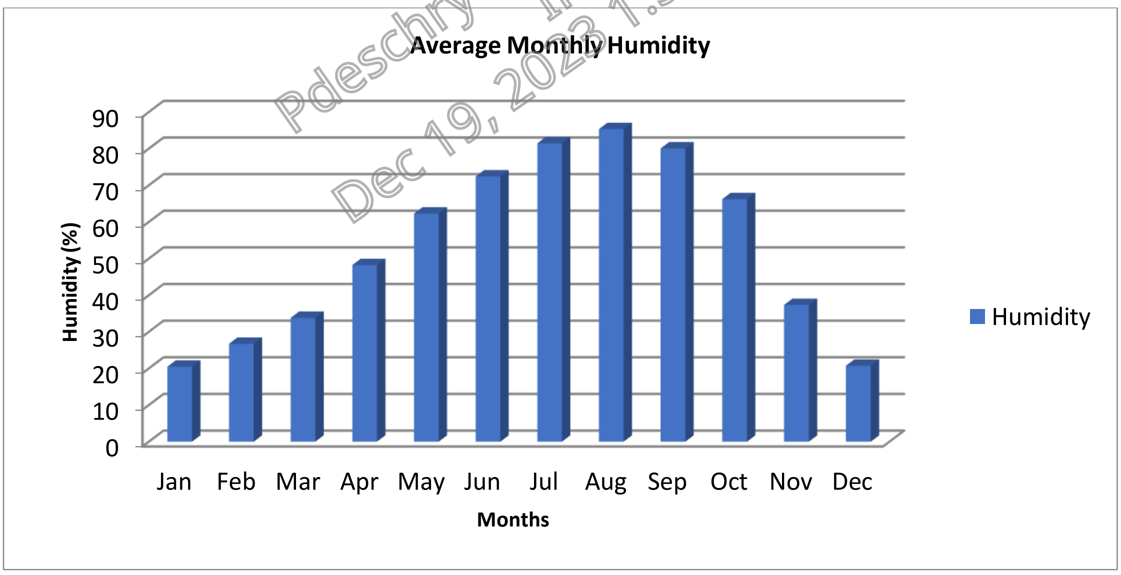

Figure 4.14: Average Monthly humidity of the study area (1996-2019)
Source: NIMET 2020

(d) Wind Direction

Surface wind speed in the area depends on the seasonal variation due to the main air masses which alternate with the season. The North-East wind predominates in the dry season while during the wet season, the South-West wind predominates.

(e) Wind Speed

The lowest mean value (wind speed) is recorded in the month of October while the highest mean values are obtained in December as presented in Figure 4.15.

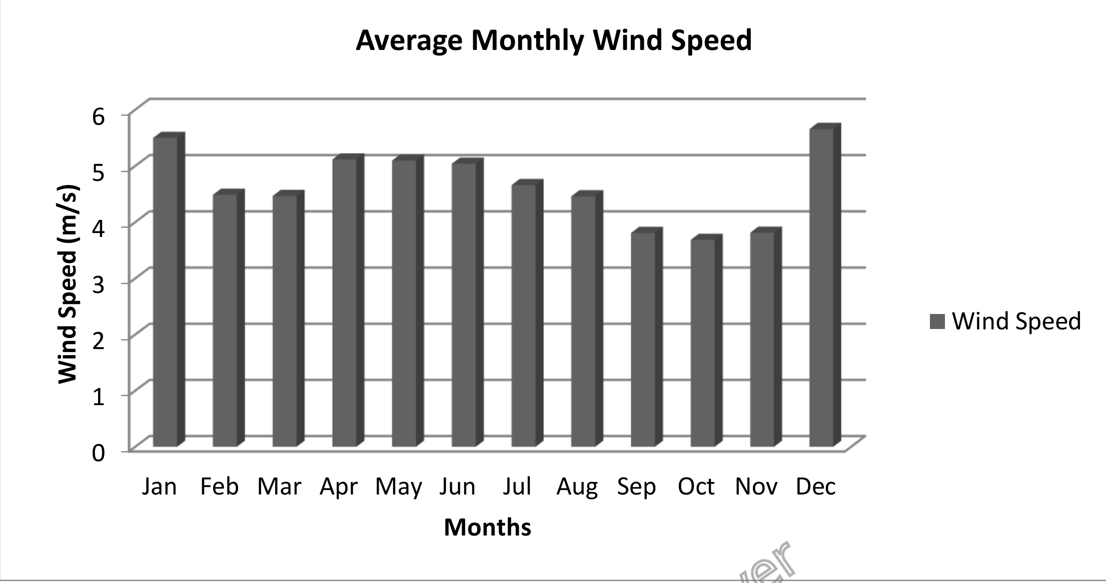

Figure 4.15: Average monthly Wind Speed of the study area (1996-2019)
Source: NIMET 2020

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(f) Sunshine Hours

Based on the information gathered from NiMet (1996-2019), the average monthly sunshine hours range between a low value of 74 hours in August and a high value of 125 hours in January and December (Figure 4.16).

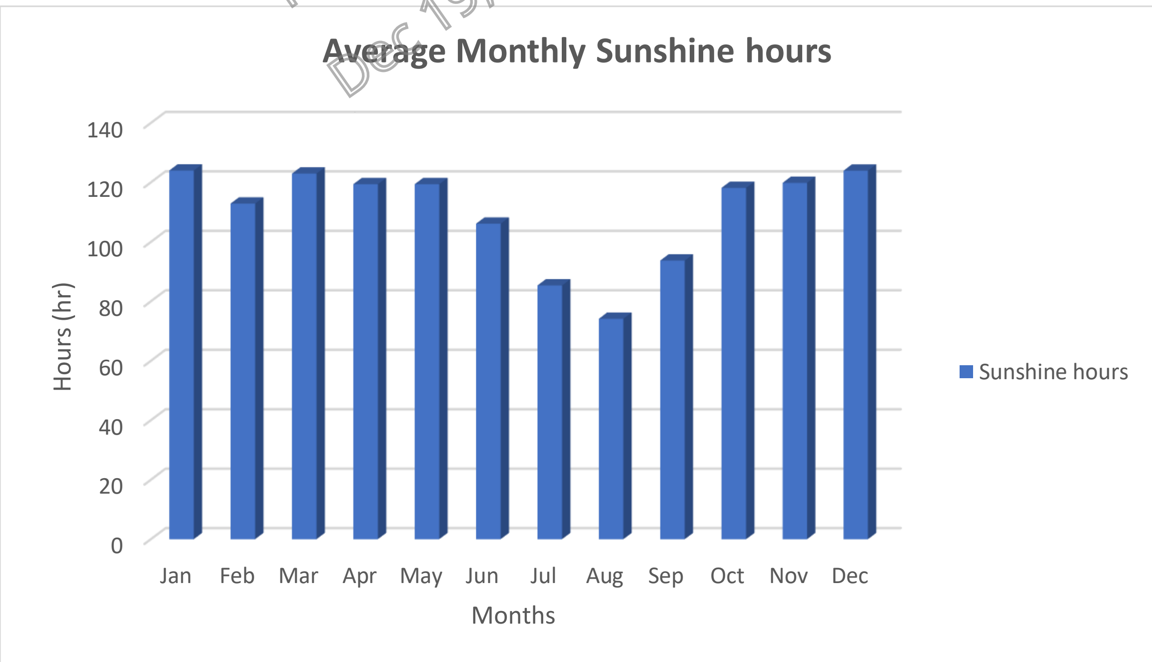

Figure 4.16: Average monthly Sunshine hours of the study area (1996-2019)
Source: NIMET 2020

4.3.2 Geology and Hydrogeology

4.3.2.1 Geology

About one half of the landmass of Niger State is underlain by the Basement Complex rocks while the other is occupied by the Cretaceous sedimentary rocks of the Bida Basin and part of the Sokoto (Iullemeden Basin). The boundary between these runs in a northwest – southeast direction, with the Basement rocks to the north and the sedimentary Formation to the south, Figure 4.17 shows a generalized geological map of Niger State.

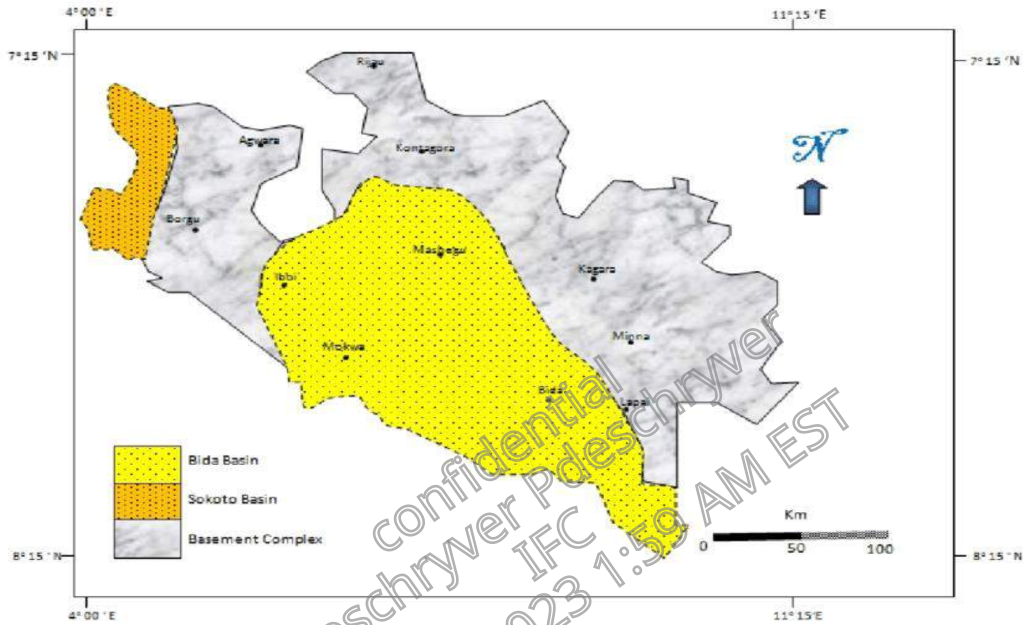

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Figure 4.17: Generalized geological map of Niger State
Source: Idris–Nda et al., 2014

The Basement rocks consist of a suite of Precambrian gneisses, migmatites and metasedimentary schists crosscut by granitoids. The gneisses and metasedimentary schist which constitute the host rocks to the granitoids and are found mostly flat – lying outcrops. They are often not well exposed except along river channels and road cuttings. The sedimentary Formations on the other hand consists of loosely cemented sandstones of varying grain sizes, siltstones, clays and shale, and are often capped by lateritic and/orironstone concretions, particularly in upland areas these cover much of the state. At the north western part of the state occurs the sedimentary Formation of the Sokoto (Iullemeden)Basin. The sedimentary deposits belong to the Upper part of the continental interclaire which comprises of a group of poorly fossiliferous sediments covering a very extensive area and lies unconformably on the Basement. The lithologic units comprise generally of sand grits, which are conglomeratic in places. The cement is ferruginous and clayey with colours varying from dominantly reddish-brown, through pink to yellowish brown. It is poorly sorted and cemented, semi-consolidated and fine to coarse grained (Idris–Nda *et al.*, 2014).

4.3.2.2 Hydrogeology

A typical weathered profile of the Basement consists of two main zones, firstly the surficial zone which ranges between two to ten meters in Minna and over thirty meters in Kontagora, and secondly the fractured or fissured rock zone, which range from about twenty meters to over sixty meters, these usually constitute the water bearing zones of interest in groundwater development. Excellent yields are obtained where both zones serve as the aquifer, while a somewhat reduced yield is obtained where only one of the units represents the aquifer. In the sedimentary Formations the aquifer is represented by the sandstone, conglomerate and grits. In some parts of the state groundwater potential is very low, where boreholes will have to be drilled to a minimum depth of one hundred meters and the Birnin Gwari schist which extends through Pandogari to almost Minna also has a very low groundwater potential. In the sedimentary areas the aquifers are in a semi-confined with the saturated zone starting mostly from 100m, the schist on the other is mainly a Metasedimentary rock resulting from the metamorphism of clay/shale which is an impermeable material that does not transmit water easily to wells placed in them (Figure 4.18). The low groundwater yield in these areas is directly linked to the local geological conditions. The rocks underlying the areas are mostly crystalline rocks with low permeability and low fracture density (Idris–Nda et al., 2014).

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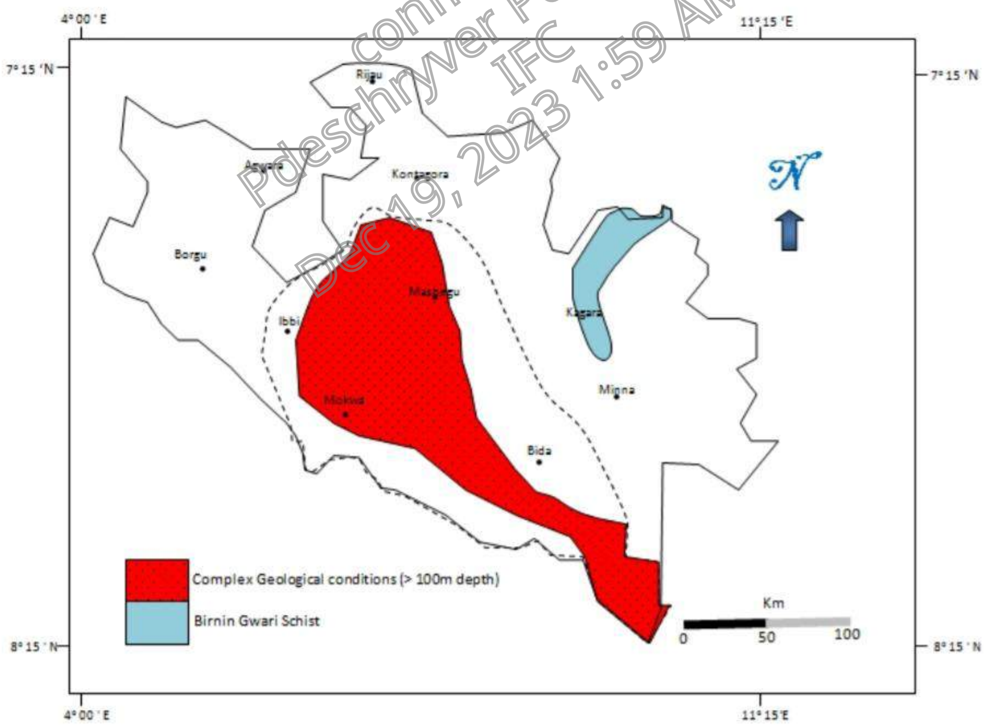

Figure 4.18: Hydrogeological map of Niger State
Source: Idris–Nda et al., 2014

4.3.3 Ambient Air Quality and Noise

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

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

A total number of five (5) sampling locations were established for ambient air quality and noise study for each project site as shown in Figures 4.1 to 4.10.

4.3.3.1 Air Quality Standards

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

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Table 4.3: Ambient Air Quality Standards

Parameter	Averaging Time	Nigeria Standards FMEnv Limit (µg/m³)	WHO Ambient Air Quality Guidelines (µg/m³)
CO	1-hour	11, 400	-
NO_2	1-hour	75-113	200
SO_2	1-hour	26	20 (24hr)
TSP	1-hour	250	-

Source: FMEnv, 1991 and World Bank General EHS 2007

Table 4.4: Noise Exposure Limits for Nigeria

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

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

Table 4.5: Noise Level Guidelines adopted by the World Bank

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

Source: The World Bank General EHS Guidelines, 2007

4.3.3.2 Air Quality of the Project Area

The geographical coordinates of the air sampling points studied at the project sites are presented in Table 4.6.

Table 4.6: Air quality and noise sampling locations for all the proposed project sites

Sampling location	Within the Project site						Within 1km AoI			
	AQ1		AQ2		AQ3		AQ4		AQ5	
	Lat (N)	Long (E)	Lat (N)	Long (E)	Lat (N)	Long (E)	Lat (N)	Long (E)	Lat (N)	Long (E)
Gbangba	9.40968	6.12868	9.40930	6.12880	9.40942	6.12937	9.41077	6.12042	9.40247	6.12421
Sheshimandiko	9.34534	5.98582	9.34550	5.98604	9.34497	5.98606	9.35089	5.97929	9.33634	5.98569
Kuchitagi	9.01454	5.83952	9.01427	5.83977	9.01474	5.84010	9.02045	5.83347	9.00796	5.84428
Dokogi	8.82177	6.03311	8.82155	6.03315	8.82175	6.03392	8.82192	6.02478	8.81316	6.03243
Dakpan	9.02920	5.82014	9.02895	5.82077	9.02877	5.82055	9.02538	5.81742	9.02694	5.82902
Ragidda Hausawa	9.68766	5.53668	9.68745	5.53671	9.68736	5.53734	9.69063	5.53005	9.68526	5.53474
Nakoko Siyidi	9.77074	5.65247	9.77089	5.65280	9.77031	5.65273	9.77375	5.64465	9.76301	5.65319
Mashigi	9.64903	5.57518	9.64908	5.57542	9.64845	5.57541	9.65059	5.56665	9.64003	5.57749
Kpanje	8.82534	5.98694	8.82564	5.98711	8.82549	5.98749	8.82673	5.97935	8.82035	5.99173
Mayaki	8.85088	6.69753	8.85071	6.69764	8.85103	6.69835	8.85208	6.68909	8.84422	6.70302

Source: EnvAccord Field Survey, 2020

The descriptive summary of the results of air quality study conducted in the Project sites and their AoI are presented below, while the detailed results are presented in Appendix 4.2.

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- *Dakpan Community*

The descriptive summary of air quality and noise level measurements from Dakpan community project site and AoI are presented in Table 4.7 below.

Table 4.7: Ambient air quality and noise level results at Dakpan project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m³)	0.065	0.038	0.085	0.047	0.045	0.049
CO_2 (mg/m³)	857	803	930		721	812
Noise dB(A)	51.77	50.7	53.2	52.8	50.3	55.3

Source: EnvAccord Field Survey, 2020

The ambient air of the Project site in Dakpan community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.038 mg/m^3 to 0.085 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

The day-time noise levels recorded within the Project site ranged from 50.7 dB(A) to 53.2 dB(A) with an average of 51.77 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

❖ *Sheshimandiko Community*

The descriptive summary of air quality and noise level measurements from Sheshimandiko community project site and AoI are presented in Table 4.8 below.

Table 4.8: Ambient air quality and noise level results at Sheshimandiko project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m^3)	0.056	0.036	0.078	0.046	0.04	0.053
CO_2 (mg/m^3)	954.7	938	988	861.5	819	904
Noise dB(A)	54.4	52.1	59.0	51.95	51.4	52.5

Source: EnvAccord Field Survey, 2020

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The ambient air of the Project site in Sheshimandiko community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.036 mg/m^3 to 0.078 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

The day-time noise levels recorded within the Project site ranged from 52.1 dB(A) to 59.0 dB(A) with an average of 54.4 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

❖ *Kuchitagi Community*

The descriptive summary of air quality and noise level measurements from Kuchitagi community project site and AoI are presented in Table 4.9 below.

Table 4.9: Ambient air quality and noise level results at Kuchitagi project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m^3)	0.039	0.026	0.055	0.06	0.052	0.068
CO_2 (mg/m^3)	848.3	819	888	713	688	738
Noise dB(A)	56.4	55.5	57.1	52.7	51.3	54.1

Source: EnvAccord Field Survey, 2020

The ambient air of the Project site in Kuchitagi community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.026 mg/m^3 to 0.055 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

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The day-time noise levels recorded within the Project site ranged from 55.5 dB(A) to 57.1 dB(A) with an average of 56.4 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

- *Gbangba Community*

The descriptive summary of air quality and noise level measurements from Gbangba community project site and AoI are presented in Table 4.10 below.

Table 4.10: Ambient air quality and noise level results at Gbangba project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m^3)	0.04	0.035	0.046	0.04	0.038	0.042
CO_2 (mg/m^3)	864.3	853	878	824	818	830
Noise dB(A)	52.16	50.7	54.5	51	48.1	53.9

Source: EnvAccord Field Survey, 2020

The ambient air of the Project site in Gbangba community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.035 mg/m^3 to 0.046 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

The day-time noise levels recorded within the Project site ranged from 50.7 dB(A) to 54.5 dB(A) with an average of 52.16 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

❖ *Dokogi Community*

The descriptive summary of air quality and noise level measurements from Dokogi community project site and AoI are presented in Table 4.11 below.

Table 4.11: Ambient air quality and noise level results at Dokogi project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m^3)	0.048	0.041	0.055	0.03	0.021	0.039
CO_2 (mg/m^3)	832	798	863	893	888	898
Noise dB(A)	47.26	46.4	48.3	55.6	53.3	57.9

Source: EnvAccord Field Survey, 2020

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The ambient air of the Project site in Dokogi community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.041 mg/m^3 to 0.055 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

The day-time noise levels recorded within the Project site ranged from 46.4 dB(A) to 48.3 dB(A) with an average of 47.26 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

❖ *Ragidda Hausawa Community*

The descriptive summary of air quality and noise level measurements from Ragidda Hausawa community project site and AoI are presented in Table 4.12 below.

Table 4.12: Ambient air quality and noise level results at Ragidda Hausawa project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m^3)	0.015	0.011	0.019	0.034	0.025	0.042
CO_2 (mg/m^3)	765.7	760	769	819.5	801	838
Noise dB(A)	45.4	42.9	47.2	54.9	54.2	55.6

Source: EnvAccord Field Survey, 2020

The ambient air of the Project site in Ragidda Hausawa community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.011 mg/m^3 to 0.019 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

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The day-time noise levels recorded within the Project site ranged from 42.9 dB(A) to 47.2 dB(A) with an average of 45.4 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

❖ *Nakoko Siyidi Community*

The descriptive summary of air quality and noise level measurements from Nakoko Siyidi community project site and AoI are presented in Table 4.13 below.

Table 4.13: Ambient air quality and noise level results at Nakoko Siyidi project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m^3)	0.033	0.029	0.038	0.035	0.027	0.044

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
CO_2 (mg/m^3)	820.3	818	823	843	818	868
Noise dB(A)	54.77	53.9	56.1	51.35	50.2	52.5

Source: EnvAccord Field Survey, 2020

The ambient air of the Project site in Nakoko Siyidi community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.029 mg/m^3 to 0.038 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

The day-time noise levels recorded within the Project site ranged from 53.9 dB(A) to 56.1 dB(A) with an average of 54.77 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

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- *Mashigi Community*

The descriptive summary of air quality and noise level measurements from Mashigi community project site and AoI are presented in Table 4.14 below.

Table 4.14: Ambient air quality and noise level results at Mashigi project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m^3)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m^3)	0.037	0.032	0.041	0.055	0.041	0.068
CO_2 (mg/m^3)	826.3	808	844	867.5	849	886
Noise dB(A)	47.77	45.5	51.1	50.15	49.5	50.8

Source: EnvAccord Field Survey, 2020

The ambient air of the Project site in Mashigi community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.032 mg/m^3 to 0.041 mg/m^3, which fall below the national ambient air quality standard (0.250 mg/m^3) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m^3. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

The day-time noise levels recorded within the Project site ranged from 45.5 dB(A) to 51.1 dB(A) with an average of 47.77 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

❖ *Kpanje Community*

The descriptive summary of air quality and noise level measurements from Kpanje community project site and AoI are presented in Table 4.15 below.

Table 4.15: Ambient air quality and noise level results at Kpanje project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m³)	0.07	0.063	0.075	0.047	0.045	0.049
CO_2 (mg/m³)	866.7	853	878	806.5	801	812
Noise dB(A)	55.73	55.2	56.1	54.85	52.5	57.2

Source: EnvAccord Field Survey, 2020

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The ambient air of the Project site in Kpanje community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.063 mg/m³ to 0.075 mg/m³, which fall below the national ambient air quality standard (0.250 mg/m³) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m³. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

The day-time noise levels recorded within the Project site ranged from 55.2 dB(A) to 56.1 dB(A) with an average of 55.73 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

❖ *Mayaki Community*

The descriptive summary of air quality and noise level measurements from Mayaki community project site and AoI are presented in Table 4.16 below.

Table 4.16: Ambient air quality and noise level results at Mayaki project site and AoI

Parameters	Within the Project site			Within 1km AoI (area of influence) radius		
	Mean	Min	Max	Mean	Min	Max
VOC (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
H_2S (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
NO_2 (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
SO_2 (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
CO (mg/m³)	-	<0.01	<0.01	-	<0.01	<0.01
TSP (mg/m³)	0.055	0.029	0.082	0.043	0.021	0.064
CO_2 (mg/m³)	839.7	747	893	777	741	813
Noise dB(A)	52.66	50.1	55.1	52.5	51.5	53.5

Source: EnvAccord Field Survey, 2020

The ambient air of the Project site in Mayaki community is considered to be good based on the results of air quality parameters obtained during the field sampling. TSP values within the Project site ranged from 0.029 mg/m³ to 0.082 mg/m³, which fall below the national ambient air quality standard (0.250 mg/m³) for TSP in ambient air. CO, SO_2, NO_2, VOC concentrations measured within the site and the AoI were below the equipment detection limit of 0.01 mg/m³. In summary, all air quality parameters measured were within the FMEnv and World Bank maximum permissible limits.

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The day-time noise levels recorded within the Project site ranged from 50.1 dB(A) to 55.1 dB(A) with an average of 52.66 dB(A). There were no major noise emission sources identified within the project site and the local community due to their remoteness and rural setting. Thus, all noise levels recorded were below the World Bank maximum limit of 70dB(A), as well as FMEnv limit of 90dB(A).

4.3.4 Soil Quality

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

4.3.4.1 Soil Sampling

A total of three (3) soil sampling stations: two (2) within the Project site and one (1) within 1km radius AoI were established for each community. At each of the sampling station, both top soil (0-15cm) and sub-soil (15-30cm) were collected. The GPS coordinates of the soil sampling points for all the communities are presented in Table 4.17, while the sampling points are shown in Figure 4.1 to 4.10.

Table 4.17: Soil sampling locations for all the proposed project sites

Sampling locations	SL1		SL2		SL3	
	Lat (N)	Long (E)	Lat (N)	Long (E)	Lat (N)	Long (E)
Gbangba	9.40964	6.12888	9.40941	6.12916	9.40160	6.12905
Sheshimandiko	9.34511	5.98636	9.34526	5.98600	9.34440	5.99244
Kuchitagi	9.01478	5.83961	9.01454	5.83973	9.01280	5.83175
Dokogi	8.82156	6.03391	8.82167	6.03345	8.81957	6.02501

Sampling locations	SL1		SL2		SL3	
	Lat (N)	Long (E)	Lat (N)	Long (E)	Lat (N)	Long (E)
Dakpan	9.02903	5.82046	9.02932	5.82029	9.03413	5.81605
Ragidda Hausawa	9.68761	5.53719	9.68753	5.53684	9.68127	5.53208
Nakoko Siyidi	9.77041	5.65299	9.77060	5.65268	9.76521	5.65291
Mashigi	9.64854	5.57571	9.64877	5.57541	9.64709	5.57057
Kpanje	8.82545	5.98709	8.82531	5.98739	8.81958	5.98246
Mayaki	8.85117	6.69817	8.85091	6.69786	8.84787	6.69327

Source: EnvAccord Field Survey, 2020

Soil sampling was carried out using a stainless steel auger. The soil samples collected in plastic bucket lined with aluminum foil sheet, and from the soil samples, sub samples were taken for physico-chemical and microbial analysis. All samples collected were preserved and transported to the laboratory for analysis. Soil samples were analyzed for the following parameters; Particle size, pH, Total organic carbon, Electrical Conductivity, moisture content, Exchangeable cations (Ca^{2+}, K^{+}, Mg^{2+}, Na^{+}) and anions (Cl^{-}, SO_4^{2-}, NO_3^{-}, PO_4^{3-}), Heavy metals (Fe, Zn, Cr, Pb, Cu, Cd, Hg, V, and Ni) and Soil microbiology. The descriptive summary of laboratory results for physico-chemical and microbial analysis results of soil samples from each community are provided in the following sections, while the detailed laboratory results are presented in Appendix 4.2.

❖ *Dakpan community*

The descriptive summary of soil characteristics from the project site in Dakpan community and AoI is presented in Table 4.18.

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Table 4.18: Physico-chemical and microbial properties of soil samples from Dakpan Community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	6.65	6.48	6.76	6.67	6.63	6.75	
TOC %	2.50	1.88	2.92	2.49	1.96	2.77	
Moisture Content %	2.55	1.53	3.50	3.31	3.02	3.65	
Chloride mg/Kg	3.92	1.27	7.26	4.60	3.27	5.27	
Nitrate mg/Kg	0.77	0.21	1.21	0.71	0.07	1.39	
Sulphate mg/Kg	4.85	3.47	6.39	2.79	1.27	4.41	
Phosphate mg/Kg	0.95	0.15	2.04	0.91	0.40	1.54	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.72	0.04	1.32	0.37	0.03	0.54	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	66.43	36.06	99.35	68.09	43.34	84.74	NS
Zn mg/Kg	0.14	0.09	0.23	0.07	0.06	0.08	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	62.67	57.35	69.49	61.94	60.29	62.84	
K mg/Kg	17.68	14.70	19.38	14.75	12.73	17.78	
Ca mg/Kg	7.49	6.45	8.17	7.41	6.57	8.86	
Mg mg/Kg	1.79	0.75	2.47	1.71	0.86	3.16	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	21.59	14.09	29.74	21.38	11.41	27.03	
%Silt	5.03	1.63	8.59	4.65	2.08	7.59	
%Clay	73.38	61.67	84.27	73.97	65.38	84.30	
THB cfu/ml	2.87 X 10^{7}	2.09 X 10^{6}	5.70 X 10^{7}	1.09 X 10^{7}	2.00 X 10^{6}	2.50 X 10^{7}	
THF cfu/g	1.45 X 10^{5}	2.50 X 10^{4}	3.40 X 10^{5}	3.77 X 10^{4}	1.40 X 10^{4}	5.70 X 10^{4}	
THUB cfu/g	4.47 X 10^{4}	3.20 X 10^{4}	6.30 X 10^{4}	3.83 X 10^{4}	3.00 X 10^{4}	5.10 X 10^{4}	
THUF cfu/g	2.33 X 10^{3}	1.90 X 10^{3}	2.70 X 10^{3}	1.83 X 10^{3}	1.10 X 10^{3}	2.20 X 10^{3}	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 14.09 % to 29.74 %, silt ranged from 1.63 % to 8.59 % while the percentage of clay particles ranged from 61.67 % to 84.27 %. In the sub soil, sand particles ranged from 11.41 % to 27.03 %, silt ranged from 2.08 % to 7.59 % while clay ranged from 65.38 % to 84.30 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.48 to 6.76 (slightly acidic) for top soil and a range of 6.63 to 6.75 (slightly acidic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 1.53 – 3.50% for the topsoil samples while the subsoil ranged from 3.02 – 3.65%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

In the top soil, the Sodium (Na) concentrations ranged from 57.35 mg/kg to 69.49 mg/kg while in the sub-soil, the measured Na values ranged from 60.29 mg/kg to 62.84 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 3.47 mg/kg to 6.39 mg/kg in topsoil samples, and 1.27mg/kg to 4.41 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were

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also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Zinc analyzed in the soil samples from the study area had a range of 0.09 mg/kg to 0.23 mg/kg in topsoil and 0.06 mg/kg to 0.08 mg/kg in subsoil samples, suggesting that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 2.09 x 10^6 cfu/g to 5.70 x 10^7 cfu/g and subsoils ranged from 2.00 x 10^6 cfu/g to 2.50 x 10^7 cfu/g. Total Heterotrophic Fungi (THF) ranged between 2.50 x 10^4 cfu/g and 3.40 x 10^5 cfu/g for topsoil samples while it ranged from 1.40 x 10^4 cfu/g and 5.7 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

- *Sheshimandiko community*

The descriptive summary of soil characteristics from the project site in Sheshimandiko community and AoI is presented in Table 4.19.

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Table 4.19: Physico-chemical and microbial properties of soil samples from Sheshimandiko community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**	
pH	7.05	5.92	7.81	6.85	6.23	7.61	
TOC %	1.74	1.60	1.87	1.88	1.72	1.98	
Moisture Content	2.08	1.07	3.12	3.44	2.60	4.16	
Chloride mg/Kg	4.30	3.23	5.46	2.43	1.27	3.27	
Nitrate mg/Kg	0.86	0.39	1.59	0.48	0.26	0.79	
Sulphate mg/Kg	2.59	0.78	4.01	1.84	1.21	2.99	
Phosphate mg/Kg	0.84	0.71	1.03	0.42	0.12	1.21	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.77	0.64	0.89	0.53	0.24	0.90	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	54.88	46.18	62.12	52.79	47.84	60.76	NS
Zn mg/Kg	0.08	0.05	0.09	0.05	0.04	0.06	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	74.95	70.59	82.79	75.99	70.86	83.85	
K mg/Kg	45.77	18.03	60.61	50.45	33.44	74.36	
Ca mg/Kg	6.30	5.61	7.24	7.17	6.10	8.15	
Mg mg/Kg	0.60	-0.09	1.54	1.47	0.40	2.45	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	16.09	11.00	21.18	28.37	23.00	35.84	
%Silt	5.45	3.85	6.74	6.40	2.86	8.64	
%Clay	78.47	73.07	82.26	65.23	61.30	68.36	
THB cfu/ml	4.03×10^6	3.60×10^6	4.40×10^6	2.87×10^6	1.80×10^6	4.30×10^6	
THF cfu/g	3.03×10^4	2.30×10^4	3.80×10^4	1.20×10^4	7.00×10^3	1.80×10^4	
THUB cfu/g	1.87×10^4	1.00×10^4	2.50×10^4	6.57×10^3	2.20×10^3	1.50×10^4	
THUF cfu/g	3.47×10^3	1.00×10^2	1.00×10^4	1.67×10^2	1.00×10^2	2.00×10^2	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 11.0 % to 21.18 %, silt ranged from 3.85 % to 6.74 % while the percentage of clay particles ranged from 73.07 % to 82.26 %. In the sub soil, sand particles ranged from 23.00 % to 35.84 %, silt ranged from 2.86 % to 8.64 % while clay ranged from 61.30 % to 68.36 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

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The pH of soil samples from the study area ranged from 5.92 to 7.81 (slightly acidic to slightly basic) for top soil and a range of 6.23 to 7.61 (slightly acidic to slightly basic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 1.01 – 3.12% for the topsoil samples while the subsoil ranged from 2.60 – 4.16%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

In the top soil, the Sodium (Na) concentrations ranged from 70.59 mg/kg to 82.79 mg/kg while in the sub-soil, the measured Na values ranged from 70.86 mg/kg to 83.85 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 0.78 mg/kg to 4.01 mg/kg in topsoil samples, and 1.21 mg/kg to 2.99 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were

also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Zinc analyzed in the soil samples from the study area had a range of 0.05 mg/kg to 0.09 mg/kg in topsoil and 0.04 mg/kg to 0.06 mg/kg in subsoil samples, suggesting that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 3.60 x 10^6 cfu/g to 4.40 x 10^6 cfu/g and subsoils ranged from 1.80 x 10^6 cfu/g to 4.30 x 10^6 cfu/g. Total Heterotrophic Fungi (THF) ranged between 2.30 x 10^4 cfu/g and 3.80 x 10^5 cfu/g for topsoil samples while it ranged from 7.00 x 10^3 cfu/g and 1.80 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

- *Kuchitagi community*

The descriptive summary of soil characteristics from the project site in Kuchitagi community and AoI are presented in Table 4.20.

Table 4.20: Physico-chemical and microbial properties of soil samples from Kuchitagi community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	6.09	6.92	7.61	6.79	6.14	7.52	
TOC %	2.14	1.87	2.33	2.33	1.98	2.76	
Moisture Content	3.12	2.00	4.22	4.01	3.50	4.44	
Chloride mg/Kg	7.23	4.21	9.22	6.60	5.27	7.27	
Nitrate mg/Kg	0.90	0.67	1.21	0.90	0.59	1.36	
Sulphate mg/Kg	3.62	2.36	5.61	3.95	1.36	6.71	
Phosphate mg/Kg	0.51	0.47	0.54	0.30	0.16	0.53	
Oil andGrease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.94	0.01	2.61	1.10	0.01	3.21	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	50.58	32.44	75.30	46.73	17.29	73.73	NS
Zn mg/Kg	0.16	0.08	0.29	0.15	0.03	0.29	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	

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Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	69.98	56.51	82.84	72.39	63.50	81.29	
K mg/Kg	23.40	13.89	36.09	22.59	10.64	39.01	
Ca mg/Kg	5.75	5.45	5.93	5.42	5.04	5.86	
Mg mg/Kg	0.05	-0.25	0.23	-0.29	-0.67	0.16	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	21.74	18.51	24.31	15.79	5.18	21.96	
%Silt	4.34	3.18	5.18	4.27	3.22	5.15	
%Clay	73.92	72.41	76.84	79.94	74.82	89.67	
THB cfu/ml	7.30 X 10^6	5.50 X 10^6	8.60 X 10^6	7.83 X 10^6	6.70 X 10^6	9.10 X 10^6	
THF cfu/g	5.43 X 10^4	4.80 X 10^4	5.90 X 10^4	3.27 X 10^4	5.10 X 10^3	5.00 X 10^4	
THUB cfu/g	1.89 X 10^4	7.80 X 10^3	2.80 X 10^4	1.13 X 10^4	2.80 X 10^3	2.00 X 10^4	
THUF cfu/g	1.17 X 10^2	1.00 X 10^2	1.50 X 10^2	1.00 X 10^2	1.00 X 10^2	1.00 X 10^2	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 18.51 % to 24.31 %, silt ranged from 3.18 % to 5.18 % while the percentage of clay particles ranged from 72.41 % to 76.84 %. In the sub soil, sand particles ranged from 5.18 % to 21.96 %, silt ranged from 3.22 % to 5.15 % while clay ranged from 74.82 % to 89.67 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.92 to 7.61 (slightly neutral) for top soil and a range of 6.4 to 7.52 (slightly acidic to slightly basic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 2.00 – 4.22% for the topsoil samples while the subsoil ranged from 3.50 – 4.44%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

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In the top soil, the Sodium (Na) concentrations ranged from 56.51 mg/kg to 82.84 mg/kg while in the sub-soil, the measured Na values ranged from 63.50 mg/kg to 81.29 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 2.36 mg/kg to 5.61 mg/kg in topsoil samples, and 1.36 mg/kg to 6.71 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were

also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Zinc analyzed in the soil samples from the study area had a range of 0.08 mg/kg to 0.29 mg/kg in topsoil and 0.03 mg/kg to 0.29 mg/kg in subsoil samples, suggesting that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 5.50 x 10^6 cfu/g to 8.60 x 10^6 cfu/g and subsoils ranged from 6.70 x 10^6 cfu/g to 9.10 x 10^6 cfu/g. Total Heterotrophic Fungi (THF) ranged between 4.80 x 10^4 cfu/g and 5.90 x 10^4 cfu/g for topsoil samples while it ranged from 5.20 x 10^3 cfu/g and 5.00 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

❖ *Gbangba Community*

The descriptive summary of soil characteristics from the project site in Gbangba community and AoI are presented in Table 4.21.

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Table 4.21: Physico-chemical and microbial properties of soil samples from Gbangba Community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	7.22	6.79	7.64	7.20	7.07	7.33	
TOC %	1.92	1.73	2.10	2.05	1.98	2.11	
Moisture Content	3.33	2.57	3.15	3.76	3.50	4.02	
Chloride mg/Kg	25.01	18.76	31.26	22.01	21.26	22.76	
Nitrate mg/Kg	0.66	0.4	0.88	0.41	0.35	0.47	
Sulphate mg/Kg	8.175	3.73	12.62	7.83	5.31	10.35	
Phosphate mg/Kg	0.54	0.29	0.79	1.00	1.00	1.00	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.482	0.063	0.90	0.36	0.19	0.54	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	32.38	13.09	47.40	49.80	46.42	53.17	NS
Zn mg/Kg	0.08	0.05	0.10	0.06	0.05	0.08	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	67.387	62.378	72.40	62.44	61.49	63.39	
K mg/Kg	18.262	2.232	34.29	15.81	15.10	16.51	
Ca mg/Kg	8.6115	8.204	8.84	7.26	7.22	7.31	
Mg mg/Kg	2.9065	2.499	3.14	1.56	1.51	1.61	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	14.16	11.17	17.15	13.50	10.51	16.48	
%Silt	9.575	4.47	14.68	7.69	7.48	7.89	
%Clay	76.94	74.15	79.35	78.82	76.04	81.60	
THB cfu/ml	1.89 X 10^{7}	5.70 X 10^{6}	3.20 X 10^{7}	1.96 X 10^{7}	9.20 X 10^{6}	3.0 X 10^{7}	
THF cfu/g	1.59 X 10^{5}	4.80 X 10^{4}	2.70 X 10^{5}	3.50 X 10^{4}	1.80 X 10^{4}	5.20 X 10^{4}	
THUB cfu/g	5.80 X 10^{4}	4.50 X 10^{4}	7.10 X 10^{4}	4.60 X 10^{4}	4.20 X 10^{4}	5.00 X 10^{4}	
THUF cfu/g	1.66 X 10^{3}	1.20 X 10^{2}	3.20 X 10^{3}	1.35 X 10^{3}	1.20 X 10^{3}	1.50 X 10^{3}	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 11.17 % to 17.15 %, silt ranged from 4.47 % to 14.68 % while the percentage of clay particles ranged from 74.15 % to 79.35 %. In the sub soil, sand particles ranged from 10.51 % to 16.48 %, silt ranged from 7.48 % to 7.89 % while clay ranged from 76.04 % to 81.60 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.79 to 7.64 (slightly neutral) for top soil and a range of 7.07 to 7.33 (neutral to slightly basic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 2.57 – 3.15% for the topsoil samples while the subsoil ranged from 3.50 – 4.02%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

In the top soil, the Sodium (Na) concentrations ranged from 62.378 mg/kg to 72.40 mg/kg while in the sub-soil, the measured Na values ranged from 61.49 mg/kg to 63.39 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 3.73 mg/kg to 12.62 mg/kg in topsoil samples, and 5.31 mg/kg to 10.35 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

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For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Iron (Fe) analyzed in the soil samples from the study area had a range of 13.09 mg/kg to 47.40 mg/kg in topsoil and 46.42 mg/kg to 53.17 mg/kg in subsoil samples, the highest among all heavy metals analysed and indicating that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 5.70 x 10^6 cfu/g to 3.20 x 10^7 cfu/g and subsoils ranged from 9.20 x 10^6 cfu/g to 3.00 x 10^7 cfu/g. Total Heterotrophic Fungi (THF) ranged between 4.80 x 10^4 cfu/g and 2.7 x 10^5 cfu/g for topsoil samples while it ranged from 1.80 x 10^4 cfu/g and 5.00 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

❖ *Dokogi Community*

The descriptive summary of soil characteristics from the project site Dokoji community and AoI are presented in Table 4.22.

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Table 4.22: Physico-chemical and microbial properties of soil samples from Dokogi community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	7.08	6.60	7.83	6.56	6.43	6.69	
TOC %	2.62	2.50	2.77	2.69	2.61	2.76	
Moisture Content	3.02	2.20	4.22	3.93	3.42	4.44	
Chloride mg/Kg	3.94	1.27	5.27	4.79	1.33	8.26	
Nitrate mg/Kg	0.47	0.44	0.51	0.59	0.49	0.68	
Sulphate mg/Kg	5.45	4.74	6.53	6.58	3.39	9.76	
Phosphate mg/Kg	0.64	0.42	0.94	0.51	0.48	0.54	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.05	0.02	0.08	0.01	0.01	0.01	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	52.11	29.37	64.44	26.73	16.48	36.98	NS
Zn mg/Kg	0.47	0.10	1.10	0.15	0.08	0.22	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	62.98	51.64	73.75	60.43	60.38	60.48	

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
K mg/Kg	8.50	0.89	19.45	11.83	2.35	21.31	
Ca mg/Kg	8.07	7.25	9.08	7.30	6.43	8.16	
Mg mg/Kg	2.36	1.54	3.37	1.59	0.73	2.46	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	13.02	9.22	19.79	6.44	3.58	9.29	
%Silt	2.22	1.97	2.42	2.70	2.37	3.02	
%Clay	84.76	77.95	88.36	90.87	88.34	93.40	
THB cfu/ml	1.19×10^7	2.70×10^6	2.70×10^7	2.40×10^7	1.90×10^7	2.90×10^7	
THF cfu/g	4.00×10^4	1.70×10^4	7.10×10^4	3.40×10^4	2.50×10^4	4.30×10^4	
THUB cfu/g	4.57×10^4	2.40×10^4	8.90×10^4	3.70×10^4	2.30×10^4	5.10×10^4	
THUF cfu/g	1.50×10^3	4.90×10^2	3.00×10^3	1.60×10^3	1.00×10^3	2.20×10^3	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 9.22 % to 19.79 %, silt ranged from 1.97 % to 2.42 % while the percentage of clay particles ranged from 77.95 % to 88.36 %. In the sub soil, sand particles ranged from 3.58 % to 9.29 %, silt ranged from 2.37 % to 3.02 % while clay ranged from 88.34 % to 93.40 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

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The pH of soil samples from the study area ranged from 6.60 to 7.83 (slightly acidic to slightly basic) for top soil and a range of 6.43 to 6.69 (slightly acidic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 2.20 – 4.22% for the topsoil samples while the subsoil ranged from 3.42 – 4.44%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

In the top soil, the Sodium (Na) concentrations ranged from 51.64 mg/kg to 73.75 mg/kg while in the sub-soil, the measured Na values ranged from 60.38 mg/kg to 60.48 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 4.74 mg/kg to 6.53 mg/kg in topsoil samples, and 3.39 mg/kg to 9.76 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).
For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg

respectively. However, the concentrations of Iron (Fe) analyzed in the soil samples from the study area had a range of 29.37 mg/kg to 64.44 mg/kg in topsoil and 16.48 mg/kg to 36.98 mg/kg in subsoil samples, the highest among all heavy metals analysed and indicating that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 2.70 x 10^6 cfu/g to 2.70 x 10^7 cfu/g and subsoils ranged from 1.90 x 10^7 cfu/g to 2.90 x 10^7 cfu/g. Total Heterotrophic Fungi (THF) ranged between 1.70 x 10^4 cfu/g and 7.10 x 10^4 cfu/g for topsoil samples while it ranged from 2.50 x 10^4 cfu/g and 4.30 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

❖ *Ragidda Hausawa Community*

The descriptive summary of soil characteristics from the project site in Raggida Hausawa community and AoI are presented in Table 4.23.

Table 4.23: Physico-chemical and microbial properties of soil samples from Ragidda Hausawa Community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	6.75	6.09	7.48	7.22	6.55	7.58	
TOC %	2.13	1.96	2.31	2.18	1.95	2.50	
Moisture Content	2.55	1.16	3.45	3.19	2.31	3.99	
Chloride mg/Kg	13.93	7.27	26.26	13.08	8.73	21.25	
Nitrate mg/Kg	0.66	0.50	0.88	0.61	0.36	0.89	
Sulphate mg/Kg	15.60	8.81	19.00	11.63	4.94	16.41	
Phosphate mg/Kg	0.82	0.30	1.23	0.48	0.39	0.67	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	1.18	0.66	1.89	0.89	0.62	1.14	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	57.21	52.26	61.10	64.74	55.81	70.45	NS
Zn mg/Kg	0.09	0.03	0.12	0.06	0.03	0.09	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	67.77	61.49	74.39	62.39	53.48	72.39	
K mg/Kg	24.32	16.19	40.09	16.72	6.83	36.18	
Ca mg/Kg	7.16	6.23	8.49	7.28	6.53	8.48	
Mg mg/Kg	1.45	0.53	2.78	1.58	0.83	2.77	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	

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Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
%Sand	26.86	19.04	34.74	27.39	25.10	28.80	
%Silt	4.21	1.36	6.85	3.85	1.75	5.96	
%Clay	68.93	60.84	74.11	68.76	67.88	69.45	
THB cfu/ml	$4.97 X 10^{6}$	$2.80 X 10^{6}$	$6.70 X 10^{6}$	$1.42 X 10^{7}$	$2.60 X 10^{6}$	$3.50 X 10^{7}$	
THF cfu/g	$2.21 X 10^{4}$	$8.40 X 10^{3}$	$2.90 X 10^{4}$	$8.50 X 10^{5}$	$2.40 X 10^{4}$	$2.50 X 10^{6}$	
THUB cfu/g	$3.71 X 10^{4}$	$8.40 X 10^{3}$	$5.20 X 10^{4}$	$3.32 X 10^{4}$	$2.60 X 10^{3}$	$5.00 X 10^{4}$	
THUF cfu/g	$1.33 X 10^{3}$	$1.80 X 10^{2}$	$3.50 X 10^{3}$	$1.13 X 10^{3}$	$1.60 X 10^{2}$	$3.00 X 10^{3}$	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 19.04 % to 34.74 %, silt ranged from 1.36 % to 6.85 % while the percentage of clay particles ranged from 60.84 % to 74.11 %. In the sub soil, sand particles ranged from 25.10 % to 28.80 %, silt ranged from 1.75 % to 5.96 % while clay ranged from 67.88 % to 69.45 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.09 to 7.48 (slightly acidic to neutral) for top soil and a range of 6.55 to 7.58 (slightly acidic to neutral) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 1.16 – 3.45% for the topsoil samples while the subsoil ranged from 2.31 – 3.99%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

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In the top soil, the Sodium (Na) concentrations ranged from 61.49 mg/kg to 74.39 mg/kg while in the sub-soil, the measured Na values ranged from 53.48 mg/kg to 72.39 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 8.81 mg/kg to 19.00 mg/kg in topsoil samples, and 4.94 mg/kg to 16.41 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Iron (Fe) analyzed in the soil samples from the study area had a range of 52.26 mg/kg to 61.10 mg/kg in topsoil and 55.81 mg/kg to 70.45 mg/kg in subsoil samples, the highest among all heavy metals analysed and indicating that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 2.80 x 10^6 cfu/g to 6.70 x 10^6 cfu/g and subsoils ranged from 2.60 x 10^6 cfu/g to 3.50 x 10^6 cfu/g. Total Heterotrophic Fungi (THF) ranged between 8.40 x 10^3 cfu/g and 2.90 x 10^4 cfu/g for topsoil samples while it ranged from 2.40 x 10^4 cfu/g and 2.50 x 10^6 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

❖ *Nakoko Siyidi Community*

The descriptive summary of soil characteristics from the project site Nakoko Siyidi community and AoI are presented in Table 4.24.

Table 4.24: Physico-chemical and microbial properties of soil samples from Nakoko Siyidi community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	6.53	6.39	6.69	6.64	6.59	6.70	
TOC %	2.59	1.97	3.15	2.41	1.95	2.88	
Moisture Content	2.36	2.00	2.85	3.44	3.02	3.67	
Chloride mg/Kg	7.13	4.85	9.27	3.42	1.47	5.27	
Nitrate mg/Kg	0.39	0.27	0.49	0.44	0.11	0.61	
Sulphate mg/Kg	2.64	1.31	5.31	1.63	0.73	3.37	
Phosphate mg/Kg	0.87	0.54	1.17	0.52	0.36	0.78	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.58	0.02	1.46	0.33	0.01	0.95	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	69.78	56.94	78.87	60.37	44.50	87.66	NS
Zn mg/Kg	0.14	0.06	0.26	0.09	0.03	0.13	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	64.45	59.48	67.59	61.84	58.74	64.39	
K mg/Kg	25.99	12.61	44.25	20.98	8.40	38.43	
Ca mg/Kg	6.25	5.83	6.70	6.56	6.15	6.89	
Mg mg/Kg	0.55	0.13	0.99	0.86	0.45	1.18	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	

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Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
%Sand	17.71	6.53	30.02	22.89	13.10	31.45	
%Silt	5.95	4.18	7.90	5.56	3.92	7.82	
%Clay	76.33	65.80	85.57	71.55	64.63	79.08	
THB cfu/ml	--	3.30 X 10^6	1.70 X 10^7	9.63 X 10^6	2.90 X 10^6	2.30 X 10^7	
THF cfu/g	4.13 X 10^4	1.40 X 10^4	5.80 X 10^4	3.57 X 10^4	2.00 X 10^4	4.60 X 10^4	
THUB cfu/g	2.27 X 10^4	1.20 X 10^4	4.30 X 10^4	2.40 X 10^4	1.30 X 10^4	3.60 X 10^4	
THUF cfu/g	2.35 X 10^3	4.50 X 10^2	3.80 X 10^3	1.52 X 10^3	3.50 X 10^2	3.10 X 10^3	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 6.53 % to 30.02 %, silt ranged from 4.18 % to 7.90 % while the percentage of clay particles ranged from 65.80 % to 85.57 %. In the sub soil, sand particles ranged from 13.10 % to 31.45 %, silt ranged from 3.92 % to 7.82 % while clay ranged from 64.63 % to 79.08 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.39 to 6.69 (slightly acidic) for top soil and a range of 6.59 to 6.70 (slightly acidic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 2.00 – 2.85% for the topsoil samples while the subsoil ranged from 3.02 – 3.67%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

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In the top soil, the Sodium (Na) concentrations ranged from 59.48 mg/kg to 67.59 mg/kg while in the sub-soil, the measured Na values ranged from 58.74 mg/kg to 64.39 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 1.31 mg/kg to 5.31 mg/kg in topsoil samples, and 0.73 mg/kg to 3.37 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Iron (Fe) analyzed in the soil samples from the study area had a range of 56.94 mg/kg to 78.87 mg/kg in topsoil and 44.50

mg/kg to 87.66 mg/kg in subsoil samples, the highest among all heavy metals analysed and indicating that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 3.30 x 10^6 cfu/g to 1.70 x 10^7 cfu/g and subsoils ranged from 2.90 x 10^6 cfu/g to 2.30 x 10^7 cfu/g. Total Heterotrophic Fungi (THF) ranged between 1.40 x 10^4 cfu/g and 5.80 x 10^4 cfu/g for topsoil samples while it ranged from 1.30 x 10^4 cfu/g and 3.60 x 10^6 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

❖ *Mashigi Community*

The descriptive summary of soil characteristics from the project site Mashigi community and AoI are presented in Table 4.25.

Table 4.25: Physico-chemical and microbial properties of soil samples from Mashigi Community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	6.90	6.70	7.20	6.89	6.63	7.37	
TOC %	2.34	2.23	2.45	2.44	2.26	2.76	
Moisture Content	2.73	1.90	3.55	3.44	2.71	4.27	
Chloride mg/Kg	11.22	2.13	26.26	11.92	2.22	31.26	
Nitrate mg/Kg	0.69	0.59	0.76	0.72	0.44	1.12	
Sulphate mg/Kg	6.84	3.46	10.56	5.40	2.17	8.67	
Phosphate mg/Kg	0.93	0.43	1.58	1.08	0.34	2.11	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.98	0.52	1.78	0.70	0.29	1.49	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	78.79	73.73	84.96	75.35	67.93	89.18	NS
Zn mg/Kg	0.12	0.10	0.13	0.08	0.05	0.09	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	61.59	52.29	71.45	63.44	55.44	75.29	
K mg/Kg	36.06	22.41	43.94	36.11	21.69	50.25	
Ca mg/Kg	6.97	6.01	8.11	6.69	6.32	6.96	
Mg mg/Kg	1.27	0.30	2.40	0.98	0.61	1.25	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	20.60	13.01	26.84	22.83	12.41	28.16	
%Silt	5.50	3.79	7.84	5.73	4.59	6.74	
%Clay	73.90	69.37	79.15	71.44	65.98	80.85	
THB cfu/ml	3.33 X 10^6	2.80 X 10^6	3.70 X 10^6	5.30 X 10^6	5.00 X 10^6	5.80 X 10^6	

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Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
THF cfu/g	6.75 X 10^5	1.00 X 10^4	2.00 X 10^6	1.57 X 10^4	1.40 X 10^4	1.70 X 10^4	
THUB cfu/g	8.10 X 10^2	1.30 X 10^2	1.30 X 10^3	2.57 X 10^3	2.10 X 10^3	3.30 X 10^3	
THUF cfu/g	2.00 X 10^2	1.00 X 10^2	3.00 X 10^2	2.67 X 10^2	2.00 X 10^2	4.00 X 10^2	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 13.01 % to 26.84 %, silt ranged from 3.79 % to 7.84 % while the percentage of clay particles ranged from 69.37 % to 79.15 %. In the sub soil, sand particles ranged from 12.41 % to 28.16 %, silt ranged from 4.59 % to 6.74 % while clay ranged from 65.98 % to 80.85 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.70 to 7.20 (slightly acidic to neutral) for top soil and a range of 6.63 to 7.37 (slightly acidic to neutral) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 1.90 – 3.55% for the topsoil samples while the subsoil ranged from 2.71 – 4.27%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

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In the top soil, the Sodium (Na) concentrations ranged from 52.29 mg/kg to 71.45 mg/kg while in the sub-soil, the measured Na values ranged from 55.44 mg/kg to 75.29 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 3.46 mg/kg to 10.56 mg/kg in topsoil samples, and 2.17 mg/kg to 8.67 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Iron (Fe) analyzed in the soil samples from the study area had a range of 73.73 mg/kg to 84.96 mg/kg in topsoil and 67.93 mg/kg to 89.18 mg/kg in subsoil samples, the highest among all heavy metals analysed and indicating that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 2.80 x 10^6 cfu/g to 3.70 x 10^6 cfu/g and subsoils ranged from 5.00 x 10^6 cfu/g to 5.80 x 10^6 cfu/g. Total Heterotrophic Fungi (THF) ranged between 1.00 x 10^4 cfu/g and 2.00 x 10^6 cfu/g for topsoil samples while it ranged from 1.40 x 10^4 cfu/g and 1.70 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

- *Kpanje Community*

The descriptive summary of soil characteristics from the project site Kpanje community and AoI are presented in Table 4.26.

Table 4.26: Physico-chemical and microbial properties of soil samples from Kpanje Community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	7.28	6.57	7.69	7.58	7.54	7.63	
TOC %	2.32	1.96	2.75	2.15	1.88	2.33	
Moisture Content	2.08	1.07	3.12	3.44	2.60	4.16	
Chloride mg/Kg	6.00	2.38	9.36	4.87	3.27	7.06	
Nitrate mg/Kg	0.54	0.40	0.69	0.59	0.49	0.71	
Sulphate mg/Kg	2.36	0.02	5.70	1.76	0.01	4.14	
Phosphate mg/Kg	0.34	0.12	0.47	0.55	0.16	0.96	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.90	0.48	1.31	1.14	0.85	1.66	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	63.27	51.00	78.34	60.76	23.35	95.16	NS
Zn mg/Kg	0.49	0.35	0.68	0.46	0.24	0.74	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	71.76	61.05	82.79	72.91	59.59	83.85	
K mg/Kg	30.58	7.65	42.46	27.35	4.57	46.88	
Ca mg/Kg	8.07	7.82	8.46	7.47	6.83	8.64	
Mg mg/Kg	2.37	2.12	2.75	1.76	1.13	2.93	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	10.92	10.02	12.24	12.22	8.85	15.38	
%Silt	5.52	3.25	6.76	4.65	3.18	5.89	
%Clay	83.56	81.00	86.74	83.14	79.75	87.97	
THB cfu/ml	2.92 X 10^7	8.70 X 10^6	5.10 X 10^7	2.56 X 10^7	6.20 X 10^6	6.20 X 10^7	
THF cfu/g	2.60 X 10^4	1.80 X 10^4	3.50 X 10^4	3.27 X 10^4	1.00 X 10^4	5.60 X 10^4	

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Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
THUB cfu/g	2.84 X 10^4	1.30 X 10^3	4.20 X 10^4	2.65 X 10^4	1.50 X 10^3	4.00 X 10^4	
THUF cfu/g	1.33 X 10^2	1.00 X 10^2	1.50 X 10^2	1.33 X 10^2	1.00 X 10^2	1.50 X 10^2	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 10.02 % to 12.24 %, silt ranged from 3.25 % to 6.76 % while the percentage of clay particles ranged from 81.00 % to 86.74 %. In the sub soil, sand particles ranged from 8.85 % to 15.38 %, silt ranged from 3.18 % to 5.89 % while clay ranged from 79.75 % to 87.97 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.57 to 7.69 (slightly acidic to slightly basic) for top soil and a range of 7.54 to 7.63 (slightly basic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 1.07 – 3.12% for the topsoil samples while the subsoil ranged from 2.60 – 4.16%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

In the top soil, the Sodium (Na) concentrations ranged from 61.05 mg/kg to 82.79 mg/kg while in the sub-soil, the measured Na values ranged from 59.59 mg/kg to 83.85 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 0.02 mg/kg to 5.70 mg/kg in topsoil samples, and 0.01 mg/kg to 4.14 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005 mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Iron (Fe) analyzed in the soil samples from the study area had a range of 51.00 mg/kg to 78.34 mg/kg in topsoil and 23.35 mg/kg to 95.16 mg/kg in subsoil samples, the highest among all heavy metals analysed and indicating that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

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The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 8.70 x 10^6 cfu/g to 5.10 x 10^7 cfu/g and subsoils ranged from 6.20 x 10^6 cfu/g to 6.20 x 10^7 cfu/g. Total Heterotrophic Fungi (THF) ranged between 1.80 x 10^4 cfu/g and 3.50 x 10^4 cfu/g for topsoil samples while it ranged from 1.00 x 10^4 cfu/g and 5.60 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

❖ *Mayaki Community*

The descriptive summary of soil characteristics from the project site Mayaki community and AoI are presented in Table 4.27.

Table 4.27: Physico-chemical and microbial properties of soil samples from Mayaki Community

Parameters	Top Soil (0-15cm)			Sub Soil (15-30cm)			Alloway (1991)
	Mean	Min	Max	Mean	Min	Max	
pH	7.09	6.79	7.70	6.95	6.53	7.68	
TOC %	2.04	1.60	2.77	2.12	1.72	2.70	
Moisture Content	2.57	2.20	2.85	3.43	3.21	3.67	
Chloride mg/Kg	9.25	7.24	13.25	6.59	3.27	10.77	
Nitrate mg/Kg	0.90	0.61	1.21	0.60	0.59	0.63	
Sulphate mg/Kg	3.14	0.18	5.61	3.64	0.11	9.50	
Phosphate mg/Kg	1.22	0.73	1.81	0.85	0.49	1.19	
Oil and Grease mg/Kg	-	BDL	BDL	-	BDL	BDL	
Cu mg/Kg	0.77	0.39	0.98	0.92	0.82	1.03	5-500
Pb mg/Kg	-	BDL	BDL	-	BDL	BDL	2-20
Fe mg/Kg	48.30	39.48	62.41	55.89	41.02	81.82	NS
Zn mg/Kg	0.39	0.07	0.85	0.57	0.01	0.92	10-50
Cd mg/Kg	-	BDL	BDL	-	BDL	BDL	0.03-0.30
Cr mg/Kg	-	BDL	BDL	-	BDL	BDL	-
Ni mg/Kg	-	BDL	BDL	-	BDL	BDL	5-500
Mn mg/Kg	-	BDL	BDL	-	BDL	BDL	
Ba mg/Kg	-	BDL	BDL	-	BDL	BDL	
Hg mg/Kg	-	BDL	BDL	-	BDL	BDL	
V mg/Kg	-	BDL	BDL	-	BDL	BDL	
Na mg/Kg	64.70	52.29	74.39	60.44	53.48	72.39	
K mg/Kg	49.14	35.18	74.45	53.14	38.80	71.51	
Ca mg/Kg	6.98	6.81	7.25	7.49	6.62	7.99	
Mg mg/Kg	1.27	1.11	1.55	1.79	0.91	2.29	
THC mg/Kg	-	BDL	BDL	-	BDL	BDL	
%Sand	14.39	6.00	25.08	17.23	12.81	21.74	
%Silt	3.86	2.18	5.08	4.85	1.84	8.61	
%Clay	81.75	69.84	89.68	77.92	74.15	85.35	
THB cfu/ml	5.93 X 10^6	5.50 X 10^6	6.50 X 10^6	4.80 X 10^6	3.30 X 10^6	6.90 X 10^6	
THF cfu/g	4.63 X 10^4	3.90 X 10^4	5.90 X 10^4	3.30 X 10^4	2.40 X 10^4	5.00 X 10^4	
THUB cfu/g	6.03 X 10^3	4.20 X 10^3	8.10 X 10^3	4.07 X 10^3	3.20 X 10^3	5.30 X 10^3	
THUF cfu/g	2.17 X 10^2	2.00 X 10^2	2.50 X 10^2	2.00 X 10^2	2.00 X 10^2	2.00 X 10^2	

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limit

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The soil texture of the Project site can be classified as predominantly clay texture going by the particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 6.00 % to 25.08 %, silt ranged from 2.18 % to 5.08 % while the percentage of clay particles ranged from 69.84 % to 89.68 %. In the sub soil, sand particles ranged from 12.81 % to 21.74 %, silt ranged from 1.84 % to 8.61 % while clay ranged from 74.15 % to 85.35 %. Soils with high clay content are more cohesive and are inherently more stable. These soils are at lesser risk of erosion by water and wind, compared to sandy or loamy soils.

The pH of soil samples from the study area ranged from 6.79 to 7.70 (slightly acidic to slightly basic) for top soil and a range of 6.53 to 7.68 (slightly acidic to slightly basic) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on the site. The moisture content of the soil was in the range of 2.20 – 2.85% for the topsoil samples while the subsoil ranged from 3.21 – 3.67%. Moisture content of soil depends on factors such as temperature, soil type, presence of organic matter, etc.

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In the top soil, the Sodium (Na) concentrations ranged from 52.29 mg/kg to 74.39 mg/kg while in the sub-soil, the measured Na values ranged from 53.48 mg/kg to 72.39 mg/kg. The concentrations of other cations analysed Magnesium (Mg), Calcium (Ca), and Potassium (K) fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991).

Sulphate recorded the highest concentrations among the anions analysed with a range of 0.15 mg/kg to 5.61 mg/kg in topsoil samples, and 0.11 mg/kg to 9.50 mg/kg in subsoil samples. The concentrations of other anions (Phosphate and Nitrate) were also within the natural occurrence levels for tropical soils as prescribed by Alloway (1991).

For the heavy metals analysed which include: Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), their concentrations were below the detection limits of 0.005 mg/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. However, the concentrations of Iron (Fe) analyzed in the soil samples from the study area had a range of 39.48 mg/kg to 62.41 mg/kg in topsoil and 41.02 mg/kg to 81.82 mg/kg in subsoil samples, the highest among all heavy metals analysed and indicating that the soil environment of the area is not polluted as the values were below the limit prescribed for unpolluted soil.

The population of total heterotrophic bacteria (THB) counts in topsoil samples from the study area ranged from 5.50 x 10^6 cfu/g to 6.50 x 10^6 cfu/g and subsoils ranged from 3.30 x 10^6 cfu/g to 6.90 x 10^6 cfu/g. Total Heterotrophic Fungi (THF) ranged between 3.90 x 10^4 cfu/g and 5.90 x 10^4 cfu/g for topsoil samples while it ranged from

2.40 x 10^4 cfu/g and 5.00 x 10^4 cfu/g for subsoil samples. The THB and THF counts in the soils are similar to those occurring in natural levels.

4.3.5 Groundwater Quality

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

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

4.3.5.1 Groundwater Sampling

Groundwater samples were collected from two (2) boreholes and/or wells in the communities during the field sampling; one close to the Project site and one from the nearby local community. At each sampling location, groundwater samples were collected into a 2-litre polyethylene bottle for general physico-chemical analysis, while samples for oil & grease determination were collected in 1-litre glass bottle and preserved with concentrated sulphuric acid. Samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized 50ml McCartney bottles were used for samples meant for microbial analysis. In-situ measurements of pH, Electrical Conductivity, Total Dissolved Solids (TDS), Temperature, and Dissolved Oxygen (DO) were taken at each location using Extech Digital DO700 meter. The GPS coordinates of the groundwater sampling points are presented in Table 4.28.

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Table 4.28: Groundwater sampling points

Sampling locations	GW 01		GW 02	
	Latitude (N)	Longitude (E)	Latitude (N)	Longitude (E)
Gbangba	9.40933	6.12863	9.40766	6.12695
Sheshimandiko	9.34463	5.98516		
Kuchitagi	9.01450	5.83903	9.01547	5.83252
Dokogi	8.82142	6.03367	8.81934	6.03137
Dakpan	9.02895	5.82034	9.02592	5.82356
Ragidda Hausawa	9.68991	5.53456	9.68468	5.53594
Nakoko Siyidi	9.76981	5.65366	9.76465	5.65215
Mashigi	9.64865	5.57525	9.64507	5.57695
Kpanje	8.82469	5.98557		
Mayaki	8.85175	6.69835		

4.3.5.2 Physico-chemical Characteristics of Groundwater Samples

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

- *Dakpan Community*

The results of physico-chemical analysis conducted on groundwater samples from Dakpan community and AoI are presented in Table 4.29.

Table 4.29: Physico-chemical and microbial characteristics of groundwater samples from Dakpan Community

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	4.90	5.40	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	Clear	**NS**	**NS**	**NS**
Odour	Odourless	Odourless	**NS**	**NS**	**NS**
Temperature ºC	27.7	27.3	**NS**	**NS**	**<40**
Salinity ppt	0.01	0.01	**NS**	**NS**	**NS**
Conductivity µS/cm	69.0	182.0	**NS**	**1000**	**NS**
TDS ppm	35.0	91.0	**200**	**500**	**500**
Turbidity NTU	0.00	1.10	**NS**	**NS**	**1.0**
Total Hardness mg/L	52.0	58.0	**100**	**500**	**200**
Dissolved Oxygen mg/L	4.50	4.30	**NS**	**NS**	**7.5**
BOD mg/L	6.70	6.00	**NS**	**NS**	**0**
COD mg/L	26.88	30.60	**NS**	**NS**	**NS**
Chloride mg/L	3.499	3.499	**NS**	**NS**	**NS**
Nitrate mg/L	0.040	0.090	**NS**	**NS**	**10.0**
Sulphate mg/L	4.560	6.870	**200**	**400**	**500**
Phosphate mg/L	0.000	0.000	**NS**	**NS**	**5.0**
Cu mg/L	0.191	0.266	**0.05**	**1.5**	**1.0**
Pb mg/L	BDL	BDL	**NS**	**NS**	**0.05**
Fe mg/L	0.439	0.391	**0.1**	**1.0**	**1.0**
Zn mg/L	0.162	0.063	**NS**	**NS**	**5.0**
Cd mg/L	BDL	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.377	0.411	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	BDL	**NS**	**NS**	**NS**
Hg mg/L	BDL	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	BDL	**NS**	**NS**	**NS**
Na mg/L	6.829	7.572	**NS**	**NS**	**NS**
K mg/L	1.407	1.532	**NS**	**NS**	**NS**
Ca mg/L	8.876	7.372	**NS**	**NS**	**NS**
Mg mg/L	5.881	4.785	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	1.03×10^{5}	1.0×10^{5}	**NS**	**NS**	**NS**
THF cfu/ml	1.0×10^{2}	1.9×10^{2}	**NS**	**NS**	**NS**
THUB cfu/ml	2.2×10^{3}	1.5×10^{3}	**NS**	**NS**	**NS**
THUF cfu/ml	4.1×10^{1}	3.0×10^{1}	**NS**	**NS**	**NS**
Coliform	4.2×10^{4}	4.3×10^{3}	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

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The pH of the groundwater samples ranged from 4.90 to 5.40 (acidic), below the FMEnv and WHO limits which may be attributed to the geology of the area, thus indicating potential corrosiveness. The in-situ water temperature ranged between

27.3 ^{0}C and 27.7 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 69.00 µS/cm to 182.00 µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 35.00mg/l to 91.00mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (0.01 ppm) in both samples indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc ranged from 0.06 mg/l to 0.16 mg/l, while Iron ranged from 0.39 mg/l to 0.44 mg/l in the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform ranged from 4.30 X 10^3 cfu/ml to 4.20 X 10^4 cfu/ml in the groundwater samples from the project area.

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- *Sheshimandiko Community*

The results of physico-chemical analysis conducted on groundwater samples from Sheshimandiko community and AoI are presented in Table 4.30.

Table 4.30: Physico-chemical and microbial characteristics of groundwater samples from Sheshimandiko Community

ID	GW01	WHO Limits		FMEnv. Limits
		Highest Desirable Level	Max. Permissible Level	
pH	6.77	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	**NS**	**NS**	**NS**
Odour	Odourless	**NS**	**NS**	**NS**
Temperature ^{0}C	31	**NS**	**NS**	**<40**
Salinity ppt	0.22	**NS**	**NS**	**NS**
Conductivity µS/cm	843.0	**NS**	**1000**	**NS**
TDS ppm	421.0	**200**	**500**	**500**
Turbidity NTU	1.00	**NS**	**NS**	**1.0**
Total Hardness mg/L	410.0	**100**	**500**	**200**
Dissolved Oxygen mg/L	4.20	**NS**	**NS**	**7.5**
BOD mg/L	6.30	**NS**	**NS**	**0**
COD mg/L	83.21	**NS**	**NS**	**NS**
Chloride mg/L	119.46	**NS**	**NS**	**NS**
Nitrate mg/L	0.084	**NS**	**NS**	**10.0**
Sulphate mg/L	9.451	**200**	**400**	**500**
Phosphate mg/L	0.002	**NS**	**NS**	**5.0**
Cu mg/L	0.411	**0.05**	**1.5**	**1.0**

ID	GW01	WHO Limits		FMEnv. Limits
		Highest Desirable Level	Max. Permissible Level	
Pb mg/L	BDL	**NS**	**NS**	**0.05**
Fe mg/L	0.476	**0.1**	**1.0**	**1.0**
Zn mg/L	0.334	**NS**	**NS**	**5.0**
Cd mg/L	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.328	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	**NS**	**NS**	**NS**
Hg mg/L	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	**NS**	**NS**	**NS**
Na mg/L	17.471	**NS**	**NS**	**NS**
K mg/L	1.954	**NS**	**NS**	**NS**
Ca mg/L	11.579	**NS**	**NS**	**NS**
Mg mg/L	8.629	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	2.1×10^4	**NS**	**NS**	**NS**
THF cfu/ml	1.5×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	6.0×10^2	**NS**	**NS**	**NS**
THUF cfu/ml	1.0×10^1	**NS**	**NS**	**NS**
Coliform	3.0×10^3	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

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The pH of the groundwater sample was 6.77 (slightly acidic) while the in-situ water temperature was 31.0 ^{0}C. The temperature and pH values fall within the FMEnv recommended limit for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current was measured as 843.00 µS/cm, within the WHO limit of 1000 µS/cm. Correspondingly, the Total Dissolved Solids (TDS) value recorded was 421.00mg/l which falls below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater sample was very low (0.22 ppm), indicating a fresh water environment.

Heavy metals in the groundwater sample were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc was detected at 0.334 mg/l, while Iron was 0.476 mg/l in the groundwater sample analysed.
The concentrations of Oil & Grease in the groundwater sample was below the detection limit of the analytical instrument. Coliform was detected at 3.00 X 10^3 cfu/ml in the groundwater sample from the community.

- *Kuchitagi Community*

The results of physico-chemical analysis conducted on groundwater samples from Kuchitagi community and AoI are presented in Table 4.31.

Table 4.31: Physico-chemical and microbial characteristics of groundwater samples from Kuchitagi Community

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	5.69	5.53	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	Clear	**NS**	**NS**	**NS**
Odour	Odourless	Odourless	**NS**	**NS**	**NS**
Temperature ^{0}C	27.3	27.2	**NS**	**NS**	**<40**
Salinity ppt	0.01	0.01	**NS**	**NS**	**NS**
Conductivity µS/cm	183.0	268.0	**NS**	**1000**	**NS**
TDS ppm	91.0	134.0	**200**	**500**	**500**
Turbidity NTU	1.00	1.00	**NS**	**NS**	**1.0**
Total Hardness mg/L	62.0	206.0	**100**	**500**	**200**
Dissolved Oxygen mg/L	4.10	4.00	**NS**	**NS**	**7.5**
BOD mg/L	5.80	6.00	**NS**	**NS**	**0**
COD mg/L	30.95	32.45	**NS**	**NS**	**NS**
Chloride mg/L	5.498	6.498	**NS**	**NS**	**NS**
Nitrate mg/L	0.080	0.083	**NS**	**NS**	**10.0**
Sulphate mg/L	5.870	6.060	**200**	**400**	**500**
Phosphate mg/L	0.012	0.011	**NS**	**NS**	**5.0**
Cu mg/L	0.311	0.318	**0.05**	**1.5**	**1.0**
Pb mg/L	BDL	BDL	**NS**	**NS**	**0.05**
Fe mg/L	0.274	0.659	**0.1**	**1.0**	**1.0**
Zn mg/L	0.059	0.152	**NS**	**NS**	**5.0**
Cd mg/L	BDL	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.634	0.553	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	BDL	**NS**	**NS**	**NS**
Hg mg/L	BDL	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	BDL	**NS**	**NS**	**NS**
Na mg/L	6.102	7.946	**NS**	**NS**	**NS**
K mg/L	1.385	1.059	**NS**	**NS**	**NS**
Ca mg/L	6.931	5.181	**NS**	**NS**	**NS**
Mg mg/L	1.634	4.345	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	7.2×10^4	2.1×10^4	**NS**	**NS**	**NS**
THF cfu/ml	4.0×10^2	2.0×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	1.5×10^3	1.0×10^2	**NS**	**NS**	**NS**
THUF cfu/ml	1.5×10^1	4.0×10^1	**NS**	**NS**	**NS**
Coliform	3.8×10^3	1.6×10^3	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

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The pH of the groundwater samples ranged from 5.53 to 5.69 (acidic), below the FMEnv and WHO limits which may be attributed to the geology of the area, thus indicating potential corrosiveness. The in-situ water temperature ranged between 27.2 ^{0}C and 27.3 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 183.00 µS/cm to 268.00 µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 91.00mg/l to 134.00mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (0.01 ppm) in both samples indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc ranged from 0.059 mg/l to 0.152mg/l, while Iron ranged from 0.274 mg/l to 0.659 mg/l in the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform ranged from 1.60 X 10^3 cfu/ml to 3.80 X 10^3 cfu/ml in the groundwater samples from the project area.

❖ *Gbangba Community*

The results of physico-chemical analysis conducted on groundwater samples from Gbangba community and AoI are presented in Table 4.32.

Table 4.32: Physico-chemical and microbial characteristics of groundwater samples from Gbangba Community

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	6.08	6.15	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Brownish	Clear	**NS**	**NS**	**NS**
Odour	Odourless	Odourless	**NS**	**NS**	**NS**
Temperature ^{0}C	27.9	27.8	**NS**	**NS**	**<40**
Salinity ppt	0.07	0.04	**NS**	**NS**	**NS**
Conductivity µS/cm	520.0	540.0	**NS**	**1000**	**NS**
TDS ppm	260.0	270.0	**200**	**500**	**500**
Turbidity NTU	1.30	1.00	**NS**	**NS**	**1.0**
Total Hardness mg/L	88.0	94.0	**100**	**500**	**200**
Dissolved Oxygen mg/L	4.10	4.00	**NS**	**NS**	**7.5**
BOD mg/L	8.48	6.80	**NS**	**NS**	**0**
COD mg/L	43.53	44.29	**NS**	**NS**	**NS**
Chloride mg/L	36.489	22.493	**NS**	**NS**	**NS**
Nitrate mg/L	0.168	0.080	**NS**	**NS**	**10.0**
Sulphate mg/L	18.830	7.360	**200**	**400**	**500**
Phosphate mg/L	0.012	0.010	**NS**	**NS**	**5.0**
Cu mg/L	0.277	0.153	**0.05**	**1.5**	**1.0**
Pb mg/L	BDL	BDL	**NS**	**NS**	**0.05**
Fe mg/L	1.756	1.012	**0.1**	**1.0**	**1.0**
Zn mg/L	0.368	0.015	**NS**	**NS**	**5.0**
Cd mg/L	BDL	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.529	0.383	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	BDL	**NS**	**NS**	**NS**

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ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
Hg mg/L	BDL	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	BDL	**NS**	**NS**	**NS**
Na mg/L	13.517	13.084	**NS**	**NS**	**NS**
K mg/L	1.183	1.095	**NS**	**NS**	**NS**
Ca mg/L	8.042	7.764	**NS**	**NS**	**NS**
Mg mg/L	2.832	3.774	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	2.4×10^3	2.4×10^3	**NS**	**NS**	**NS**
THF cfu/ml	1.7×10^2	7.0×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	1.2 x 101	1.5×10^1	**NS**	**NS**	**NS**
THUF cfu/ml	1.0×10^1	1.0 x 101	**NS**	**NS**	**NS**
Coliform	4.3×10^2	7.3×10^2	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

The pH of the groundwater samples ranged from 6.08 to 6.15 (acidic), below the FMEnv and WHO limits which may be attributed to the geology of the area, thus indicating potential corrosiveness. The in-situ water temperature ranged between 27.8 ^{0}C and 27.9 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

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Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 520.00µS/cm to 540.00µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 260.0mg/l to 270.0mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (0.04 ppm to 0.07 ppm) in both samples indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc ranged from 0.015 mg/l to 0.368 mg/l, while Iron ranged from 1.012 mg/l to 1.756 mg/l in the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform ranged from 4.30 X 10^2 cfu/ml to 7.30 X 10^2 cfu/ml in the groundwater samples from the project area.

- *Dokogi Community*

The results of physico-chemical analysis conducted on groundwater samples from Dokogi community and AoI are presented in Table 4.33.

Table 4.33: Physico-chemical and microbial characteristics of groundwater samples from Dokogi Community

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	6.26	6.21	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	Clear	**NS**	**NS**	**NS**
Odour	Odourless	Odourless	**NS**	**NS**	**NS**
Temperature ^{0}C	28.3	28.1	**NS**	**NS**	**<40**
Salinity ppt	0.02	0.02	**NS**	**NS**	**NS**
Conductivity µS/cm	268.0	277.0	**NS**	**1000**	**NS**
TDS ppm	134.0	139.0	**200**	**500**	**500**
Turbidity NTU	1.00	1.00	**NS**	**NS**	**1.0**
Total Hardness mg/L	76.00	86.0	**100**	**500**	**200**
Dissolved Oxygen mg/L	3.30	3.90	**NS**	**NS**	**7.5**
BOD mg/L	5.60	6.50	**NS**	**NS**	**0**
COD mg/L	31.93	33.84	**NS**	**NS**	**NS**
Chloride mg/L	12.496	13.496	**NS**	**NS**	**NS**
Nitrate mg/L	0.096	0.070	**NS**	**NS**	**10.0**
Sulphate mg/L	5.480	4.120	**200**	**400**	**500**
Phosphate mg/L	0.022	0.018	**NS**	**NS**	**5.0**
Cu mg/L	0.121	0.101	**0.05**	**1.5**	**1.0**
Pb mg/L	BDL	BDL	**NS**	**NS**	**0.05**
Fe mg/L	0.845	0.655	**0.1**	**1.0**	**1.0**
Zn mg/L	0.064	0.124	**NS**	**NS**	**5.0**
Cd mg/L	BDL	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.413	0.331	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	BDL	**NS**	**NS**	**NS**
Hg mg/L	BDL	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	BDL	**NS**	**NS**	**NS**
Na mg/L	9.752	8.718	**NS**	**NS**	**NS**
K mg/L	1.423	1.012	**NS**	**NS**	**NS**
Ca mg/L	6.621	8.419	**NS**	**NS**	**NS**
Mg mg/L	4.022	6.835	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	9.3×10^4	6.1×10^4	**NS**	**NS**	**NS**
THF cfu/ml	8.0×10^1	2.2×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	9.2×1^{02}	7.5×10^2	**NS**	**NS**	**NS**
THUF cfu/ml	2.0×10^1	3.0×10^0	**NS**	**NS**	**NS**
Coliform	1.7×10^4	3.2×10^3	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

The pH of the groundwater samples ranged from 6.21 to 6.26 (slightly acidic), below the FMEnv and WHO limits which may be attributed to the geology of the area, thus indicating potential corrosiveness. The in-situ water temperature ranged between 28.1 ^{0}C and 28.3 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 268.00µS/cm to 277.00µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000

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µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 134.0mg/l to 139.0mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (0.02 ppm) in both samples indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc ranged from 0.06 mg/l to 0.12 mg/l, while Iron ranged from 0.66 mg/l to 0.85 mg/l in the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform ranged from 3.20 X 10^3 cfu/ml to 1.70 X 10^4 cfu/ml in the groundwater samples from the project area.

- *Ragidda Hausawa Community*

The results of physico-chemical analysis conducted on groundwater samples from Ragidda Hausawa community and AoI are presented in Table 4.34.

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Table 4.34: Physico-chemical and microbial characteristics of groundwater samples from Ragidda Hausawa Community

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	5.63	5.68	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Brownish	Brownish	**NS**	**NS**	**NS**
Odour	Odourless	Odourless	**NS**	**NS**	**NS**
Temperature °C	28	28.5	**NS**	**NS**	**<40**
Salinity ppt	0.01	0.01	**NS**	**NS**	**NS**
Conductivity µS/cm	58.0	66.0	**NS**	**1000**	**NS**
TDS ppm	29.0	33.0	**200**	**500**	**500**
Turbidity NTU	1.50	1.50	**NS**	**NS**	**1.0**
Total Hardness mg/L	140.0	48.0	**100**	**500**	**200**
Dissolved Oxygen mg/L	3.40	4.00	**NS**	**NS**	**7.5**
BOD mg/L	10.93	8.34	**NS**	**NS**	**0**
COD mg/L	22.16	25.38	**NS**	**NS**	**NS**
Chloride mg/L	6.498	4.499	**NS**	**NS**	**NS**
Nitrate mg/L	0.150	0.130	**NS**	**NS**	**10.0**
Sulphate mg/L	16.550	11.420	**200**	**400**	**500**
Phosphate mg/L	0.014	0.030	**NS**	**NS**	**5.0**
Cu mg/L	0.244	0.378	**0.05**	**1.5**	**1.0**
Pb mg/L	BDL	BDL	**NS**	**NS**	**0.05**
Fe mg/L	3.763	2.427	**0.1**	**1.0**	**1.0**
Zn mg/L	0.482	0.638	**NS**	**NS**	**5.0**
Cd mg/L	BDL	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.708	0.994	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	BDL	**NS**	**NS**	**NS**

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
Hg mg/L	BDL	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	BDL	**NS**	**NS**	**NS**
Na mg/L	4.159	5.035	**NS**	**NS**	**NS**
K mg/L	0.534	0.435	**NS**	**NS**	**NS**
Ca mg/L	6.428	6.372	**NS**	**NS**	**NS**
Mg mg/L	3.311	4.859	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	9.6×10^3	1.5×10^6	**NS**	**NS**	**NS**
THF cfu/ml	2.2×10^2	4.9×10^3	**NS**	**NS**	**NS**
THUB cfu/ml	5.0×10^1	3.0×10^3	**NS**	**NS**	**NS**
THUF cfu/ml	1.0×10^1	1.0×10^1	**NS**	**NS**	**NS**
Coliform	1.0×10^2	2.5×10^4	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

The pH of the groundwater samples ranged from 5.63 to 5.68 (acidic), below the FMEnv and WHO limits which may be attributed to the geology of the area, thus indicating potential corrosiveness. The in-situ water temperature ranged between 28.0 ^{0}C and 28.5 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 58.00µS/cm to 66.00µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 29.0mg/l to 33.0mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (0.01 ppm) in both samples indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc ranged from 0.48 mg/l to 0.64 mg/l, while Iron ranged from 2.43 mg/l to 3.76 mg/l in the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform ranged from 1.00 X 10^2 cfu/ml to 2.50 X 10^4 cfu/ml in the groundwater samples from the project area.

❖ *Nakoko Siyidi Community*

The results of physico-chemical analysis conducted on groundwater samples from Nakoko Siyidi community and AoI are presented in Table 4.35.

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Table 4.35: Physico-chemical and microbial characteristics of groundwater samples from Nakoko Siyidi Community

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	5.90	6.04	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	Clear	**NS**	**NS**	**NS**
Odour	Odourless	Odourless	**NS**	**NS**	**NS**
Temperature ^{0}C	27.7	28.6	**NS**	**NS**	**<40**
Salinity ppt	0.02	0.01	**NS**	**NS**	**NS**
Conductivity µS/cm	232.0	220.0	**NS**	**1000**	**NS**
TDS ppm	116.0	110.0	**200**	**500**	**500**
Turbidity NTU	1.10	1.00	**NS**	**NS**	**1.0**
Total Hardness mg/L	62.000	64.000	**100**	**500**	**200**
Dissolved Oxygen mg/L	3.50	3.80	**NS**	**NS**	**7.5**
BOD mg/L	5.80	5.00	**NS**	**NS**	**0**
COD mg/L	29.18	30.91	**NS**	**NS**	**NS**
Chloride mg/L	11.496	6.998	**NS**	**NS**	**NS**
Nitrate mg/L	0.060	0.028	**NS**	**NS**	**10.0**
Sulphate mg/L	4.432	6.790	**200**	**400**	**500**
Phosphate mg/L	0.020	0.012	**NS**	**NS**	**5.0**
Cu mg/L	0.099	0.168	**0.05**	**1.5**	**1.0**
Pb mg/L	BDL	BDL	**NS**	**NS**	**0.05**
Fe mg/L	1.101	0.836	**0.1**	**1.0**	**1.0**
Zn mg/L	0.033	0.134	**NS**	**NS**	**5.0**
Cd mg/L	BDL	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.637	0.638	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	BDL	**NS**	**NS**	**NS**
Hg mg/L	BDL	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	BDL	**NS**	**NS**	**NS**
Na mg/L	8.148	8.048	**NS**	**NS**	**NS**
K mg/L	1.433	1.478	**NS**	**NS**	**NS**
Ca mg/L	8.032	7.153	**NS**	**NS**	**NS**
Mg mg/L	4.444	3.342	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	1.5×10^1	2.0×10^3	**NS**	**NS**	**NS**
THF cfu/ml	7.0×10^0	3.0×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	ND	5.5×10^2	**NS**	**NS**	**NS**
THUF cfu/ml	ND	1.2×10^1	**NS**	**NS**	**NS**
Coliform	ND	5.0×10^2	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits, ND- Not Detected

The pH of the groundwater samples ranged from 5.90 to 6.04 (slightly acidic), below the FMEnv and WHO limits which may be attributed to the geology of the area, thus indicating potential corrosiveness. The in-situ water temperature ranged between 27.7 ^{0}C and 28.6 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 220.0 µS/cm to 232.0µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000 µS/cm.

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Similarly, the Total Dissolved Solids (TDS) values ranged from 110.0mg/l to 116.0mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (0.01 ppm to 0.02 ppm) in both samples indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc ranged from 0.03 mg/l to 0.13 mg/l, while Iron ranged from 0.84 mg/l to 1.10 mg/l in the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform was detected at 5.00 X 10^2 cfu/ml in one groundwater sample from the project area.

❖ *Mashigi Community*

The results of physico-chemical analysis conducted on groundwater samples from Mashigi community and AoI are presented in Table 4.36 below.

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Table 4.36: Physico-chemical and microbial characteristics of groundwater samples from Mashigi Community

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	5.77	5.73	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	Clear	**NS**	**NS**	**NS**
Odour	Odourless	Odourless	**NS**	**NS**	**NS**
Temperature ⁰C	28.9	27.9	**NS**	**NS**	**<40**
Salinity ppt	0.02	0.02	**NS**	**NS**	**NS**
Conductivity µS/cm	164.0	152.0	**NS**	**1000**	**NS**
TDS ppm	82.00	76.00	**200**	**500**	**500**
Turbidity NTU	1.00	1.10	**NS**	**NS**	**1.0**
Total Hardness mg/L	50.0	53.0	**100**	**500**	**200**
Dissolved Oxygen mg/L	3.10	3.50	**NS**	**NS**	**7.5**
BOD mg/L	7.10	4.80	**NS**	**NS**	**0**
COD mg/L	26.65	29.79	**NS**	**NS**	**NS**
Chloride mg/L	10.497	8.497	**NS**	**NS**	**NS**
Nitrate mg/L	0.046	0.029	**NS**	**NS**	**10.0**
Sulphate mg/L	6.590	3.880	**200**	**400**	**500**
Phosphate mg/L	0.027	0.003	**NS**	**NS**	**5.0**
Cu mg/L	0.238	0.211	**0.05**	**1.5**	**1.0**
Pb mg/L	BDL	BDL	**NS**	**NS**	**0.05**
Fe mg/L	0.742	1.100	**0.1**	**1.0**	**1.0**
Zn mg/L	0.078	0.104	**NS**	**NS**	**5.0**
Cd mg/L	BDL	BDL	**NS**	**NS**	**NS**
Cr mg/L	BDL	BDL	**NS**	**NS**	**NS**
Ni mg/L	0.525	0.427	**NS**	**NS**	**NS**
Mn mg/Kg	BDL	BDL	**NS**	**NS**	**NS**
Ba mg/L	BDL	BDL	**NS**	**NS**	**NS**

ID	GW01	GW02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
Hg mg/L	BDL	BDL	**NS**	**NS**	**NS**
V mg/L	BDL	BDL	**NS**	**NS**	**NS**
Na mg/L	2.937	3.046	**NS**	**NS**	**NS**
K mg/L	0.553	0.820	**NS**	**NS**	**NS**
Ca mg/L	7.461	5.738	**NS**	**NS**	**NS**
Mg mg/L	3.329	4.225	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	3.7×10^4	3.0×10^4	**NS**	**NS**	**NS**
THF cfu/ml	2.0×10^2	1.7×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	2.0×10^2	6.0×10^1	**NS**	**NS**	**NS**
THUF cfu/ml	3.0×10^0	1.0×10^0	**NS**	**NS**	**NS**
Coliform	9.2×10^3	3.1×10^3	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

The pH of the groundwater samples ranged from 5.73 to 5.77 (slightly acidic), below the FMEnv and WHO limits which may be attributed to the geology of the area, thus indicating potential corrosiveness. The in-situ water temperature ranged between 27.9 ^{0}C and 28.9 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 152.0µS/cm to 164.0µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 76.0mg/l to 82.0mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (0.02 ppm) in both samples indicating a fresh water environment.

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Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc ranged from 0.08 mg/l to 0.10 mg/l, while Iron ranged from 0.74 mg/l to 1.10 mg/l in the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform ranged from 3.10 X 10^3 cfu/ml to 9.20 X 10^3 cfu/ml in the groundwater samples from the project area.

- *Kpanje Community*

The results of physico-chemical analysis conducted on groundwater samples from Kpanje community and AoI are presented in Table 4.37 below.

Table 4.37: Physico-chemical and microbial characteristics of groundwater samples from Kpanje Community

ID	GW01	WHO Limits		FMEnv. Limits
		Highest Desirable Level	Max. Permissible Level	
pH	6.20	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	**NS**	**NS**	**NS**
Odour	Odourless	**NS**	**NS**	**NS**
Temperature ^{0}C	30.0	**NS**	**NS**	**<40**
Salinity ppt	0.04	**NS**	**NS**	**NS**
Conductivity µS/cm	443.00	**NS**	**1000**	**NS**
TDS ppm	222.00	**200**	**500**	**500**
Turbidity NTU	1.00	**NS**	**NS**	**1.0**
Total Hardness mg/L	38.00	**100**	**500**	**200**
Dissolved Oxygen mg/L	4.10	**NS**	**NS**	**7.5**
BOD mg/L	6.00	**NS**	**NS**	**0**
COD mg/L	49.32	**NS**	**NS**	**NS**
Chloride mg/L	21.342	**NS**	**NS**	**NS**
Nitrate mg/L	0.080	**NS**	**NS**	**10.0**
Sulphate mg/L	4.340	**200**	**400**	**500**
Phosphate mg/L	0.018	**NS**	**NS**	**5.0**
Cu mg/L	0.132	**0.05**	**1.5**	**1.0**
Pb mg/L	<0.04	**NS**	**NS**	**0.05**
Fe mg/L	0.385	**0.1**	**1.0**	**1.0**
Zn mg/L	0.158	**NS**	**NS**	**5.0**
Cd mg/L	<0.005	**NS**	**NS**	**NS**
Cr mg/L	<0.04	**NS**	**NS**	**NS**
Ni mg/L	0.305	**NS**	**NS**	**NS**
Mn mg/Kg	<0.03	**NS**	**NS**	**NS**
Ba mg/L	<0.25	**NS**	**NS**	**NS**
Hg mg/L	<0.001	**NS**	**NS**	**NS**
V mg/L	<0.4	**NS**	**NS**	**NS**
Na mg/L	9.255	**NS**	**NS**	**NS**
K mg/L	0.939	**NS**	**NS**	**NS**
Ca mg/L	4.289	**NS**	**NS**	**NS**
Mg mg/L	5.217	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	5.8×10^4	**NS**	**NS**	**NS**
THF cfu/ml	1.8×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	7.2×10^2	**NS**	**NS**	**NS**
THUF cfu/ml	5.0×10^0	**NS**	**NS**	**NS**
Coliform	1.5×10^3	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

The pH of the groundwater sample was 6.20 (slightly acidic) while the in-situ water temperature was 30.0 ^{0}C. The temperature and pH values fall within the FMEnv recommended limit for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current was measured as 443.00 µS/cm, within the WHO limit of 1000 µS/cm. Correspondingly, the Total Dissolved Solids (TDS) value recorded was 222.00mg/l which falls below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in

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the water samples. Salinity of the groundwater sample was very low (0.04 ppm), indicating a fresh water environment.

Heavy metals in the groundwater sample were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc was detected at 0.158 mg/l, while Iron was 0.385 mg/l in the groundwater sample analysed.

The concentrations of Oil & Grease in the groundwater sample was below the detection limit of the analytical instrument. Coliform was detected at 1.50 X 10^3 cfu/ml in the groundwater sample from the community.

❖ *Mayaki Community*

The results of physico-chemical analysis conducted on groundwater samples from Mayaki community and AoI are presented in Table 4.38 below.

Table 4.38: Physico-chemical and microbial characteristics of groundwater samples from Mayaki Community

ID	GW01	WHO Limits		FMEnv. Limits
		Highest Desirable Level	Max. Permissible Level	
pH	5.59	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Appearance	Clear	**NS**	**NS**	**NS**
Odour	Odourless	**NS**	**NS**	**NS**
Temperature °C	28.9	**NS**	**NS**	**<40**
Salinity ppt	0.04	**NS**	**NS**	**NS**
Conductivity µS/cm	430.00	**NS**	**1000**	**NS**
TDS ppm	215.00	**200**	**500**	**500**
Turbidity NTU	1.00	**NS**	**NS**	**1.0**
Total Hardness mg/L	52.000	**100**	**500**	**200**
Dissolved Oxygen mg/L	4.00	**NS**	**NS**	**7.5**
BOD mg/L	5.80	**NS**	**NS**	**0**
COD mg/L	47.29	**NS**	**NS**	**NS**
Chloride mg/L	24.492	**NS**	**NS**	**NS**
Nitrate mg/L	0.050	**NS**	**NS**	**10.0**
Sulphate mg/L	5.720	**200**	**400**	**500**
Phosphate mg/L	0.005	**NS**	**NS**	**5.0**
Cu mg/L	0.202	**0.05**	**1.5**	**1.0**
Pb mg/L	<0.04	**NS**	**NS**	**0.05**
Fe mg/L	0.710	**0.1**	**1.0**	**1.0**
Zn mg/L	0.093	**NS**	**NS**	**5.0**
Cd mg/L	<0.005	**NS**	**NS**	**NS**
Cr mg/L	<0.04	**NS**	**NS**	**NS**
Ni mg/L	0.450	**NS**	**NS**	**NS**
Mn mg/Kg	<0.03	**NS**	**NS**	**NS**
Ba mg/L	<0.25	**NS**	**NS**	**NS**
Hg mg/L	<0.001	**NS**	**NS**	**NS**
V mg/L	<0.4	**NS**	**NS**	**NS**
Na mg/L	8.343	**NS**	**NS**	**NS**
K mg/L	1.161	**NS**	**NS**	**NS**
Ca mg/L	3.653	**NS**	**NS**	**NS**

ID	GW01	WHO Limits		FMEnv. Limits
		Highest Desirable Level	Max. Permissible Level	
Mg mg/L	4.291	**NS**	**NS**	**NS**
Oil and grease mg/L	BDL	**NS**	**NS**	**0.05**
THB cfu/ml	1.7×10^5	**NS**	**NS**	**NS**
THF cfu/ml	1.0×10^2	**NS**	**NS**	**NS**
THUB cfu/ml	4.0×10^2	**NS**	**NS**	**NS**
THUF cfu/ml	5.0×10^0	**NS**	**NS**	**NS**
Coliform	4.3×10^3	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2020 BDL – Below Detection Limits

The pH of the groundwater sample was 5.59 (slightly acidic) while the in-situ water temperature was 28.9 ^{0}C. The temperature and pH values fall within the FMEnv recommended limit for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current was measured as 430.00µS/cm, within the WHO limit of 1000 µS/cm. Correspondingly, the Total Dissolved Solids (TDS) value recorded was 215.00mg/l which falls below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater sample was very low (0.04 ppm), indicating a fresh water environment.

Heavy metals in the groundwater sample were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd) and Chromium (Cr) were not detected in the samples. Zinc was detected at 0.093 mg/l, while Iron was 0.710 mg/l in the groundwater sample analysed.

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The concentrations of Oil & Grease in the groundwater sample was below the detection limit of the analytical instrument. Coliform was detected at 4.30 X 10^3 cfu/ml in the groundwater sample from the community.

4.3.6 Terrestrial Flora and Fauna

4.3.6.1 Terrestrial Flora

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

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

The results of the vegetation assessment are presented as follows:

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

❖ *Habitat characterization*

The typical vegetation type of the ecoregion in which the Project sites fall is the Southern Guinea Savanna. Savanna is a seasonal tropical vegetation type that is characterized by a closed or nearly closed groundcover of grasses that have flat, cauline leaves and are at least 0.8 meters (m) in height. It comprises trees and shrubs that burn periodically due to humid climatic conditions (Sanford and Isichei, 1986). Undisturbed savanna ecosystem has diversity of trees and shrubs forming a mosaic with grassland on the landscape. However, the anthropogenic influences have always resulted in decrease in tree diversity and tremendous changes in the physiognomy of the landscape. Owing to the homogeneity of the vegetation profile of the proposed project sites, the description of their ecological features has been discussed as a composite unit to avoid tautology. However, where a unit that is remarkably distinct from others, it is discussed separately to ensure that salient details are not left out.

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❖ *Physiognomy, Floristic composition, and Biodiversity assessment*

Species composition, distribution and structure of the vegetation of Project as well as the physiognomic view show few trees, shrubs and grasses. The vegetation of the project sites has been significantly altered due to human activities, mainly farming, burning, and fuelwood harvesting. From the field analysis, it was evident that the flora composition of the all the project sites were identical because the project sites all fall within the same vegetation zone (Guinea Savanna) and also as a result of anthropogenic influences, mainly agricultural and pastoral activities. The sites had little diversity of plants since the natural vegetation has been replaced by different populations of weeds such as *Hyptis suaveolens* and *Cleome viscosa.*

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

The IUCN Red List also includes information on plants, fungi and animals that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants, fungi and animals that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e., are Near Threatened).

The plant species encountered in the study area fall under Not Evaluated. None of the recorded plant species in the study area is critically endangered or endangered. In addition, there are no known protected species on the Project site under the Nigerian legislation. The IUCN status of the plant species encountered in the study area is highlighted in Table 4.39.

Table 4.39: Plant Species observed around proposed project sites

Dominant Species Encountered	Family Name	Habit	Common Name (Local name)	IUCN Status	Communities
Andropogon tectorum Schumach. & Thonn.	Poaceae	Grass	Gambaa	NA	GB, KU, DO, NA, MA
Eleusine indica (L.) Gaertn.	Poaceae	Grass	Goose grass	NA	GB, KU, DO, DA, NA, MA, RA, SH
Euphorbia heterophylla L.	Euphorbiaceae	Forb	Milkweed	NA	GB, KU, DO, RA, SH
Cleome viscosa L.	Capparaceae	Forb	Miya	NA	GB, KU, DA, NA, MA, MY
Aspilia africana (Pers.) C.D.Adams	Asteraceae	Forb	Sunflower	NA	GB, KU, DO, DA, KP
Hyparrhenia involucrata Stapf.	Poaceae	Grass	Kakario	NA	GB, KU, DO, DA, NA, MA, RA, SH
Mariscus alternifolius Vahl	Cyperaceae	Sedge	Ayaa	NA	GB, NA, MA, RA, SH, KP
Pennisetum glaucum (L.) R.Br.	Poaceae	Grass	Pearl millet	NA	GB, KU, DO, DA, SH
Pennisetum polystachyon (Linn) Schuff	Poaceae	Grass	Millet	NA	DO, DA, NA, MA, RA, SH
Pennisetum purpureum Schumach.	Poaceae	Grass	Millet	NA	GB, MY, KU, DO, DA
Piliostigma thonningii (Schumach.) Milne-Redh	Fabaceae	Shrub/Tree	Kalgo	NA	DO, DA, KP, NA, SH
Sida acuta Burm. F.	Malvaceae	Forb	Wire weed	NA	GB, KU, DO, DA, NA, MA, RA, SH
Solenostemon monostachyus (P. Veauv.) Briq.	Lamiaceae	Forb	Tùmúƙùn bírí	NA	GB, KU, DO, DA, RA, SH
Hyparrhenia involucrata Stapf.	Poaceae	Grass		NA	DA, NA, MA, RA, KP, MY
Mariscus alternifolius Vahl	Cyperaceae	Sedge		NA	GB, KU, SH, MY

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Dominant Species Encountered	Family Name	Habit	Common Name (Local name)	IUCN Status	Communities
Hyptis suaveolens	Lamiaceae	Shrub	Jogbo	NA	GB, KU, DO, DA, NA, MA, MY, SH
Cleome viscosa	Cleomaceae	Shrub	Miya	NA	GB, KP, DO, DA, NA, MA, RA, SH

IUCN – International Union for Conservation of Nature; NA – Not Assessed
Gbangba (GB), Sheshimandiko (SH), Kuchitagi (KU), Dakpan (DA), Dokogi (DO), Nakoko-Siyidi (NA), Ragidda Hausawa (RA), Mashigi (MA), Mayaki (MY), Kpanje (KP)
Source: EnvAccord Field Survey, 2020

4.3.6.2 Fauna Species

The methodology used in identifying the terrestrial fauna species within the Project site includes direct sighting, sound, nest type, and foot prints. The fauna species observed at the sites were generally few and mostly small invertebrates such as earthworms, insects, Grasshoppers, Butterflies, spiders. Also, vertebrates such as Lizards, birds, and rodents were sighted within the Project sites and AoI.

4.4 Socio-Economic and Health Studies of the Study Areas

4.4.1 Introduction

This section provides information on the socio-economic and health conditions of the beneficiary communities of the Engie Fenix Nigeria solar mini-grid projects. The baseline information obtained from the communities describes the existing conditions, essential for the identification and assessment of the potential impacts of the Projects. The study also assessed the gender-based issues, ranging from gender roles and gender-based violence within the study areas.

4.4.2 Study Methodology

An extensive literature review was conducted from relevant published and unpublished materials including the census documents of the National Population Commission (NPC), local literature, United Nations documents, World Bank resources, and other research specific to the Project area. The survey also involved observational methods wherein notes were taken on the ongoing activities observed in each community. This method was used to obtain real-time qualitative data and studying the current status of the socio-environment.

This study also makes use of mixed-methods; by using a quantitative and qualitative approach to collect data. Questionnaire administration was used to assess the socio-economic and health of residents in selected households of all the beneficiary communities, meaningful consultations were conducted with relevant stakeholder groups in form of Focus Group Discussions (FGDs) with the women, men and youths, Key Informant Interviews (KIIs) were held with the leader of the beneficiary communities, in-depth interviews with the healthcare practitioners available in some of the communities were also conducted. A purposive sampling approach was

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adopted as respondents and group discussion participants were selected based on their community residency and longevity within their respective community.

4.4.2.1 Sampling Size and Sampling Technique

The socio-economic baseline data gathering exercise was conducted in all the ten (10) beneficiary communities. For sampling purposes, since there were no reliable census data for the beneficiary communities, the Cochran sampling formula was adapted as it can be used to determine sample size from an unknown population. The Cochran sampling formula is presented below.

$$\boldsymbol{N} = \frac{Z^2(p * 1 - p)}{e^2}$$

N is the number of sample size.
Z is the standard normal deviation set at 95% confidence level
p is the (estimated) proportion of the population which has the attribute in question
q is 1 – p
e is the desired level of prevision or the margin of error

$$\boldsymbol{N} = \frac{(1.96)^2 * (0.5) * (0.5)}{(0.05)^2}$$

$$\boldsymbol{N} = \frac{0.9604}{0.0025}$$

N (Sample Size) = 384 respondents

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Also, the purposive sampling recognised a respondent to represent each sample household in each community. The respondent could be the head of the household or a household member who is more than 18 years in age.

4.4.3 Coverage Areas

Each of the community was divided into 10 clusters, with each cluster covering elements known as households. Each of the clusters was treated as a unit of sample where a random selection of households was conducted. Due to the relative homogeneity of the communities in terms of language, religion, livelihood activities, culture, customs and household settings, an average of at least 3 households were sampled per cluster. However, the number of sampled households varied within the communities based on field observations of the population densities within each community.

In Dokogi, Gbangba, Sheshimandiko, and Kuchitagi communities; 35 households were sampled within the clusters in each community. 40 households were sampled in Mashigi, Ragidda Hausawa, and Dakpan communities; and 46 households were sampled in Mayaki community. In Nakoko Siyidi, a much larger community, 50 households were sampled while only 30 households were sampled within Kpanje community. Table 4.40 shows the breakdown of sampled households in all clusters at each community.

Table 4.40: Pattern of Sampled Household for the study

S/N	Communities/Village	Sampled Households in all Clusters
1.	Dokoji	35
2.	Gbangba	35
3.	Mashigi	40
4.	Nakoko-Siyidi	50
5.	Sheshimadiko	35
6.	Ragidda Hausawa	40
7.	Dakpan	40
8.	Kuchitagi	35
9.	Mayaki	46
10.	Kpanje	30
	Total Households sampled	**384**

In total, 384 questionnaires were purposively administered across the ten (10) communities. The questionnaires were administered using the Computer Assisted Personal Interview (CAPI), a KoboToolBox Software using smartphones with the support of competent survey enumerators. The interview data were collected through a digital audio recorder and stored in a central database for real-time quality control and analysis. The use of CAPI software and digital recorder allowed the survey enumerators (Social Experts) to minimize errors, monitor and organize the data gathering process efficiently. Plates 4.2 to 4.11 show sample pictures taken during the baseline surveys at the communities.

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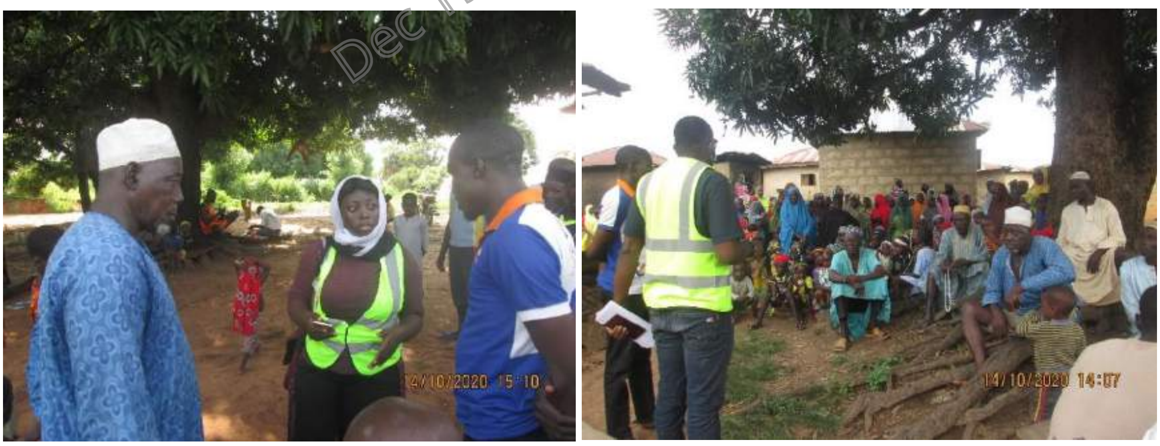

Plate 4.2: Community Engagement in Dakpan Village
Source: EnvAccord Field Survey, 2020

Plate 4.3: Community Engagement in Dokoji Village
Source: EnvAccord Field Survey, 2020

Plate 4.4: Community Engagement in Gbangba Village
Source: EnvAccord Field Survey, 2020

Plate 4.5: Community Engagement in Raggida Hausawa Village
Source: EnvAccord Field Survey, 2020

Plate 4.6: Community Engagement in Kuchitagi Village
Source: EnvAccord Field Survey, 2020

Plate 4.7: Community Engagement in Masheyi Village
Source: EnvAccord Field Survey, 2020

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Plate 4.8: Community Engagement in Nakoko Sidiyi Village
Source: EnvAccord Field Survey, 2020

Plate 4.9: Community Engagement in Sheshimandiko Village
Source: EnvAccord Field Survey, 2020

Plate 4.10: Community Engagement in Kpanje Village
Source: EnvAccord Field Survey, 2020

Plate 4.11: Community Engagement in Mayaki Village
Source: EnvAccord Field Survey, 2020

4.4.4 The Baseline Report Structure

In line with the social framework for projects developed by Smyth and Vanclay in 2017, the socio-economic baseline report is structured as follows:

- Overview of key socio-economic indicators
- Demographic Profile
- Administrative and socio-cultural institutions
- Livelihood Assets and Activities
- Infrastructure and Services
- Housing, Business Structures and Settlement Patterns
- Land Acquisition
- Health Profile
- Gender Assessment
- Community Concerns, Perceptions and Expectations

4.4.4.1 Overview of Key Socio-Economic Indicators

According to the data presented by the World Bank, Nigeria is Africa's most populous country with a 2020 population estimate of 202 million people based on a population growth rate of 3.2% per annum (NBS, 2018). The UN Department of Economic and Social Affairs (2018) projected that Nigeria will add 189 million to its current population between the years 2018 and 2050. Approximately 51% of the national population is male while 49% are female (Nigeria Bureau of Statistics, 2019). Nigeria is a multi-ethnic country with socio-cultural differences among its component ethnic groups all of which have resulted in cultural dissimilarities. Although the major ethnic group can be categorized into Hausa, Igbo and Yoruba, each manages a separate geographical location distinctive from another. These cultural dissimilarities have been manifested by the differences in culture which include language, diet, dress and choice of social system. Table 4.41 shows key socio-economic indicators for Nigeria.

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Table 4.41: Key Socio-economic Indicators for Nigeria

Socio-economic Indicators	National Level	Source
Population (m)	208 million (2020)	World Population Review https://worldpopulationreview.com/countries/nigeria-population
Population growth rate	2.58% (2017)	World Population Review, 2020
Life expectancy (Years)	53.9 (2017)	UNDP Human Development Report 2018 http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/NGA.pdf
HDI Index Value	0.532 (2017)	UNDP Human Development Report 2018 http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/NGA.pdf
Religion	Christianity 46.3% Muslim 46% Traditional 7.4% Others 0.3%	ACS ITALIA https://acs-italia.org/wp-content/uploads/Nigeria.pdf
GDP per capita	USD 6,030.4 (2018)	IMF: World Economic Outlook http://nigeria.opendataforafrica.org/pjeqzh/gdp-per-capita-by-country-statistics-from-imf-1980-2023?country=Nigeria
Inflation rate (%)	11.61 (October 2019)	Central Bank of Nigeria https://www.cbn.gov.ng/rates/inflrates.asp

Socio-economic Indicators	National Level	Source
School enrolment, primary	25,591,181 (2016)	Nigeria Education Indicators https://www.nemis.gov.ng/downloads_fold/Nigeria%20Education%20Indicators%202016.pdf
Adult Literacy rate (15 years and above) (%)	61.3 (2010)	UNESCO Institute of Statistics http://www.uis.unesco.org/literacy/Documents/UIS-literacy-statistics-1990-2015-en.pdf
Proportion of total population served with piped water (%)	55.7 (2013)	UNODC Water Supply Statistics, 2013 http://nigeria.opendataforafrica.org/cxwlolg/water-supply
Estimated adult rate (15-49) of people living with HIV/AIDS (%)	3.2 (2014)	UNAIDS http://data.worldbank.org/indicator/SH.DYN.AIDS.ZS

***The Human Development Index (HDI) is a summary measure of human development. It measures the average achievements in a country in three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living**

4.4.4.2 Demographic Profile

- *National Profile*

Nigeria population is experiencing exponential growth with an annual growth rate of 2.58%, making it the 27th fastest growing population in the world (World Population Review, 2020). The current population of Nigeria is 208 million, based on projections of the latest United Nations data, making her the largest population in Africa. It was estimated that 51% of the population lives in an urban area, while 49% lives in a rural area. Approximately 51% of the national population is male, against 49% female. Nigeria is a multi-ethnic and cultural society with diverse languages such as Hausa, Yoruba, Igbo, among others.

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- *Niger State and LGAs Profile*

Niger State is located in the Middle belt region of Nigeria and is recognised as one of the largest states in Nigeria with regards to its landmass which is approximately 68,925 km^2 (NBS, 2010). The capital of the state is Minna. Aside from Minna other urban areas in the state include Bida, Suleja and Kontagora. There are three major ethnic groups in the state, Nupe, Gbagyi, and Hausa; other tribal groups include Kadara, Koro, Baraba, Kakanda, GanaGana, Dibo, Kambari, Kamuku, Pangu, Dukkawa, Gwada and Ingwai. The State also has numerous settlers from other parts of the Country (Niger State Bureau of Statistics, 2011).

According to the National Population Commission (NPC), the 2006 census puts the population of the State at 3.9 million people. Using the population growth rate of 2.58% for Nigeria (World Population Review, 2020), the 2020 projected population of the State is approximately 5.7 million people. Additionally, the Housing Census of the same year (2006) stated that Niger State is made of 2,004,350 males and 1,950,422 females while the 2020 projected figures are approximately 2.9 million males and 2.7 million females. The age distribution within Niger State is skewed towards young and economically active people; 50.3% are within the age group of 15-64 years and 47% are within the age group of 0-14 years.

The population of Gbako LGA in 2006 was 126,845 comprising of 63,871 males and 62,974 females. The LGA occupies a total of 1,671 km^2 (National Population Commission, 2006). Based on the population growth rate of 2.58% (World Population Review, 2020), the 2020 population for the LGA is 182,028 comprising 91, 658 males and 90,370 females.

The population of Mashegu LGA in 2006 was 215,197 comprising of 107,909 males and 107,288 females. The LGA occupies a total of 8,763 km^2 (National Population Commission, 2006). Based on the population growth rate of 2.58% (World Population Review, 2020), the 2020 population for the LGA is 308,818 comprising 154,854 males and 153,963 females.

- *Marital Status*

In Nigeria, marriage is mostly regarded as a union of a man and woman. However, in some regions, marriage of a man to more than one woman is acceptable. According to the 2018 Nigeria Demographic and Health Survey, 70% of women and 57% of men within the age range of 15 – 49 are currently married. About 31% of married women in Nigeria reported that their husbands had multiple wives. The median age at first marriage among Nigerian women is approximately 19 years. Men marry later than women, with the median age at first marriage being 27.7 years. By the age of 45 – 49, only 2% of both women and men have never been married. Overall, women in Nigeria are more likely than men to be divorced, separated, or widowed. Women are less likely to be single, with only 25% of women and 42% of men have never been married (Nigeria Demographic and Health Survey, 2018).

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Marital data in Niger State is mostly unavailable, however, the NBS Annual Abstract Statistics provided that 78.5% of Niger State populations are married, 0.2% are divorced, 0.4% separated, 0.5% are widowed and 20.6% never married (National Bureau of Statistics, 2012). Disaggregated marital data by local governments in the state are not readily available.

- *Culture, Ethnicity and Religion*

Nigeria has over 250 ethnic groups; the most populous and politically influential are: Hausa and the Fulani 30%, Yoruba 15.5%, Igbo (Ibo) 15.2%, Ijaw 1.8%, Kanuri 2.4%, Ibibio 1.8%, Tiv 2.4% and others 24.7%. There are over 500 indigenous languages spoken in Nigeria but the most populous ones are Igbo (Ibo), Hausa, Fulani and Yoruba. English is the official spoken language in Nigeria. The most predominant religion in Nigeria is Christianity and Islam although there are also few traditional worshippers and atheist; Muslim 53.5%, Roman Catholic 10.6%, other Christian 35.3%, other 0.6% (The CIA World Factbook, 2020).

The people of Niger State are predominantly Muslims and Christians with very few Traditional Religionists and Atheists. There are more than fifteen different ethnic groups, each having its peculiar cultural affiliations, but the major ethnic groups in the State are; Nupe, Gbagyi, Fulani/Hausa. The minority indigenous tribes are the Dibo, Kakanda, Kupa and Zhitako in the two Nupe Emirates of Agaie and Lapai; Kambari and Dukawa in Kontagora Emirate; Kadara in Minna Emirate; and Fulani, Bissan, Laru and Bundawa in Borgu Emirate. Ethnic settler communities are very few in Niger State (Muhammad, 2012).

- *Migration Status and Patterns*

The current net migration rate for Nigeria in 2020 is -0.295 per 1000 population, a 2.64% decline from 2019 (MacroTrends, 2020), revealing that more people are leaving Nigeria than the number of people entering. This, however, can be attributed to several factors such as political environment, general economic situation and outlook, labour force participation and market dynamics, income and productivity, unemployment challenges, poverty and insecurity (International Organisation for Migration, 2016).

In Niger State, historical migration was evident. People moved from one territory to another for several reasons such as farming, grazing: especially the Fulani cattle herders, seekers of economic opportunities. However, land remains a crucial factor in understanding the patterns of migration among the people of Niger State. Often due to drought and change in weather conditions, farmers migrate, along with their families another pastoral land to cultivate food and cash crops (Muhammed, 2014).

- *Crime and Security*

Crime Statistics on reported offenses reflected that a total of 125,790 cases were reported in 2016. Offense against property has the highest number of cases reported with 65,397 of such cases reported. Offense against persons recorded 45,554 cases reported while offense against lawful authority and local acts recorded the least with 12,144 and 2,695 cases recorded respectively (National Bureau of Statistics, 2017).

The National Bureau of Statistics reported different offenses committed within Niger State. More than 528 offenses against persons e.g. murder, manslaughter, infanticide, concealment of birth, rape and other physical abuse are recorded; more than 1,083 offenses against properties of any kind such as stealing, receiving stolen properties, obtaining property by pretense, robbery, burglary and housebreaking are recorded and about 53 offenses against lawful authority are recorded. Unlike other states in the North Central region of Nigeria, Niger State has a large share of the percentage (1.41%) of offenses recorded (National Bureau of Statistics, 2017).

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- *Vulnerable or Marginalized Groups*

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

Within the beneficiary communities, vulnerable groups can be identified as old people, women of low economic status and those who are made ordinary housekeepers and are not permitted to engage in trading or any other business activities. Female-headed households who may not be able to afford to pay for the solar service due to financial constraints. Children, especially those trapped in the *Almajiri System*.

4.4.4.3 Community Profiles

- *Nakoko Siyidi*

Nakoko Siyidi village was founded about thirty-six (36) years ago, according to the Village leader. The current settlement was initially owned by the Kao Village, the neighbouring village. The members of Nakoko village, about 36 years ago seek permission to settle in the area within the boundary of Kao village. The Kao village head and their council granted permission to stay and asked the Nakoko people to move around the territory and choose a comfortable area for their settlement. The Nakoko people are a collection of different people from different areas, who settle in the village for different purposes; some came as farmers, some as traders, others came when they realized that the area is habitable. Interviews with the village leader and members indicate that the people of Nakoko village settled in their present settlement about 36 years ago. The village head, Usman Mohammed was chosen shortly after the people were fully settled in the area. Usman Mohammed was one of the founding members of the village and the only village head to have emerged. He has been living in the area since inception and stands as the local administrative head who settles internal conflict. The maintenance of law and order in the village falls on the shoulders of the village leader. The current village head as the time of the baseline is Usman Muhammed.

As noted during the baseline survey, the households in the village are living relatively peacefully, which denotes a strong communal relationship among the inhabitants. The village has not experienced any communal or internal conflict since their settlement in the area.

During the baseline survey, 74.8% of the respondents were males while 25.2% were females. It was observed that married women often spend a lot of their time in the house, and are restricted from engaging with strangers, especially men. However, to

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reduce gender disparity during the survey, a female social scientist was involved to manage survey activities related to women in the community.

According to the data collected during the KII and baseline survey, the community is composed of Nupe, Hausa and Fulani ethnic groups. The prevalent religion in the community is Islam, 100% of respondents identified as Muslims. With regards to educational attainment in the village, 22.50% had primary school education, others had no formal education. In summary, the literacy level of the village is low.

As at the time of the survey, about 96% of the respondents were self-employed, the majority are into farming while others are involved in petty trading. All respondents have spent more than ten (10) years in the village. This suggests that the respondents have a good knowledge of the village. The baseline data further showed the marital status, about 77.50% were married, 22.5% identified as single.

- *Dokoji Village*

Dokoji Village is a remote village where the residents are majorly farmers and traders. The current village head is Muhammed Muhammed. The first settlers in Dokoji village migrated from Apofu, an area in Edati local government. The early settlers were rice farmers, who came to the area to farm due to the village's proximity to a river. Before their settlement, the people had been making use of the area for their rice farming and often resided in the area to cultivate their farmland. The decision to settle in the area was reached and they migrated their families to the area. The proximity to the river made the settlers fishermen. However, farming is the major livelihood activity in the village, involving about 80% of sampled household members. Farming tools and equipment are basic as they still make use of cutlass and hoes in addition to other farming instruments. Farming is a year-round activity and is predominantly practiced by men. Common types of farm produce are rice and millets.

Demographic characteristics of this village as obtained using the analysis of the baseline survey showed that male respondents are openly available to interact with strangers as most of the respondents, approximately 84% were males while 16% were females. The religious and cultural beliefs of this village limit women, especially married women, to housekeeping and other household engagements. Interactions with other men within the village especially with strangers are restricted. This, however, explains the gender disparity in the baseline study. Also, the age of the respondents is skewed towards economically active people; only 3% are above 60 years, others are within the age range of 18 – 50 years old. The ethnic composition of the village comprises of Nupe, Hausa and Fulani ethnic groups. This shares similarity with several other communities in Niger State. The prevalent religion in the community is Islam, 100% of respondents identified as Muslims.

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Educational attainment is very low in this village, respondents have only attained either Islamic education, mainly Arabic and Koran study, or primary school level of education. This lack can be attributed to the distance of the village to the urban areas. As discussed during the engagements with some members of the village, most children spent time with their fathers on their farmlands. In summary, the literacy level of the village is very low.

All respondents are into agricultural activities, either farming and processing of farm produce to both. Adolescent girls were observed as petty traders. All respondents have spent more than ten (10) years in the village. This suggests that the respondents have a good knowledge of the village. The baseline data further showed the marital status, approximately 80% were married, 20% identified as single.

- *Gbangba village*

During the interview with the village head, it was gathered that the village was established by the Alhaji Ibrahim Ndaisa many years ago. Alhaji Ibrahim, a farmer who migrated from an area in Edati local government. The village head, Alhaji Ibrahim Mahmood attained the position through lineage inheritance.

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According to the data collected during the KII and baseline survey, the community is composed of Nupe, Hausa and Fulani ethnic groups. The prevalent religion in the community is Islam, 100% of respondents identified as Muslims. With regards to educational attainment, the village shares similar characteristics with Dokoji Village. Most of the respondents have attainment primary school education while others had no formal education. In summary, the literacy level of the village is low.

During the baseline survey, 69.5% of the respondents were males while 30.5% were females. It was observed that married women often spend a lot of their time in the house, and are restricted from engaging with strangers, especially men. The common ethnic group in the village is the Hausa ethnic group. The prevalent religion in the community is Islam, 100% of respondents identified as Muslims. The literacy level in the village is low. This due to the education attainment where the majority have only acquired a primary school level of education.

All respondents are self-employed either in farming, processing of farm produce, or trading. It was observed that the processing of farm produce is a major activity of women in the village. All respondents were indigenes of the village and have spent more than ten (10) years in the village, suggesting that the information obtained is reliable. Also, 100% of the respondents are married. The age composition is skewed towards the economically active people, 65% are within the age range of 25 – 50 years while others are 50 years above.

- *Kuchitagi Village*

The interview with the village head, Muhammad Kotsu, revealed that the village was established about 700 years ago. The position of the village head is not by appointment, nor democratic election, there is already a family whose only lineage has been appointed as the village leader. The ruling village head inherits the position when his father is deceased. Farming is recognised as the common livelihood activity in the village, majorly practiced by men. On the other hand, women are often restricted to housekeeping activities due to the culture, tradition and religious belief common among the people of the village.

According to the data collected during the KII and baseline survey, the community is composed majorly of Hausa and Fulani ethnic groups. The prevalent religion in the community is Islam as all respondents identified as Muslim. In summary, the literacy level of the village is low. A large percentage of respondents have no formal education with only 15% of respondents attained primary school education.

During the baseline survey, 54% of the respondents were males while 46% were females. Women, especially married women are often restricted to housekeeping while the men are economically active and involve in daily activities within the village. All respondents are self-employed either in farming, processing of farm produce, or trading. All respondents were indigenes of the village and have spent more than ten (10) years in the village, suggesting that the information obtained is reliable. All sampled women are married while 15% of men are single. The age composition is skewed towards the economically active people, 42% are within the age range of 18 – 40 years while others are 40 years above.

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- *Dakpan Village*

This is a remote rural village in Gbako LGA, which is almost exclusively inhabited by Nupe, Fulani, and a few Hausa people, all of whom are predominantly Muslims. During the interview, it was stated that the village has been established hundreds of years ago, however, the village head could not provide an estimate of the number of years. The village head, Alhaji Adamu Yakubu became the village head through inheritance from his father. The village head settles internal conflict that may arise among the neighbouring families.

The survey data revealed that respondents who are married carried a significant percentage; 76% of the respondents are married while 24% are single. Data from the household survey further indicate that about 92% of the household members were within the age group of 31-45 years. Majorly, the community contains people between 20-64 years which comprises most of the workforce. Thus, implying that community is filled with economically active people who can be put to work. All the household members who were surveyed for this study were self-employed, with 40% engaged in farming activities of cash crops. Some houses in this village were modern (built with plastered cement blocks and corrugated aluminium roofs) while some were built with mudbricks.

The level of education in this community is low with only 7.14% of the survey respondents had a primary school education, the 92.86% had training from Arabic school and no other formal education. Women, especially married women were rarely found outside; during the process of the household survey, the village elders had to accompany the interviewers to the abode of the women, where they were interviewed.

- *Sheshimandiko Village*

Sheshimandiko Village is a remote rural village in Gbako LGA. During the interview with the village head, Mohammadu Sheshi, it was revealed that the village has been established many years when their forefathers migrated into the area. The purpose of the migration was to stay close to their farmland and manage their agricultural produce. The village, having established many years has never had a female village head, this can be attributed to the restriction of women to only domestic roles.

Demographic characteristics of this village as obtained using the analysis of the baseline survey showed that male respondents are openly available to interact with strangers as most of the respondents, approximately 87% were males while 13% were females. The age composition of the baseline study is skewed among economically active people; only 8% are above 60 years, others are within the age range of 18 – 59 years old. The ethnic composition of the village comprises of Nupe and Hausa ethnic groups. The prevalent religion in the community is Islam.

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Educational attainment is very low in this village, respondents have only attained either Islamic education, mainly Arabic and Koran Study, or primary school level of education. The literacy level of the village is generally low. All respondents are into agricultural activities, either farming and processing of farm produce or both and have spent more than ten (10) years in the village, suggesting that the respondents have a good knowledge of the village. The baseline data further showed that all respondents are married.

- *Raggida Hausawa Village*

This remote village is largely dominated by the Nupe and the Hausa people. The history of the village was simple, their forefathers settled in the village to cater to their agricultural farmland. The year of the village establishment was unknown, but the village head provided an estimate of over 100 years. The livelihood of the village members is largely agriculture. Farmers plant rice, millet, guinea corn and sometimes maize. The farmers possess large farmland and their cultivation is not only for subsistence, but they also sell their farm produce in large quantity as buyers do come to their village.

The village head, Umaru Marafa settles internal conflict that may arise among the neighboring families. Marital status in the data shows that 71% of the respondents are married while 29% are single. This means that the community is filled with economically active people who can be put to work. The level of education in this community is very low that none of the respondents had attained beyond primary school education. All the household members who were surveyed for this study were active farmers who specialize in rice, corn and other farm produce. Also, polygamy is highly practiced in the village.

The age distribution shows that 94% of the village members were within the age group of 31-45 years. All the household members who were surveyed for this study were self-employed, all engaged in farming activities.

- *Mashigi Village*

Mashigi Village is a remote village with dual economic activities: agriculture and trading. The village has a market primarily occupied by the village members while most of the landed area is used for agricultural activities. Cattle grazing was observed in the village. The ethnic groups in the village are Fulani, Hausa and Nupe, who are designated as the minority. The village is dominated by Muslims as no other religious activities were observed during the baseline study.

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All respondents are married. The village is filled with agile, able-bodied men who are economically active. Most of which are already engaged in farming activities. The level of education in this village is very low that none of the respondents had attained beyond primary school education. The age distribution shows that 78% of the village members were within the age group of 20-45 years.

- *Kpanje Village*

This village was created through the unity of three villages: Kpanje, Warashiri and Koshifiyi villages. Within the Kpanje village, the common livelihood activities are farming and fishing, and the fishing activities takes place in a river called Elo River located outside the village. The village is well known for rice farming and production. The village head, Aliyu Usman, stated during the KII that different people come to the village to buy their farm produce, especially rice.

Demographic characteristics of this village as obtained using the analysis of the baseline survey showed that male respondents are openly available to interact with strangers. The gender distribution of the respondents was approximately 91% males and 9% were females. The age composition of the village is distributed majorly among economically active people; only 12% are above 60 years, others are within the age range of 18 – 59 years old. The ethnic composition of the village comprises of Nupe and Hausa ethnic groups. The prevalent religion in the community is Islam.

Educational attainment is very low in this village, respondents have only attained either Islamic education, mainly Arabic and Koran Study, or primary school level of education. The literacy level of the village is generally low. All respondents are into agricultural activities, either farming and processing of farm produce or both. All the sampled households' members have spent more than ten (10) years living in the village, suggesting that the respondents have a good knowledge of the village. The baseline data further showed that all respondents are married.

- *Mayaki Village*

This is a remote village comprising of mostly farmers, and a few farm produce traders. The current village head is Haruna Musa. The major livelihood activity common among the village is farming, and the survey data revealed that over 80% of village men are farmers. It was observed that the farmers cultivate large expanse of land using crude farming tools and equipment such as cutlass and hoes. Family members and village friends provide support in cultivating the farmland.

The village head is responsible for administrating the affairs of the village, including conflict resolutions within the community. Respondents who are married carried a significant percentage during the survey when compared with the unmarried respondents. About 81% of the respondents are married while 19% are single. Polygamy is highly practiced in the village. Members of the village are agile and economically active who can be put to work. The level of education in this village is low with only 12 respondents mentioned that they have a primary school education, others have no other formal education. All the household members who were surveyed for this study were active farmers.

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Data from the household survey further indicate that about 92% of the household members were within the age group of 20-45 years. The village contains people between 20-64 years which produces most of the workforce. Most of the houses are old, mud houses. However, some houses are plastered and covered with corrugated aluminum roofs.

4.4.4.4 <u>Administrative and Socio-Cultural Institutions</u>

- *National*

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

- *Niger State and LGAs*

Niger State, which has her capital as Minna, comprises 25 local government areas. The administrative settings of the state comprise of a democratically elected governor, whose tenure expires every four (4) years along with the deputy governor, and an executive council consisting of honourable commissioners of different ministries chosen by the governor and head of service. The state has three senate members representing three zones: Niger South, Niger North and Niger East. There are ten (10) members of the house of representatives from ten (10) constituencies in Niger State.

There are twenty-five (25) elected local government chairmen in Niger State managing the administrative duties in their respective local government. As of 2020, Gbako LGA is chaired by Hussaini Lemu; and Mashegu LGA is chaired by Shuaibu Haruna Kulho.

In Niger State, there is an Emirate traditional administrative structure headed by the Emir, who owns the responsibility of making laws, enforcing and maintaining peace and order in the Emirate. The Emir, usually male administers the emirate following provisions of the Islamic and Sharia laws and assisted in the administration of the emirate by several advisers such as *Waziri, Galadima, Madaki, Dogari, Maaji* and the *Sarkins*. For an effective administration, the emirate is divided into districts with each district headed by the *Hakimi*. The *Hakimi* appoints his village heads who help maintain law and order in the village and collection of taxes.

- *Traditional Governance in Project Areas*

Traditional leadership remains a strong and respected structure in rural and urban areas of Niger State. The powers of these traditional leaders are still much relevant and respected. The ceremonies and authorities that surround these positions remain strong, and these leaders retain significant influence over their people. In all the studied beneficiary communities, there is an established leadership structure that in line with the Emirate system. The village head, usually male, is the administrative head who settles internal conflict and upload the law and order. The village head reports directly to the Hakimi, also known as the district head. Cases that cannot be settled by the village head are transferred to the district head. The established structure is that instructions and authority move downward, from the Emir to the village head while, in most cases, although rare, the cases move from the Dagachin, the village head to the Emir (Figure 4.19).

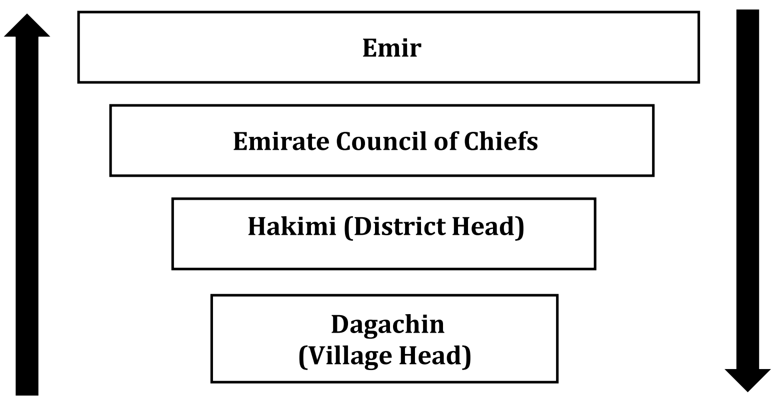

Figure 4.19: Typical traditional administrative system in Niger State

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- *Community-based Organisation and Other Local Institutions*

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

In all the beneficiary villages of study, the most prevalent groups are the youths, farmer groups and fishermen. Interviews with women in the communities further revealed that women groups are rare, as they mostly confined within the walls of their residence. The Focus Group Discussions (FGDs) with women held across all the villages revealed that no women association specifically caters to women's needs in any of the villages. However, women sometimes bond together and support each other, especially in an extended and polygamous family.

- *Social Conflict*

Social conflict is friction in human interaction and can threaten social relationships, especially among rural dwellers who have come to cherish their engagement and interactions. A conflict is a form of social interaction in which the actors seek to obtain a scarce reward by eliminating or weakening other contenders. During the baseline survey, it was recorded that there are no existing conflicts within any of the villages under study. There are similar structures of conflict resolution in the respective villages. The village heads resolve domestic and minor conflicts within their jurisdictions. Whenever the disputes go beyond the control of the village heads, the case will be transferred to Hakimi, the District Head. However, when the Hakimi cannot successfully manage the situation, the Emirate council of chiefs will be involved. When the case does not warrant the Emir's attention, the case will be transferred to the Niger State Police command. In all the villages, there are no security posts such as Police Stations and the villages are remote, at a far distance from the urban area.

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4.4.4.5 <u>Livelihood Assets and Economic Activities</u>

- *National and State Profile*

Nigeria stands as one of the largest economies with Egypt and South Africa. In 2019, the country could boost of N16.9 trillion GDP. However, in the second quarter of 2020, the real GDP dipped by 6.1% to N15.9 trillion. The economy is driven by manufacturing, financial, service, communications, technology, entertainment, agriculture, and oil sectors. Currently, Nigeria's economy is not among the fastest-growing economies in Sub-Saharan Africa (SSA) by percentage growth in GDP. Diaspora remittances continue to support the country's economy with an estimate of

$25billion sent to the country by Nigerians in diaspora in 2018. Reduced oil demand in the global market, the struggling production supply, unstable oil prices are projected to impact the economy's growth trajectory due to the fact that oil revenue has been the country's main source of foreign exchange earnings and government financing (PricewaterhouseCoopers, 2020).

Niger State's economy is driven largely by agriculture, manufacturing and commerce. The state has a strong informal sector, with numerous MSMEs across all economic activities. Rice, cotton, yam, guinea corn (sorghum), and ginger are the major agricultural products. The economy also supports cattle trading, brewing, shea nut processing and gold mining. There are traditional industries and crafts including leatherwork and metalworking.

- *Projects Areas*

Agriculture: Farming is the major livelihood activity in all the ten (10) villages, involving more than 80% of residents. The farming tools and equipment are still somewhat crude with the use of cutlass and hoes, family and friends' support on the farmland during cultivation. Farming is a year-round activity and is predominantly practiced by men who are also involved in the selling of farm produce in the market. Common types of farm produce are beans, rice, soya beans, cabbage, guinea corn and other farm products. The farmers practice both the subsistence and commercial types of farming, depending on the size of land and quantity of produce. Participants at the town hall meetings in villages like Kpanje, Sheshimandiko and Dokoji mentioned that farming as a livelihood activity can be somehow affected by the unfavourable weather conditions and flooding. However, farming activities has been largely successful and served as a means of livelihood for many people in the communities in the past. Farmers do make use of fertilizers and irrigation methods during the planting season. All the participants of the town hall meetings held across the villages mentioned that farming activities are conducted on different scales, those with large farmland close to the river often plant rice. Additional contributions indicated that farming activities are largely dependent on the weather condition.

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Trading: Petty trading is a major activity in the villages, even though most of the villages, aside from Mashigi, have no central market. Usually, the traders sell their goods in the stores located in a set of mud houses used as shops. Trading involves the sale of daily household needs. Owing to the cultural nature of northern Nigeria, men are mostly involved in the day-to-day business while young girls between ages 5 and 14 years' hawk varieties of household items and perishable goods.

Formal Employment: There is little information available regarding formal employment in the study area. Based on field observations and responses from the town hall meetings, it can be deduced that government schools and healthcare centers are the only formal employment in some selected villages such as Dakpan village.

Income Levels: In all the villages, there are similar livelihood characteristics, farming and trading. Meanwhile, income levels are different. In Figure 4.20 shows the monthly income estimate provided by respondents in the respective village, revealing the income differences among the villages.

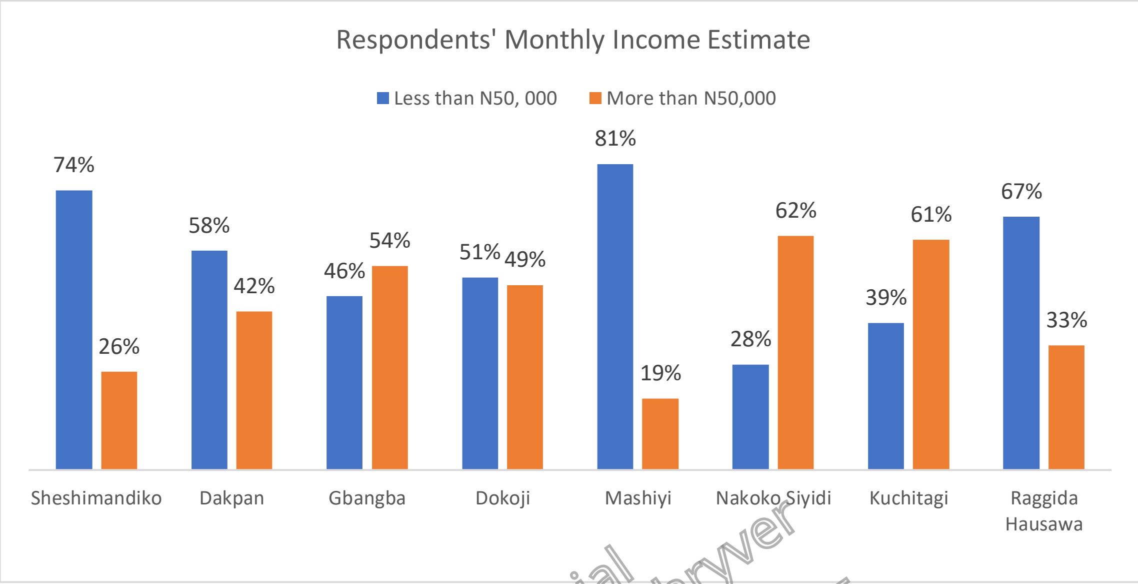

Figure 4.20: Monthly income estimate of respondents in all villages
Source: EnvAccord Field Survey, 2020.

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4.4.4.6 <u>Community Infrastructure and Services</u>

- *Electricity*

All the villages are non-electrified cluster areas in Niger State, i.e. the villages are not connected to the national grid. During the interview with the villages' heads and town hall meeting with the members of the villages, they expressed the desire to have their villages electrified, either through the alternative electricity supply or the national grid. Some of the villagers do make use of generators to power their homes and machines.

- *Access to Potable Water*

Within the villages, there are no government-owned boreholes or water supply facilities. However, the village members within their capacity have erected boreholes in their respective villages to create access to water. These boreholes are powered by petrol-fuel generators. For usage, members of the villages are charged N10 for a 50kg gallon of water. Some members do transport themselves to another village to access water. Hand-dug wells were observed in some villages such as Dakpan, Gbangba and Raggida Hausawa. In Dokoji village, a borehole was erected to be used for irrigation and other household water accessibilities or whenever water is scarce. Table 4.42 and Plate 4.12 and 4.13 shows the type of water access available in the villages.

Table 4.42: Water access in each of the communities in the study area

S/N	Villages	Type of Water Accessibility	
		Hand-dug well	**Community-owned borehole**
1.	Dakpan		
2.	Gbangba		
3.	Raggida Hausawa		
4.	Dokoji		
5.	Kuchitagi		
6.	Mashigi		
7.	Nakoko Sidiyi		
8.	Mashigi		
9.	Kpanje		
10.	Mayaki		

Source: EnvAccord Field Survey, 2020

Plate 4.12: Showing pictures of water resources available in each village: A: Dakpan Village; B: Dokoji Village; C: Gbangba Village; D: Raggida Hausawa Village;

Source: EnvAccord Field Survey, 2020

Plate 4.13: Showing pictures of water resources available in each village: E: Kuchitagi Village; F: Mashegi Village; G: Nakoko Siyidi Village; H: Sheshimandiko Village; I: Mayaki Village; J: Kpanje Village.
Source: EnvAccord Field Survey, 2020

- *Telecommunication and Transportation*

The villages are remote and the mobile telecommunication networks are not easily accessible. However, some of the villages do have a 2G network. It was observed that only Kpanje village can boost a 3G mobile network providing access to phone calls and internet access (Plate 4.14). In all the villages, the roads leading to all the villages are narrow and untarred. It was reported that during raining season, the roads are not motorable. Means of transportation observed in the villages are majorly motorcycles.

Plate 4.14: A network transmission station in Kpanje Village
Source: EnvAccord Field Survey, 2020

- *Access to Education*

School blocks were observed in some of the villages such as Gbangba, Dakpan and Sheshimandiko (Plate 4.15). However, education attainment is very low in all villages. Overall, approximately 15% of respondents have attained primary education in all the villages, only 7 respondents among the sampled population in all the villages have been able to attain secondary school and tertiary levels of education.

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Plate 4.15: (A) Primary school block in Dakpan Village. (B) Primary school block in Sheshimandiko Village
Source: EnvAccord Field Survey, 2020

- *Waste Generation and Disposal*

Waste generation in the villages is often a result of the processing of farm produce, disposal of PET bottles for beverages and other liquid substances, nylon for packaging of items, service and trading activities in the market. The survey data and field observation revealed that open dumping and waste burning are the two common waste disposal management in the study areas.

4.4.4.7 Housing, Business Structure and Settlement Patterns

The typical housing structures observed in the villages include huts built with mudbrick and tenement houses built with cement blocks as displayed in Plates 4.12 and 4.13. Some houses are fenced for privacy and protection with mudbricks. There are houses with small windows and some house windows are large enough for proper ventilation. Each house has more than two windows depending on how large the house is built. The aggregated data obtained during the baseline survey showed that 32.7% of the survey respondents are living in houses built with cement blocks; 66.6% are living in houses built with mudbrick and 0.57% are living in houses built with wood planks. None of the project sites has a housing structure erected on it.

All the villages are clustered rural settlements where families live close to each other; their houses are surrounded by fields and farmlands. This layout reflects historical circumstances, the nature of the land, economic conditions and further reveals the local cultural characteristics of the villages. Furthermore, the settlement patterns in the ten (10) villages are compact. Many of the houses are clustered together and are built with mud, bricks and cement blocks. Most houses have corrugated iron sheet roofs and some have thatch. Also, while a few houses are plastered, most houses are not plastered and unpainted. Except for a few, most households in all the villages have no toilet facilities. The spacing between the houses is not uniform and in most cases, they are less than three meters apart (Plates 4.16 to 4.17).

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Plate 4.16: Mud housing Structures and Settlement Patterns in the Study Areas

Source: EnvAccord Field Survey, 2020

Plate 4.17: Cement block housing Structures observed in the Study Areas
Source: EnvAccord Field Survey, 2020

4.4.4.8 Land Acquisition

- *Land Ownership, Tenure and Use*

Land is a key economic and sociological asset especially in developing and agrarian economies such as Niger State. Land, its holding and relations including its control and management are very significant because a majority of the people earn their livelihood from it. Land also serves as a source of materials such as sand, clay and wood for housing and other infrastructural development of the society. Land ownership in Nigeria is subject to a range of diverse cultural and traditional practices and customs. Land ownership can be broadly classified as follows: Community land or land commonly referred to as ancestral land, communal land consisting mostly of under-developed forests, clan or family land that is owned by clans/families, as the name implies, institutional lands, that is, pieces of land allocated to traditional institutions such as traditional authorities and chiefs and individual land: land acquired by an individual, which may be inherited by the immediate family, depending on customary practices.

In the study areas, lands are communally owned, and they can be assigned but not leased nor sold. Lands are kept in the custody of the village heads and most indigenes of their respective village can access land for farm use and erect structures. However, some villages do not sell their land, they can lease to another individual who can put to use of their choice, without conflicting the traditions and cultural beliefs of the villages. Rights over lands are under the authority of the village heads. This makes it imperative that any negotiation to lease or acquire any land for personal, corporate or industrial use should be done through the traditional leadership in the villages, who are in the best position to offer proper guidance concerning land acquisition and use. It was revealed during the KII with the traditional leaders that the village heads do enquire about the intent of land acquisition before giving their support and approval. This is done to protect the village's traditional values from being corrupted by external people. In each village, land for the proposed project was provided by the village heads.

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4.4.4.9 Health Profile

- *National Profile*

The Nigerian healthcare system is organised into primary, secondary and tertiary healthcare levels. The Local Government Areas (LGAs) are responsible for primary healthcare, the State Governments are responsible for providing secondary care while the Federal Government is responsible for policy development, regulation, overall stewardship and providing tertiary care (PharmAccess Foundation Report, 2015).

Nigeria reportedly has high rates of infectious disease, including HIV, malaria, yellow fever, rabies, hepatitis A and E, and meningococcal meningitis; with an HIV prevalence rate of 1.3%. Maternal mortality was estimated in 2017 to be 917 deaths per 100,000 live births (CIA World Factbook, 2020). The WHO reports that in 2004, there were 5.0 hospital beds per 10,000 people (World Data Atlas, n.d.). Nigeria's crude birth rate in 2009 was 40 per 1,000 people, compared to a crude death rate (DR) of 15 per 1,000 people. The total fertility rate in 2009 was 6 births per woman. Only 35.2% of births were attended by skilled health staff in 2013 (World Bank, 2018).

- *Project Areas*

The morbidity pattern of all the villages was not available, this is attributed, majorly to the lack of healthcare facilities and personnel in some of the villages. However, there are primary healthcare centers in Dakpan village, Gbangba and Sheshimandiko villages (Plate 4.18). As observed during the study, these facilities are mostly inadequate and can only serve a limited number of patients at a time.

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People in the villages generally have less access to healthcare than their urban counterparts. There are fewer medical practitioners and a shortage of healthcare facilities in these areas often mean less preventative care and longer response times during emergencies. The lack of healthcare workers can result in the adoption of unconventional ways of addressing healthcare needs, especially through the use of unregulated traditional herbal medicine, along with the unconventional local and cultural approach to healthcare.

The in-depth interviews with the healthcare practitioners in Sheshimandiko and Dakpan (Plate 4.18) revealed that common diagnoses are measles, malaria, cholera and skin rashes. These diseases are prevalent and majorly caused by mosquito bites, poor personal and environmental hygiene among the residents, inadequate food consumption and lack of knowledge on the management of health. During the socio-economic survey, it was established that the communities do not have adequate access to a well-equipped healthcare facility.

Plate 4.18: Interview with the Healthcare Practitioner and the Healthcare Centre in (A) Dakpan and (B) Sheshimandiko Villages
Source: EnvAccord Field Survey, 2020

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4.4.4.10 Gender Assessment

Gender refers to the social, behavioral, and cultural attributes, expectations, and norms associated with being male or female. The social definitions of what it means to be female or male vary among cultures and change over time. Males and females are not homogeneous groups, but are stratified by race, ethnicity, and disability, which together with income level, geographic location, and migratory status, can lead to multiple overlapping layers of vulnerability and discrimination. Gender equality refers to how these factors determine the way in which women and men relate to each other and to the resulting differences in power between them. (World Bank Good Practice Note, 2019).

Gender equality has been identified as one of the development strategies for reducing poverty. Women constitute about 50% of the total population in Nigeria and contribute significantly to national development, particularly in the informal sectors. However, they are the lowest income earners and constitute the highest percentage of the poor and vulnerable. The World Bank, IFC and other Development Finance Institutions (DFIs) are making efforts to ensure that developmental projects should be gender inclusive and gender responsive.

Special attention has been placed on gender equality, especially with regards to including women as major stakeholders in developmental projects. Gender equality which according to Reed *et al* (2010) means, women having the same opportunities in life as men (including the ability to participate in the public sphere), has been identified as a core development objective (Reed, Raj, Miller, & Silverman, 2010). This is because of its capacity to:

- Enhance productivity
- Improve development (especially for the next generation)
- Make institutions more representative

Financial organizations such as World Bank and IFC have therefore adjusted the social analysis framework for development projects to be gender-informed, gender-inclusive, and gender-responsive (World Bank Good Practise Note, 2019). These Gender-related issues include but not limited to:

- The disparity in power,
- Autonomy for decision-making,
- Women empowerment and ability to influence,
- Food security, and access to human and productive resources,
- Disproportionate time use and work burdens,
- Vulnerability to poverty,
- Gender-based violence,
- Sexual exploitation and abuse.

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Gender assessment has found its ground as a tool in the social analysis of developmental projects. This is based on the recognition that due to societal gender disparity and the vulnerability of women, development projects might actually benefit men more than women, or indeed affect the socioeconomic status of women. DFIs such as World Bank and IFC have therefore adjusted the social analysis framework of developmental projects to be more gender-informed, gender-inclusive, and gender-responsive. This adjustment is capable of enhancing projects in the following ways:

- Assessment of project feasibility
- Understanding of the project environment
- Project responsiveness to community needs
- Maximization of project benefits
- Sensitivity to potential project-related risks
- Project implementation efficiency
- Evaluation of project outcomes and impacts

The baseline socioeconomic study of the Engie Fenix Nigeria Mini-Grid Project, therefore, incorporated the involvement of gender assessment with the aid of focus group discussions with women within the communities under the following themes designed in line with World Bank Good Practice Note (GPN):

- **Gender roles and responsibilities**: to examine the expected roles and responsibilities that women are expected to spend time with as it is related to the local communities.
- **Security and health challenges**: to assess the various challenges women experience as related to the local communities.
- **Household patterns of Power and Decision Making**: to assess where the household power lies and women's ability to contribute to decision making
- **Access to and control over assets and resources**: to assess the rate of poverty or vulnerability to poverty of the women as related to the communities.
- **Meaningful participation in Public Decision Making**: to assess women's involvement in public decisions and access to social service and benefits.
- **Gender-Based Violence:** to identify the actual and at-risk types of abuses and violence that women are vulnerable to in the communities. One of the data collection tools adopted to identify the various categories of abuse within the communities was the vignette approach. A vignette is a qualitative approach that helps provide entry points to sensitive matters in research, they help improve access to sensitive themes by creating distance between the context of the vignette and the participant by not asking people directly about their own experiences, rather by asking how third parties might feel or act (Kandemir & Budd, 2018). This approach was used to identify the following categories of Gender-based violence, sexual exploitation, and abuse using the indicators developed by the Gender Monitoring Office in the Republic of Rwanda (Gender Monitoring Office, 2018):

    - *Sexual abuse:* also referred to as molestation, the act of using force or taking advantage of others or attempt to stimulate others sexually without their informed consent. There can also be marital abuse which occurs when the abuse involves threats of unwanted sexual contact or forced sex by a woman's husband or ex-husband, it may constitute rape or assault.
    - *Physical abuse*: an intentional act causing injury to another person by way of bodily contact.
    - *Economic abuse*: a form of abuse that includes control over the other person's access to economic resources. Which diminishes the victim's capacity to support themselves, and forces them to depend on the perpetrator financially. Economic abuse includes the control of someone's present or future earning by preventing them from obtaining a job or education.

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  - *Emotional abuse:* non-physical abusive behavior, including verbal aggression, intimidation, manipulation, and humiliation, which most often unfold as a pattern of behavior over time that aims to diminish other person's sense of identity, dignity, and self-worth (Gender Monitoring Office, 2018).

- **Knowledge and Expectation from the Project**: the acceptance of the project by the women and their expectations and concerns.

The desktop review of gender analysis of Niger State has revealed that the state government generally has made several attempts towards gender equality, and an example is the Gender Policy Dialogue programs held at Minna. The outcome of the program emphasized education, equal opportunities, and support at all levels for the girl child. Another effort made by the government is the representation of women in the leadership of the state, Niger State created offices for women which include: members of the executive council, permanent secretaries, and Director-Generals (Isah & Nafiu, 2013).

However, despite the government's efforts towards empowering women in the state, there is still an outstanding imbalance in female representation in the major sectors of the state. In education for instance, women participation in the state is worse than the average for the North Central Region (Agbalajobi , 2009). The local communities within the state including the project areas, are notable for high levels of gender inequality, patriarchy, and gender imbalance.

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4.4.4.10.1 Gender Issues within the Study Areas

Dakpan Community: It was observed and discussed during the FGD with women that there are no economic expectations from the women. Hence, their primary roles are limited to household management. In this community, women and young girls spend ample time doing house chores and taking care of the children. The safety of the women group is guaranteed in the community, but they mentioned that they somehow feel insecure when going out to fetch water in the community due to wild animal attacks. There is limited decision-making authority ascribed to women, as only the man in the house makes important decisions.

Women in the Dakpan community are not coordinated nor committed to any women association or group. However, they have a leader who represents them at the leadership level of the community. The right to own personal properties is limited among women but they can access whatever belongs to their husbands. Men and women are both engaged in farming activities such as planting and harvesting of rice, maize, and groundnut. Though the FGD revealed that women do not own the land they use for farming, and are not expected or permitted to own anything that their husband does not have.

During the FGD, gender-based violence, sexual exploitation and abuse were assessed using a vignette qualitative approach. The following were identified:

- Women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. There is a general norm that young girls between the ages of 15 – 18 years should be married.
- Economic abuse was identified as the women did not have any active economic activity, without the consent of their husband.
- It was observed that, though women contribute to household decision making, their power of execution is constrained.

Table 4.43 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Dakpan community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.19).

Table 4.43: GBV Indicators in Dakpan Community

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Dakpan Community			
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Fear of sexual abuse by strangers ▪ Lack of knowledge and understanding of sexual abuse, specifically marital rape ▪ The practice of female genital mutation at its peak ▪ Early marriage as early as age 15 ▪ No GBV response center for survivors	The actual incidence of sexual abuse identified include: ▪ The presence of marital rape is the norm among women.	▪ Based on the vignette, we were able to identify that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years. And it was further reported that the majority of the young girls are either married or have people they will be married to.
Physical	▪ No authority is in charge of addressing physical abuse; hence, the perpetrators can go unpunished. ▪ No GBV response channel for survivors	▪ Aggressive behavior from husbands	▪ One of the normal behavior of men towards women in the community as reported by the women is aggressiveness, which tends to lead to physical combat.

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Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Dakpan Community			
Economic Abuse	▪ They have no power to decide their economic activity, ▪ They are not aware of what economic abuse is, ▪ No access to credit facility and association, ▪ No formal and informal level of education could qualify them for formal employment.	▪ They are not gainfully employed.	▪ Economic abuse was identified because women did not have any active economic activity.
Emotional Abuse	▪ They have limited household decision making power. ▪ Aggressive reactions from men.	▪ Survivors of abuse are stigmatized and forced into marriage. ▪ Culture of the silence of all sorts of abuse.	▪ It was observed that, though they contribute to the household decision-making process, they have limited power when it comes to execution, also the aggressive reactions from men and culture of silence could be a major cause of emotional trauma.

Source: EnvAccord Field Survey, 2020

Plate 4.19: Cross-section of the FGD with women in Dakpan Village
Source: EnvAccord Field Survey, 2020

Kuchitagi Community: Women and young girls in this community spent the majority of their time attending to household chores such as fetching water, gathering firewood, and cleaning. There are occasions where their husband assists by taking up a few house chores. Educational differences were observed, young girls are not enrolled in school, unlike their male counterparts. It was revealed during the FGD that women make contributions to the household decision, however, their husbands make the final decisions. It was further discussed that sometimes husbands consider their contributions and apply them when necessary. There is a women association within the community called "*Egboro*", saddled with the responsibilities of standing for women's rights. The community operates communal ownership of land, men and women can make use of the land with the permission of the community head. Women are permitted to use the land for farming and build houses. Women in the community only engaged in farming and not active in any other economic activities.

During the FGD, gender-based violence, sexual exploitation, and abuse were assessed using a vignette qualitative approach. The following were identified:

- Women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. There is a general norm that young girls between the ages of 15 – 18 years should be married.
- Female genital mutilation is still a norm, and it is an indicator of vulnerability to sexual abuse.
- No case of physical brutality against women was reported, however, there is no existing structure to penalized or protect victims
- The women do not have the liberty to explore various economic options because their lack of education has disqualified them, and also the economic option for women is limited to farming and petty trading.
- The women mentioned that any rape victim within the community will be forced into marriage with the perpetrator.

Table 4.44 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Kuchitagi community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village.

Table 4.44: GBV Indicators in Kuchitagi Community

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Kuchitagi Community			
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape specifically ▪ The practice of female genital mutation at its peak ▪ Early marriage as early as age 15 ▪ No GBV response center for survivors	The actual incidence of sexual abuse identified include: ▪ The presence of marital rape is the norm among women.	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years. And it was

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Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Kuchitagi Community			
			further reported that the majority of the young girls are either married or have people they will be married to. ▪ Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
Physical Abuse	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors	▪ None observed during the study	▪ No case of physical brutality against women was reported, but the present structure in the community condones it without appropriate measures and penalties to protect victims.
Economic Abuse	▪ They have limited power to decide their economic activity ▪ They are not aware of what economic abuse is ▪ No access to credit facility and association ▪ No formal and informal level of education	▪ Not employed in any formal sector	▪ The women do not have the liberty to explore various economic options because their lack of education has disqualified them, and also the economic option for women is limited to farming and petty trading.
Emotional Abuse	▪ They have limited household decision making power	▪ Survivor of abuse are stigmatized and forced into marriage	▪ The bulk of household decisions lie with the man. ▪ The women reported that the previous cases of GBV that they have had several years ago, led to the stigmatization of the victim. ▪ They also reported that any rape victim within the community will be forced into marriage with the perpetrator.

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Source: EnvAccord Field Survey, 2020

Sheshimandiko Community: Women and young girls take care of the home and also provide for the home through farming activities and petty trading. However, men render support with the chores, women do the bulk of the chores. The women mentioned during the FGD that it is unsafe to move at night within the community, especially near the streams due to presence of wild animals. There are challenges such as lack of good water and inadequate health facility that specifically affect women. The household decision making responsibility lies solely on men, the women lack the decision-making authority in the household. Women comply with the directives of their husbands on all matters pertaining to the household. There is a women leader who serves as an intermediary, sharing information with the community leaders and women. There is a women association called "*Emigun*" Association, a saving and thrift association.

During the FGD, gender-based violence, sexual exploitation and abuse were assessed using a vignette qualitative approach. The following were identified:

- Women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. There is a general norm that young girls between the ages of 15 – 18 years should be married.
- The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years.
- The young girls who have been sexually violated are forced into marriage with the men that violate them.
- Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
- Many women are economically inactive as their husbands do not permit them to engage in external activities.

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Table 4.45 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Sheshimandiko community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.20).

Table 4.45: GBV Indicators in Sheshimandiko Community

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	**Indicators of "Actual" Incidence of Abuse**	
	Sheshimandiko Community		
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape specifically ▪ The practice of female genital mutation at its peak ▪ Early marriage as early as age 15 ▪ No GBV response center for survivors	The actual incidence of sexual abuse identified include: ▪ The presence of marital rape which is a norm among the women ▪ Unreported rape cases ▪ Forced and involuntary marriage as a report of sexual violation	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed

Types of Abuse	**Identified Gender-Based Violence**		**Comments**
	Indicators of "At Risk" Of Abuse	**Indicators of "Actual" Incidence of Abuse**	
Sheshimandiko Community			
			that girls should be married between ages 15-18 years. ▪ The young girls who have been sexually violated are forced into marriage with the men that violate them. ▪ Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
Physical Abuse	▪ No authority is in charge of addressing physical abuse; hence they do not report to anyone. ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage.	▪ They experience violent reactions from their husband	▪ The women narrated that violent reactions from their husbands are a norm in their community.
Economic Abuse	▪ They do not have any decision-making power, it all depends on their husband ▪ They are not aware of what economic abuse is ▪ No access to credit facility and association ▪ No formal and informal level of education	▪ Not fully employed ▪ The decision to be the economic decision and what they use the money for lies in their husband. ▪ Lack of access to resources and assets.	▪ It was identified that, though the women desire to be economically active, they are ready to be economically inactive against their wish if their husband demands. ▪ They are permitted to own assets and resources but their economic inactivity makes it inaccessible for the women.
Emotional Abuse	▪ They have no household decision making power.	▪ The culture of silence for abused survivors	▪ Women suffer emotional and psychological trauma experienced in their marital relationship because of the culture of silence.

Source: EnvAccord Field Survey, 2020

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Plate 4.20: Focus Group Discussion Session with the women in Sheshimandiko Village
Source: EnvAccord Field Survey, 2020

Dokogi Community: Women are expected to take care of all household chores and they also get engaged in rice processing, while young girls are engaged in domestic work and are also enrolled in primary school and Arabic school. The major health related issue affecting women is skin infections as reported, caused by heat. The women have limited household decision-making power, and decision-making responsibility is shouldered by the husband, considered as the head of the family. In this community, men are considered more powerful and the head of the family, this is supported by the belief that authority and power are given to men by God and women do not have any right over the men. The women do not have any means of participating in public decision making, they did not report any women group or association or any coordination that permits power equality in the community. Unlike men, the women do not have access to assets and resources with no right to own land as at the time of the study.

During the FGD, gender-based violence, sexual exploitation, and abuse were assessed using a vignette qualitative approach. The following were identified:

- The women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm.
- The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years.
- Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
- The community women are not economically empowered at the time of the study.

Table 4.46 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Dokoji community. The

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comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.21).

Table 4.46: GBV Indicators in Dokoji Community

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	**Indicators of "Actual" Incidence of Abuse**	
Dokoji Community			
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape, specifically ▪ The practice of female genital mutation at its peak, ▪ Early marriage as early as age 15, ▪ No GBV response center for survivors.	The actual incidence of sexual abuse identified include: ▪ The presence of marital rape is the norm among women.	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years. ▪ Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
Physical Abuse	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage	▪ None was identified	▪ Though there was no actual physical violence reported, the existing cultural background does not have provision to prevent or punish perpetrators.
Economic Abuse	▪ They do not have any economic decision-making power, ▪ They are not aware of what economic abuse is. ▪ No access to credit facility and association ▪ No formal and informal level of education, ▪ Low level of female educational enrolment	▪ Women are not economically active nor gainfully employed, ▪ Decisions about economic activities and how resources are used lies with the men. ▪ Inequality in access to land and assets	▪ The women are ready to be economically inactive if their husband tells them to.
Emotional Abuse	▪ They have no household decision making power	▪ They endure violent reactions and all sorts of abuse from their husband.	▪ The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

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Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Dokoji Community			
		▪ The practice of a culture of silence for all experience of abuse.	

Source: EnvAccord Field Survey, 2020

Plate 4.21: Cross-section with the women in Dokoji Village
Source: EnvAccord Field Survey, 2020

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Gbangba Community: In this community, women are saddled with the household responsibility and also engage in rice processing. The young girls are engaged in domestic work and they are also enrolled in primary school. There is a women association called "*Wantunde*", with selected women representing others at the community leadership. The women aspired for gaining employment, however, during the time of the survey, many women were not actively employed.

During the FGD, gender-based violence, sexual exploitation, and abuse were assessed using a vignette qualitative approach. The following were identified:

- The women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm.
- The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 13-15 years.
- Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
- The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

Table 4.47 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Gbangba community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.22).

Table 4.47: GBV Indicators in Gbangba Community

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Gbangba Community			
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape specifically ▪ The practice of female genital mutation at its peak ▪ Early marriage as early as age 13 ▪ No GBV response center for survivors	▪ The actual incidence of sexual abuse identified include: ▪ The presence of marital rape which is a norm among the women	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 13-15 years. ▪ Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
Physical Abuse	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage	▪ None was identified	▪ Though there was no actual physical violence reported, the existing cultural background does not have provision to prevent or punish perpetrators.
Economic Abuse	▪ No access to credit facility and association ▪ No formal and informal level of education	▪ Not gainfully employed	▪ The women are currently not economically empowered.
Emotional Abuse	▪ They have limited household decision making power	▪ They endure violent reactions and all sorts of abuse from their husband. ▪ The existing culture of silence for abuse survivors.	▪ The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

Source: EnvAccord Field Survey, 2020

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Plate 4.22: Focus Group Discussion Session with the women in Gbangba village
Source: EnvAccord Field Survey, 2020

Ragidda Hausawa Community: Women's roles are identified within the home management such as housekeeping, some women are involved in petty trading. Generally, women are not permitted to engage in agricultural activities. The young girls are expected to assist their parents in home chores. There was no security threat reported by women. There is a women association called *"Adudu"*, coordinated by women. Despite this, there is no female representation in the leadership of the community. Resources and assets control are strictly for men as women are often not allowed to engage in any economic activities.

During the FGD, gender-based violence, sexual exploitation, and abuse were assessed using a vignette qualitative approach. The following were identified:

- Women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. There is a general norm that young girls between the ages of 15 – 18 years should be married.
- The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years.

Table 4.48 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Raggida Hausawa community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.23).

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Table 4.48: GBV Indicators in Raggida Hausawa Community

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Ragidda Hausawa Community			
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape specifically ▪ Early marriage as early as age 15 ▪ No GBV response center for survivors	▪ None was identified	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years.
Physical abuse	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage	▪ None was identified	▪ Though there was no actual physical violence reported, the existing cultural background does not have provision to prevent or punish perpetrators
Economic abuse	▪ No access to credit facility and association ▪ No formal and informal level of education.	▪ Women are not permitted to be economically active.	▪ There is high level of economic dependence hence the women do not have financial liberty to stay out of violence.
Emotional abuse	▪ They have limited household decision making power.	▪ The existing culture of silence for abuse survivors.	▪ The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

Source: EnvAccord Field Survey, 2020

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Plate 4.23: Focus Group Discussion Session with the women in Raggida Hausawa
Source: EnvAccord Field Survey, 2020

Nakoko Siyidi Community: Women and young girls take care of the home and also provide for the home through farming activities and petty trading. However, men render support with the chores, women do the bulk of the chores. There are challenges such as lack of good water and inadequate health facility that specifically affect women. The household decision making responsibility lies solely on men, the women lack the decision-making authority in the household. Women comply with the directives of their husbands on all matters pertaining to the household. There is a women leader who serves as an intermediary, sharing information with the community leaders and women. There is a women association called "*Emigun*" Association, a saving and thrift association.

Table 4.49 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Nakoko Siyidi community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village.

Table 4.49: GBV Indicators in Nakoko Siyidi Community

Types of Abuse	**Identified Gender-Based Violence**		**Comments**
	Indicators of "At Risk" Of Abuse	**Indicators of "Actual" Incidence of Abuse**	
	Nakoko Siyidi Community		
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape specifically ▪ Early marriage as early as age 15 ▪ No GBV response center for survivors	▪ None was identified	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years.
Physical Abuse	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage	▪ None was identified	▪ No physical hurt was reported.
Economic	▪ No access to credit facility and association	▪ Women are not permitted to be economically active.	▪ There is high level of economic dependence hence the women do not

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Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Nakoko Siyidi Community			
	▪ No formal and informal level of education.		have financial liberty to stay out of violence.
Emotional	▪ They have limited household decision making power	▪ The existing culture of silence for abuse survivors.	▪ The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

Source: EnvAccord Field Survey, 2020

Mashigi Community: This community shares similar characteristics with other communities in the study area. The women and young girls take care of the home, while the men focus on economic provision from the agricultural activities. The household decision making responsibility lies solely on men, the women lack the decision-making authority in the household. Women comply with the directives of their husbands on all matters pertaining to the household. There is no women association, although women are not forbidden from forming an association.

It was observed that the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. There is a general norm that young girls between the ages of 15 – 18 years should be married. The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years.

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Table 4.50 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Mashigi community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.24).

Table 4.50: GBV Indicators in Mashigi Community

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Mashigi Community			
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape specifically ▪ Early marriage as early as age 15 ▪ No GBV response center for survivors	▪ None was identified	▪ Based on the vignette, we were able to identify that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that

Types of Abuse	Identified Gender-Based Violence		Comments
	Indicators of "At Risk" Of Abuse	Indicators of "Actual" Incidence of Abuse	
Mashigi Community			
			girls should be married between ages 15-18 years.
Physical Abuse	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage	▪ None was identified	▪ No physical hurt was reported.
Economic	▪ No access to credit facility and association ▪ No formal and informal level of education.	▪ Women are not permitted to be economically active.	▪ There is high level of economic dependence hence the women do not have financial liberty to stay out of violence.
Emotional	▪ They have limited household decision making power.	▪ The existing culture of silence for abuse survivors.	▪ The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

Source: EnvAccord Field Survey, 2020

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Plate 4.24: Focus Group Discussion Session with the women in Mashigi Village
Source: EnvAccord Field Survey, 2020

Kpanje Community: This community shares similar characteristics with other communities visited during the study. The household decision making responsibility lies solely on men, the women lack the decision-making authority in the household. However, there are good number of women who take care of their homes, engage in petty trading and farming. Some of the women in the community revealed their husband do support them when they are attending to house chores. There is a women association called SOKODEKE, with a women leader who communicates the interest of the women group with the community women.

It was observed that the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. There is a general norm that young girls between the ages of 15 – 18 years should be married. The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years. Further, female genital mutilation is still a norm in the community, which is an indicator of vulnerability to sexual abuse.

Table 4.51 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Kpanje community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.25).

Table 4.51: GBV Indicators in Kpanje Community

Types of Abuse	**Identified Gender Based Violence**		**Comments**
	Indicator of "at Risk of abuse"	**Indicator of "Incident Of Abuse"**	
		Kpanje Community	
Sexual Abuse	The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape, specifically ▪ Practice of female genital mutation at its peak, ▪ Early marriage as early as age 15, ▪ No GBV response center for survivors.	The actual incidence of sexual abuse identified include: ▪ The occurrence of marital rape which is a norm among the women.	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years. ▪ Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
Physical Abuse	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage	▪ None was identified	▪ No physical hurt was reported.

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Types of Abuse	Identified Gender Based Violence		Comments
	Indicator of "at Risk of abuse"	Indicator of "Incident Of Abuse"	
Kpanje Community			
Economic Abuse	▪ They do not have any economic decision making power, ▪ They are not aware of what economic abuse is, ▪ No access to credit facility and association ▪ No formal and informal level of education, ▪ Low level of female educational enrolment	▪ Women are not economically active nor gainfully employed, ▪ Decisions pertaining to economic activities and how resources are used lies with the men. ▪ Inequality in access to land and assets	▪ The women are ready to be economically inactive if their husband tells them to.
Emotional Abuse	▪ They have no household decision making power	▪ They endure violent reactions and all sort of abuse from their husband. ▪ The practice of culture of silence for all experience of abuse.	▪ The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

Source: EnvAccord Field Survey, 2020

Plate 4.25: Focus Group Discussion Session with the women in Kpanje community
Source: EnvAccord Field Survey, 2020

Mayaki Community: Women and young girls take care of the home and also provide for the home through farming activities and petty trading. None of the women participants in Group Discussion have the capability to own land as at the time of the study. However, women expressed desire to have their own properties. The household decision making responsibility lies solely on men, the women lack the decision-making authority in the household. Women comply with the directives of their husbands on all matters pertaining to the household. There is a women leader who serves as an intermediary, sharing information with the community leaders and women. There is a women association called "*Asamihakuri*" Association.

Table 4.52 provides detailed GBV indicators (developed by the Gender Monitoring Office of Rwanda Gender Accountability for Sustainable Development) which was used to assess the information obtained during the survey in Mayaki community. The comments provided were made from a professional judgment based on the information obtained during the FGD held with the women in the village (Plate 4.26).

Table 4.52: GBV Indicators in Mayaki Community

Types of Abuse	Identified Gender Based Violence		Comments
	Indicator for "At Risk of Abuse"	Indicator for "Incident of Abuse"	
Mayaki Community			
▪ Sexual	▪ The risk factors of sexual abuse identified Include: ▪ Lack of knowledge and understanding of sexual abuse, marital rape specifically ▪ Practice of female genital mutation at its peak ▪ Early marriage as early as age 15 ▪ No GBV response center for survivors	▪ The actual incidence of sexual abuse identified include: ▪ The presence of marital rape which is a norm among the women	▪ Based on the vignette, we were able to pick that; the women do not understand what marital rape is and non-consensual sex between a man and his wife is a norm. ▪ The risk of sexual abuse for young girls was also identified due to early marriage; it is believed that girls should be married between ages 15-18 years. ▪ Female genital mutilation is still a norm, and it's an indicator of vulnerability to sexual abuse.
▪ Physical	▪ No authority is in charge of addressing physical abuse, hence they do not report to anyone ▪ No GBV response channel for survivors ▪ The practice of the culture of silence on whatever happens to a woman in her marriage	▪ None was identified	▪ No physical hurt was reported.
▪ Economic	▪ No access to credit facility and association ▪ No formal and informal level of education	▪ Not fully employed ▪ The decision to be economic decision and what they use the money for lies in their husband.	▪ The women are currently not economically empowered but they desire to be economically active, and they are ready to negotiate with their husband to permit them to engage in economic activities.
▪ Emotional	▪ They have limited household decision making power	▪ They endure violent reactions and all sort of abuse from their husband.	▪ The women expressed that whatever their husbands do to them they are ready to endure and hopes that he changes soon.

Source: EnvAccord Field Survey, 2020

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Plate 4.26: Women engagement in Mayaki community
Source: EnvAccord Field Survey, 2020

4.4.14 <u>Community Concerns and Perception</u>

In all the communities, the survey data revealed that the local authorities are fully aware of the proposed project, however, most of the communities' members were just informed of the proposed project during the period of the survey. In some of the communities visited, aside from the village heads, none of the respondents were aware of the proposed Project until the survey team explained the Project in detail to the community members. During the town hall meetings across all the ten (10) communities, discussions were held with the men, youths, and women, the Project components and associated impacts were carefully explained. As observed, the reactions of the communities' leaders and members were positive, and they provided positive comments about the Project. The community members believe that it would significantly improve their standard of living, and that there are impending economic advantages for them in terms of jobs as a result of the Project. Their major concerns were the pricing of the power supply, and how soon the project development would commence in their communities. Table 4.53 below shows the concerns and perceptions of the community.

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Table 4.53: Community concerns and perceptions from the beneficiary communities

S/N	Community	Concerns	Perception
1.	Dokoji	• Their major concern was about the payment, hoping that the charges will not be too expensive for them	• Members of the community are generally happy about the project and hoping they would be able to have a consistent supply of electricity.
2.	Sheshimandiko	• They are more concerned about the charges or price they have to pay for the project Solar electricity.	• Generally, members of the community are positively disposed to the project upon

S/N	Community	Concerns	Perception
			awareness of the importance of the Project.
3.	Kuchitagi	• They have no concrete concern, however; they are expecting the project to start on time.	• Members of the community believe that the Solar project will be a blessing for their community. • They consider the project to be a good development.
4.	Dakpan	• They are concern about the payment or charges for the consumption	• They consider the project as a welcome development.
5.	Nakoko Siyidi	• The community leaders and members have no specific concerns.	• The Solar Project is considered a welcome development and well appreciated by members of the community.
6.	Gbangba	• They are concerned if the project will be on-and-off supply like the national grid. • The distribution of the electricity • The payment method and the cost of the electricity supply	• They see the project as a welcome development
7.	Mashigi	They are concerned if they can use the electricity supply for commercial use • They are concerned about the consumption charges and the payment method	• They are happy about the project with the hope that members of the communities will have the opportunity to work within the project site.
8.	Raggida Hausawa	• They have no concrete concern, however; they are hoping that the project will start on time.	• They consider the project a welcome development
9.	Mayaki	• The payment options and the amount of money they will have to pay sustain the Solar project are priorities to the community members	• They wholeheartedly appreciate the project when they understood the importance.
10.	Kpanje	• They have no concrete concern about the project. Their experience during the installation of the BTS Station has given them a good impression of development in their community	• They perceive the Solar project as another welcome development for their community.

Source: EnvAccord Field Survey, 2020

4.5 Stakeholder Engagement

This section describes the activities that were carried out to engage and consult with key stakeholders. It describes the process by which stakeholders were identified; the means by which they were consulted; and the outcomes of the consultations to date. It describes the actions that the Project took to disclose pertinent information to stakeholders.

4.5.1 Defining Stakeholder Engagement

Stakeholder engagement is an ongoing process of sharing Project information, understanding stakeholder concerns, and building relationships based on collaboration. Stakeholder consultation is a key element of engagement and essential for effective Project delivery. Disclosure of information is equally as vital. If there are risks or adverse impacts from a Project, consultation must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. In line with current guidance from the World Bank, consultation should ensure *"that appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format"* In other words, effective consultation requires the prior disclosure of relevant and adequate Project information to enable stakeholders to understand the risks, impacts, and opportunities. The Project's consultation program was intended to ensure that stakeholder concerns are considered, addressed and incorporated in the development process, especially during the ESIA.

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4.5.2 Objectives

The stakeholder engagement process was designed to conform to the Nigerian EIA Act and international standards. For this Project, the key objectives for stakeholder engagement include:

- inform and educate stakeholders about the proposed Project;
- gather local knowledge to improve the understanding of the environmental and social context;
- better understand the locally-important issues;
- provide a means for stakeholders to have input into the Project planning process;
- take into account the views of stakeholders in the development of effective mitigation measures and management plans; and
- lay the foundation for future stakeholder engagement.

Consultations and interactions (including virtual meetings) were held with the relevant stakeholders to the Project from October 13th to 23rd , 2020. These include:

- Niger State Ministry of Environment
- Niger State Environmental Protection Agency
- Niger State Ministry of Works
- Niger State Renewable Energy Department
- Gbako LGA Authority
- Edati LGA Authority
- Mashegu LGA Authority
- Lapai LGA Authority

The consultations served to provide stakeholders with information about the proposed Project and to gather information important to the ESIA. Prior to the consultation, notification letters and Background Information Documents (BID) were sent to the stakeholders to provide high level information about the proposed Project. The notification letters and BID are provided in Appendix 4.3. Records of consultation meetings are provided in Appendix 4.4 while Table 4.54 below summarize the findings of the scoping consultation. Plate 4.27 shows the sample photograph of the stakeholder consultation exercise.

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Plate 4.27: Sample picture taken during Stakeholder Consultation with Lapai LGA representatives
Source: EnvAccord Field Survey, 2020

Table 4.54: Initial stakeholder consultation findings

Stakeholder	Priority issues	Quotes/comments during meetings	How comments have been addressed in the ESIA report
Niger State Ministry of Environment and Forestry	ESIA consultation, Project knowledge,	• General waste is manged in Niger State by NISEPA, they implement policies on waste management with the Niger	• Third party waste contractors will be engaged to manage

Stakeholder	Priority issues	Quotes/comments during meetings	How comments have been addressed in the ESIA report
(Virtual meeting with Mr Raji Sheu Adam – AG. Director Environmental services Department)	permits, and waste management in the state	State Ministry of Environment. • NISEPA collects wastes around Niger State on a daily basis and transfer to the dumpsite. Third party waste contractors are also involved in waste management in the state. • The Ministry is currently developing a waste management plan to be implemented in all LGAs in the State. • At present, there are no facilities available for e-waste management in the state. • The benefiting communities in Niger State are not evenly covered/distributed taking in to cognisance the 3 geo political separation of the state, only zone A and B were covered. • No description of the megawatt (MW) expected to be generated was mentioned in the document (BID). • The project cost was not mentioned and the project life span was not also discussed. • The Department of power and Energy in the state Ministry of works and Infrastructural Development should be contacted, involved and carried along as regulators in the project conception, implementation and sustainability.	wastes during the project operations • EnviroServe, an international e-waste management company will be engaged to handle the e-waste that will be generated by the project. • The project is being implemented in phases and more communities will be covered in subsequent phases. • The engineering design, energy audits and procurements of project components are still ongoing. The power capacity and costs are yet to be finalized at this stage. However, the estimated project cost has been provided in chapter 2 of this report. • The Niger State Ministry of Works has also been contacted as part of this ESIA process. • Engie Fenix Nigeria will engage with all relevant state authorities formally before and during project development.
Niger State Ministry of Works (Virtual meeting with Engr. Ishaq)	ESIA Process, permits, and concerns about the project	• Niger State has set up a working group on renewable energy with other stakeholders in different MDAs in the state. • The aim of the working group is to ease implementation of renewable energy projects in state. They assist security, access to land, access to	• Engie Fenix Nigeria will engage with all relevant state authorities formally before and during project development. • All comments were duly noted.

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Stakeholder	Priority issues	Quotes/comments during meetings	How comments have been addressed in the ESIA report
		communities, etc at no cost to the developers. • Some of the requirements that the working group are land survey document, MOUs with the communities, etc. • The project developer should write to the working group to engage them.	
Niger State Renewable Energy Department	Mini-Grid project development, Site approvals, Community Engagement, Legal and Technical support, ESIA process	• Introduction of project proponent • Site selection and approval consultations • Project design consultation • Coordination of pre and post project community engagement from site assessment to sensitization, agreements and conflict resolution.	• Engie Fenix Nigeria will carry the Department along in all project development activities.
Mashegu LGA (Virtual meeting with Mr Abubakar Jubril – Director of Works)	ESIA process, consultation and concerns about the project	• The LGA is pleased about the development of the project in their communities. • They do not have formal waste management practices in the LGA. • The land belongs to the LGA and the village, and they are willing to assist as intermediary for land acquisition for the project. • The project should be well designed and constructed to provide the best service.	• The information will be communicated to Engie Fenix Nigeria for further consultation. • The project will be designed and developed using international best practice and high-quality components. • All comments were duly noted
Lapai Local Government Area (Physical meeting with LGA representatives)	ESIA process, consultation and concerns about the project	• They are pleased that the project is being developed within their LGA. • Will the project power nearby communities? • Who will maintain the project during operations? • Will the company have an engineer on site for maintenance? • There are other LGAs with more sites, will Lapai LGA also get more projects? • When will the project be deployed? • They have professionals within the LGA that can be engaged for the project, and a community development	• The project is being implemented in phases, and more communities will benefit in the near future. • Currently, the project is being developed for the host community only • Engie Africa personnel will be available for project operation and maintenance.

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Stakeholder	Priority issues	Quotes/comments during meetings	How comments have been addressed in the ESIA report
		officer that can assist to liaise with the community. • The LGA wants to be carried along in the project development. • The LGA assures the company that they are willing to cooperate to ensure the success of the project.	• The project will be deployed in the near future, following the receipt of the relevant approvals, completion of design and procurement of components. • The project will provide job opportunities for local professionals. • The LGA authorities will be engaged by Engie Africa for project development • All comments were duly noted.

Engagement activities in the ESIA study stage included consultations designed to introduce the Project to stakeholders that could potentially be affected by the Project. This was intended to refine the ESIA scope by generating additional feedback on the ESIA approach, key issues and key stakeholders to be consulted, as well as to inform the development of mitigation for the Project.

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Consultation with the identified stakeholders (including regulators and community leaders) showed general acceptance of the proposed Project. Regulators such as the Niger State Ministry of Environment and Forestry and Niger State Ministry of Works made suggestions relating to the proposed Project which have been addressed in the ESIA study as indicated in Table 4.54 above.

CHAPTER FIVE:

ASSOCIATED AND POTENTIAL IMPACTS

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CHAPTER FIVE

ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

This chapter presents the potential environmental and social (E&S) impacts and risks associated with the proposed Engie Fenix mini-grid solar projects in Niger State. It also includes the methodology employed to assess the significance of the E&S impacts and risks.

5.2 Impact Assessment Overview

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

The primary objectives of the impact assessment process are to:

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

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

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

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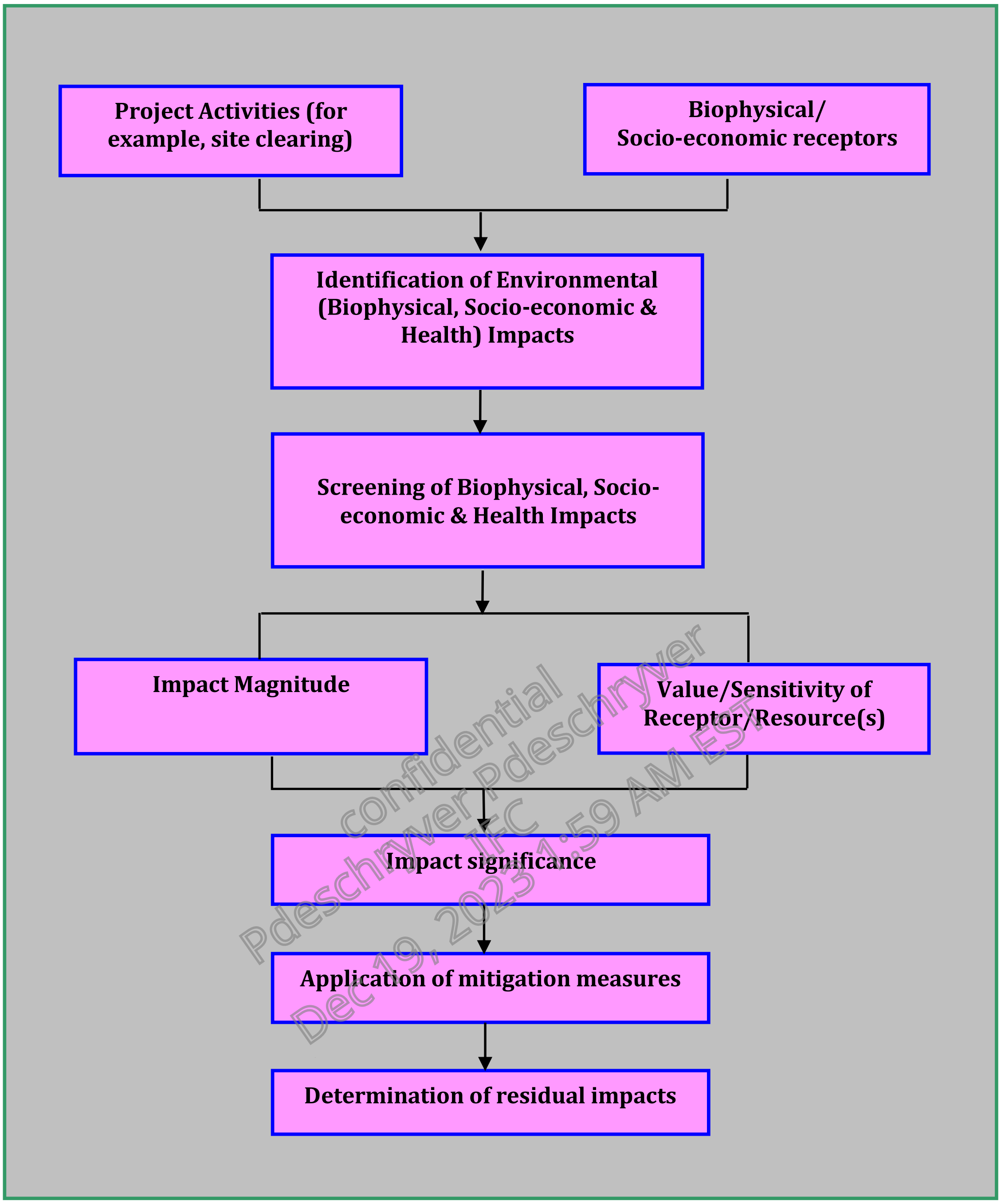

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Figure 5.1: Overview of the Impact Assessment Process

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

5.3.1 Defining Environmental and Socio-economic Aspects and Impacts

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

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

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

Activities assessed covered planned and non-planned events.

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

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

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

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5.3.2 Potential Impact Characteristics

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.3.3 Screening and Scoping for Potential Impacts

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

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

Table 5.2: Summary of Project Activities

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

Note: Activities related to decommissioning are discussed in Chapter 8

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Table 5.3: Resource/Receptors and Impacts Indicators Considered

Environmental Receptor/Medium	Comment	Impact Indicators
Physical		
Air	Ambient air quality within the Project site and its surrounding environment.	Increase in concentration of gaseous and particulate pollutants.
Noise	Ambient noise level within the Project site and its surrounding environment.	Increase in ambient noise level; day and night-time disturbance; communication impairment, etc.
Soil	Soil environment within the Project site and its AoI.	Changes in physical, chemical and biological properties of the soil; loss of soil ecology and fertility; soil erosion, etc.
Groundwater/aquifers	Underground water resources in the Project's AoI.	Decrease in underground water/aquifer reservoir level; groundwater contamination.
Landscape/topography	The geomorphological land forms and terrain of the Project site and its surrounding environment.	Alteration in drainage pattern; changes in landscape.
Biological		
Terrestrial flora and habitats	Plant species (vegetation) within the Project site and its AoI.	Loss of terrestrial flora; introduction of new species.
Terrestrial fauna	Terrestrial fauna within the Project site and its surrounding environment.	Loss of terrestrial fauna; involuntary migration.

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

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

Table 5.4: Activity-Receptor Interaction for Impact Screening

Summary of Project Activities at various Phases	Receptors															
	Physical					Biological		Socio-economic						Others (Health and Safety)		
	Air Quality	Ambient Noise	Soil	Groundwater and Aquifers	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Gender	Construction workers	Workplace health and safety	General Public
Pre-construction Phase																
Site selection								X								
Site clearing and preparation	X	X	X		X	X	X					X			X	
Mobilization of construction equipment and materials to site	X	X									X				X	X
Construction Phase																
Civil work activities including excavation, cable laying, foundation, construction of building (e.g. power house)	X	X	X	X		X	X		X			X	X	X	X	X
Installation of power plant facilities such as PV panels, mounting structures, inverters, power storage batteries;	X	X	X									X	X		X	
Waste generation and disposal			X	X							X	X				
Commissioning Phase																
Testing of power plant and associated infrastructure		X							X		X				X	X
Operational Phase																
Power generation and distribution	X	X			X							X	X		X	X
Routine maintenance; waste generation and disposal			X	X						X	X	X	X		X	

Note: Decommissioning is separately covered in Chapter 8

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5.4 Determination of Impact Significance

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

- **Impact Magnitude** which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency;

- **Value/Sensitivity/Fragility and importance of the relevant Receptor**;

- **Identification of the impact significance,** which is the "product" of a combination of the above two (2) key variables.

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

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

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

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

5.4.1 Impact Magnitude

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

The magnitude of an impact takes into account the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum from Negligible to High. These criteria are discussed further as follows:

5.4.1.1 Determining Magnitude for Biophysical Impacts

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

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

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

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

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

5.4.1.2 Determining Magnitude for Socio-economic Impacts

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

Table 5.5: Impact Magnitude Criteria for Socio-economic Impacts

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

5.4.2 Determining Receptor Sensitivity

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

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

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

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

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

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

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

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

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Category	Ranking	Definition
Low	1	Those affected are able to adapt with relative ease and maintain pre-impact status.

5.4.3 *Significance*

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

Impact Magnitude			
4	4	8	12
3	3	6	9
2	2	4	6
1	1	2	3
	1	2	3

Receptor Sensitivity/Fragility/Value/Importance

Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results

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

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Table 5.7: Environmental Impact Significance Rankings

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

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

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

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

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

5.4.3.1 Determining the Significance of Potentials Impacts of the Project

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

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

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

Note: Decommissioning is separately covered in Chapter 8

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

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

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

Positive impact: +

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5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

The Project seeks to provide uninterrupted power supply to the ten (10) beneficiary communities in Niger State through renewable (solar) energy source and thus, enhance their standard of living, health and improve their economic activities. It also forms part of the measures in ensuring that Nigeria achieves its carbon emission reduction targets as contained in Nigeria's Nationally Determined Contributions (NDC) on climate change. In line with the Government's plans for Power Sector reform, the Project will assist to promote stronger relationship and collaboration between the FGN, Private sector developers (Engie Fenix Nigeria) REA, and other relevant regulatory bodies.

The Project will improve social economic activities within the communities thereby improving on their livelihoods and way of life. Also, there are employment opportunities associated with the proposed Project for skilled, semi-skilled and unskilled workforce. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects. The larger portion (70 %) of the workforce (especially semi-skilled and unskilled craftsmen) would be drawn from the beneficiary communities where the projects are sited.

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Other potential benefits of the proposed Project include technology transfer, increased access to information for better decision making, and increase in local and regional economy through award of contracts for Project development and waste management.

5.5.2 Potential Negative Impacts

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

- Potential impact of the proposed solar-hybrid power plants and associated infrastructure
- Potential cumulative impacts

It is important to note that the significance of potential environmental and social impacts discussed in this section is without mitigation measures except those already built into the Project design. Implementation of additional mitigation measures (presented in Chapter Six of this report) are expected to further reduce the impact rating as low as reasonably practicable.

5.5.2.1 Potential Impacts of the proposed Project

5.5.2.1.1 Pre-Construction Phase Activities

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

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

- ***Site Selection***

The proposed project sites allocated in each of the beneficiary communities are located within or adjacent to the communities. The lands will be purchased from the communities by Engie Fenix, based on negotiations with the host communities and other relevant stakeholders. During the site selection activities conducted by Engie Fenix, the community leaders and their representatives participated to ensure that the sites avoided displacement of livelihoods and assets. Therefore, only unoccupied lands were allocated within the community for the project sites. However, subsistence farming activities were observed at some of the project sites during the ESIA baseline study. The communities with farming activities within their sites include:

1. Sheshimandiko project site
2. Dakpan project site
3. Mashigi project site

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The subsistence farming activities observed within these sites were short-term and small scale in nature. During consultation and interviews conducted with the community leaders, it was gathered that the farmers are aware that the lands have been allocated for the proposed project. They are cultivating the crops temporarily and will harvest their crops in the coming harvest season (before December 2020); which is before the project development activities commence. Also, there are no physical structures or livelihood activities that will be affected by land take at any of the proposed project sites.

Furthermore, it was established that the project sites in all the beneficiary communities hold no significant cultural heritage values to the community. Therefore, the overall impact significance of site selection of the proposed project on the local communities is considered to be **minor**.

- ***Site Clearing and Preparation***

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

Potential Impact on Terrestrial Flora and Fauna

The site clearing activities associated with the proposed Project will lead to loss of terrestrial flora on the Project sites. The potential impact on the terrestrial flora is considered to be negative, direct, site specific and largely irreversible. The impact magnitude on the terrestrial flora is considered to be low considering the size of the sites (0.26 ha) while the sensitivity is low because all the project sites are modified habitats (no natural vegetation and endangered fauna species were observed during baseline gathering activities). Majority of the sites are fallow lands within the communities that has been abandoned. Thus, the impact significance is considered to be **negligible**.

The clearing of the Project sites may also lead to loss of individual or localized population of fauna species, or disturbance to avifauna species present within the site. However, this magnitude of this potential impact is considered low as the sites are modified habitats located within the communities. Therefore, the species abundance and biodiversity within the site is low. Furthermore, it is unlikely that there will be a change in conservation status of the species as none of the fauna species (including avi-fauna) reported in the Project area belongs to the IUCN classification of threatened animal species. The fauna species in the project sites are mostly small animals, insects, and birds. The sensitivity of the fauna species recorded on the Project sites is thus regarded as low, and the impact significance is considered to be **negligible**.

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Potential Impact on Soil

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

Site clearing activities for the project during this phase will cover only about 0.26 ha at each project site. The extent of soil erosion could be high, especially if the site clearing activities are carried out in the wet season. Therefore, the impact magnitude is considered medium. However, based on the results of laboratory analysis conducted on soil samples from the Project area, the Project site is not considered to be significantly prone to land-based erosion. The soil texture analysis of soil samples collected at the Project site and its surrounding environment showed a high percentage of clay followed by sand and then silt. This implies that the soil texture of the project sites is relatively stable. Soils with low clay content are less cohesive and inherently more unstable, thus, more susceptible to wind or water erosion. Also, the concentration of heavy metals recorded in the soil samples from the Project sites and their surrounding environment were within the naturally occurring levels. Therefore, the sensitivity of the receptor is rated low and the impact significance is considered **minor**.

Potential Impact on Air Quality and Ambient Noise

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NO_x, CO, Total Suspended Particulates (TSP), SO_x from combustion engines of the earth moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is considered to be low since the activities will be short-termed, intermittent, localized and reversible. The site clearing activities will take between 1-3 days for each site. The sensitivity of the air shed of the Project area is also regarded as low based on the results of air quality measurements conducted in the project area during baseline studies. No elevated concentrations of air pollutant criteria beyond the FMEnv, WHO, and the World Bank Ambient Air Emission Limits were recorded in the Project site and its surrounding environment. The impact significance of site clearing on the ambient air environment of the Project site is considered to be **negligible**.

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Potential Impact on Workers Safety

Site clearing and preparation are potentially hazardous activities. Accidents may occur especially when those involved are unskilled. Such accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. The site clearing activities will take less than 2-3 days at each site and the number of workers required would be less than five (5). The impact significance is considered to be **minor**.

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

Potential Impact on Air Quality and Ambient Noise

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

It is anticipated that the potential impacts will be similar to those experienced during site clearing activities. The capacity for assimilation of vehicular emissions and dust associated with the mobilization activities in the Project's AoI is considered to be high.

The overall impact significance of mobilization activities on the ambient air quality and noise of the Project area is rated **negligible**.

<u>Potential Impact on Infrastructure (Road)</u>

Regarding community health and safety, the mobilization activities during the pre-construction phase of the project may increase the traffic volume on the roads leading to the Project area. Thereby increasing the potential for road accidents as a result of the movement of vehicles in and out of the Project site, and annoyance from other road users in the area. The magnitude of the impact is considered low since the mobilization activities would be less than 1 week. The sensitivity of the receptors is adjudged as low given that the existing vehicular movement in the community environment is low. The prominent means of transportation motorcycles and small vehicles as the access roads to the communities are narrow untarred roads. Therefore, the impact significance is considered to be **negligible**.

<u>Potential Impact on Workers Safety</u>

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

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

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

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

Activity	Receptor	Associated Impact	Significance
Site Selection	Land use	• Displacement of temporary farmlands within three (3) sites.	Minor
Site clearing and preparation	Terrestrial flora and fauna	• Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project sites.	Negligible
	Soil	• Loss of top soil, • Soil compaction and degradation, • Increased erosion potential, • Reduction in structural stability and percolative ability of soil.	Minor
	Air Quality and Noise	• Air quality impacts due to emission from site clearing equipment. • Increase in ambient noise levels.	Negligible
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor

Activity	Receptor	Associated Impact	Significance
Mobilization of construction equipment and materials to site	Air Quality and Noise	• Air quality impacts from vehicular emissions (TSP, NO_x, CO, SO_x). • Increase in noise levels.	Negligible
	Infrastructure (road)	• Increase in vehicular movement and traffic including potential for road accidents.	Negligible
	Workers Safety	• Injuries and accidents to workers during loading and offloading of construction materials.	Minor

5.5.2.2 Construction Phase

The construction phase of the proposed Project will include activities such as civil and electrical works (excavation, concrete mixing, erection of piling foundations, etc.), installation of PV panels and associated components; construction of power house; installation of cables and electricity meters, and waste generation and disposal.

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

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

Potential Impact on Air Quality

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

Although the construction works at all the project sites may not run concurrently, the construction phase of the Projects would take up to 3 months at each community. There are potential emissions associated with construction equipment. The operations of construction vehicles could increase the existing concentrations of gaseous pollutants in the ambient air of the Project sites beyond the permissible limit, and the potential impact is considered to be infrequent, localized and reversible. Thus, the impact magnitude is rated to be medium due to the period of construction. The sensitivity of the air shed of the Project sites and their surrounding environment are considered to be low judging by the results of in situ air quality measurements obtained during the baseline data gathering for each site. Also, there are no heavy industrial activities in any of the AoI of the project sites since all the communities are located in relatively remote locations. Therefore, the significance of the impact of construction activities on ambient air quality of the Project site and its surrounding environment is rated **minor**.

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Potential Impact on Noise Levels

The planned activities during the construction phase of the Project have the potential to increase the ambient noise levels at the Project site and its surroundings. Based on in situ measurements conducted as part of baseline studies, the day-time noise level recorded in the Project sites and their immediate surroundings were below the FMEnv permissible Noise Exposure Limits of 90 dB(A) and the World Bank Daytime Noise Level limit of 55 dB(A).

The potential source of noise during the construction phase of the Project includes civil work and installation activities, vehicular movement and operation of construction equipment. The noise levels from construction activities would be intermittent and localized and are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor locations offsite (i.e. residential houses close to each project site). The potential impact magnitude is regarded as low considering that the construction activities may take up to about 3 months. The impact significance prior to mitigation is rated **minor.**

Potential Impact on Soil

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

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

Potential Impact on Terrestrial Flora and Fauna

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

Also, the disturbance associated with noise and movement of construction equipment and personnel at the Project sites may deter bird species from the area and disrupt the breeding of avifauna. It may also lead to increased risk to species such as snakes, rodents and mammals. The sensitivity of the receptor is adjudged to be low. None of the Project sites are within conservation areas, or within migratory route for avifauna species based on desktop reviews and field observation. The impact significance is regarded as **negligible**.

Potential Impact on Hydrogeology and Groundwater Quality

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

Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles and/or storage containers. Currently, there are no boreholes within any of the Project sites and the nearest boreholes or wells are between 100 to 300m from each site. The results of laboratory analysis conducted on groundwater samples from existing boreholes or wells in the Project area did not reflect any heavy metal and hydrocarbon pollution. It is not anticipated that construction activities will have any direct impacts on the underground aquifer in the project area. Therefore, the potential for groundwater contamination as result of construction activities is rated **negligible.**

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The potential impact on the existing underground aquifer (water reserve) of the Project area as a result of water abstraction for construction activities such as concrete mixing and washing of construction equipment is considered to be **negligible** since the use of water for construction activities would be minimal. There are boreholes and wells close to the proposed sites which are capable of supplying water for construction activities without impacting on the aquifer. The recharge of the existing boreholes in the Project area is largely due to direct precipitation. During the rainy season, the water reserve of the aquifer in the study area increases; thus, hand dug wells and boreholes yields improve significantly.

Potential impact on Gender

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

Based on information gathered during gender assessments within the communities, women mostly play domestic roles and have little to no involvement in economic activities. During construction activities, women may experience discrimination as most employment and training opportunities may be provided to men, while women will be left with menial jobs. This may intensify marginalization of women due to lack of adequate training and income, thereby reinforcing gender stereotypes and gender pay gaps. Furthermore, there is the possibility of gender-based violence cases (GBV) against women employed to work at the Project sites. Therefore, the impact significance of construction phase activities on gender issues within the communities is regarded as **minor**.

Potential Impact on Socio-economic and Health

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

With regard to the influx of workers to the community for the construction phase, the manner in which the workers conduct themselves can affect the local community in terms of disruption of existing family structures and demography. The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of crime and drug and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies. Additional pressure may also be placed on existing social infrastructure. Considering that the proposed number of workers for the construction phase of the Project will be relatively low, the potential risk to local family structures is regarded as low. Also, given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be **minor**.

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Potential Impact on Infrastructure (Road)

Regarding road infrastructure, the movement of construction vehicles in and out of the Project site during construction has the potential to increase road traffic and accidents. The impact magnitude is considered as low due to the minimal (about 1-2 daily) amount of Project vehicles and trucks to be used during the construction Phase. Also, the traffic nature of the roads leading the communities is low as the communities are remote, and their road are mostly narrow and untarred. Therefore, the impact significance is considered **minor**.

Potential Impact on Construction Workers Safety

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

- ***Waste Generation and Disposal***

Potential Impact on Soil

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

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Potential Impact on Groundwater

Groundwater may be impacted as a result of infiltration of contaminants associated with liquid wastes especially from damaged batteries and spent oils. The impact magnitude is considered low; the nearest existing groundwater source to the Project sites are approximately 100-300 m away. The impact sensitivity is medium because the groundwater is a major source of potable water within all communities. The potential for groundwater contamination as result of waste disposal is rated **minor**.

Potential Impact on Infrastructure (Waste Management Facility)

Construction waste can potentially have impact on the existing waste management facility of the Project area. All of the communities visited during the baseline studies do not have access to proper waste management facilities, due to their remote locations. The common waste management observed was open dumps and burning of wastes at designated locations within the communities.

However, as part of the Project design, construction wastes such as scrap electrical components, batteries, damaged/defective PV panels are planned to be returned to the manufacturers based on a take-back scheme or local recycling companies (approved by regulatory authorities) for proper recycling. The quantity of domestic wastes to be disposed of would be minimal. It is estimated that approximately 0.10 m^3 of construction debris will be produced per week, and conveyed outside the community to local waste collectors. Thus, the impact of construction wastes disposal on the waste management facility of the Project area is considered **minor**.

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

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

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

Activity	Receptor	Associated Impact	Significance
Civil and Electrical Works/ Installation Activities	Air Quality	• Air quality impacts due to emission from construction equipment (SPM, NOx, CO, SO_x) • Increase in dust from cleared land and windblown stockpiles	Minor
	Ambient Nosie	• Increase in noise level due to construction activities	Minor
	Soil	• Increased erosion potential as a result of construction activities such as excavation • Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor
	Terrestrial Flora and Fauna	• Loss of plant species as a result of introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site and power evacuation route. • Loss of fauna as a result of increased human activity and associated noise.	Negligible
	Groundwater	• Decrease in groundwater aquifer as a result of groundwater abstraction for construction activities e.g. concrete mixing, equipment washing, etc.	Negligible
	Gender	• Discrimination of women during employment • GBV (sexual harassment, intimate partner violence, poor working conditions)	Minor
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases.	Minor
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor
	Construction workers safety	• Injury to construction workers during construction activities.	Minor
Waste Generation and Disposal	Soil	• Soil contamination from solid and liquid construction waste streams.	Minor
	Groundwater	• Groundwater contamination of liquid construction waste streams.	Minor
	Infrastructure (waste	• E-waste generation	Minor

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Activity	Receptor	Associated Impact	Significance
	management facility)	• Disposal of construction wastes to existing waste management facility in the Project area.	

5.5.2.3 Commissioning Phase

Once the construction phase of the solar mini-grid plant is completed at each community, the Plant will be tested to ensure that it has been installed according to the pre-design and operational requirements. During the Plant commissioning, there could be increase in noise level due to humming noise emission from the Plant components (inverters and batteries), vehicular movement (transportation of commissioning officials), public address system, crowd noise, and other ceremonial activities. The ambient noise levels recorded in the area during baseline data gathering were generally below the FMEnv and World Bank recommended limits. Also, the nearest sensitive receptors to the Project sites are the houses close to the sites. The impact significance is rated **negligible**.

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

The commissioning phase will lead to an influx of guest and officials which will have an impact on the existing population and infrastructure (road) of the Project area. Due to the short duration (1-2 hrs) of the commissioning phase, the impacts are considered to be **negligible**.

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

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

Activity	Receptor	Associated Impact	Significance
Plant testing	Ambient noise	• Increase in ambient noise level	Negligible
	Workers safety	• Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Minor
	Population influx	• Increase in population during commissioning	Negligible
	Infrastructure (road)	• Increase in road traffic	Negligible

5.5.2.4 Operational Phase

- ***Power Generation and Distribution***

Potential Impact on Air Quality

The operation of the backup diesel generators to be installed for charging the batteries at each project site will have associated gaseous emissions. The use of diesel as fuel has associated exhaust emissions containing Carbon monoxide (CO), Sulphur dioxide (SO_2), oxides of nitrogen (NO_X), and particulate matter (PM). However, since the generating sets are to be used only during unfavourable weather conditions (i.e. low sunlight) for charging the batteries. Thus, the associated air emissions will be minimal, localized and infrequent. Also, not all generators will be operated concurrently for backup charging purposes during operations to avoid general failures and reduce emissions. Thus, the significance of the impact is regarded as **minor**.

Furthermore, some potential factors that can impact negatively on the proposed project include the build-up of dust and cloud cover, which may reduce the efficiency of the solar panels during operations. Dust accumulation may increase during the dry season periods of harmattan (a period characterized by dry and dusty winds and relatively low temperatures). Heavy rainfalls and cloud cover associated with the wet season may also impact on the daily energy yields of the solar panels. The effect of cloud cover is immediate, leading to declining in solar irradiance, while the effects of dust accumulation may have long-term impacts if unmanaged. However, considering that these impacts are mainly reversible in nature and managed through the application of inherent operational controls, the impact significance is rated as **minor**.

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Potential Impact on Noise

The potential sources of noise during the operations phase are inverters and the diesel generating sets. Typically, the designed noise level from an inverter is approximately 30-35 dB(A), while uncovered diesel generators produce up to 85 dB(A). The associated noise levels from the inverters are not envisaged to result in a maximum increase in background levels of 3 dB(A) within the project areas. The anticipated noise emission from the operation of diesel generators will not exceed 70-75 dB(A), since all the generators to be installed will have soundproof covering. Also, the use of the diesel generator will not be continuous but mainly for backup purposes. Thus, the significance of the noise impact on the nearby receptors is regarded as **minor**.

Potential Impact on Gender

Women have conventionally been under-represented in the energy sector; they are often marginalized from many power sector employment and training opportunities. There is a potential that this situation may come to play during the operations phase of the Project as women may experience discrimination during employment and training opportunities. Also, poor working conditions and GBV issues such as sexual harassment, intimate partner violence, assault (physical and psychological), are likely to arise during operations. However, only one local operator (male or female) will be engaged for each project site, which will reduce the likelihood of the impacts. Therefore, the impact significance is rated **minor.**

Potential Impact on Socio-economic and Health

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

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

Regarding EMF radiations, Solar PV panels, inverters, batteries, and other components that make up solar PV arrays produce extremely low frequency EMF when generating and transmitting electricity. To protect the general public from health effects from short-term high level magnetic fields, the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 2010) advised an exposure limit for extremely low frequency magnetic fields at 2000 mG (milligauss – the unit used to measure magnetic field strength).

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

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

Potential Impact on Occupational Health, Safety and Welfare of Workers

During the Plant operation, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries) including work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions etc. The impact significance is considered to be **minor** primarily since only one workers (Local operator) is required for daily operation activities at the project site.

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

Potential Impact on Soil

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

Also, fuel spills and used oil from the backup diesel generators for the proposed project are potential sources of soil contamination. However, most of the land within the solar power plant facilities will be concretized, which will minimize the risk of soil contamination from leaks and spills. Thus, reducing the likelihood of soil contamination. The significance of the impact is rated **minor.**

Potential Impact on Groundwater

Potential impacts may include decrease in amount of groundwater reservoir as a result of water abstraction for cleaning of the PV panels. Cleaning of the PV panels is envisaged to be carried out three (3) times during the dry season.

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Based on previous experience, each panel would require approximately 5 litres of water per cleaning cycle. With a maximum number of 256 panels for at each project site, it is envisaged that the proposed Project would consume approximately 1,280 litres per cleaning cycle. The water required for the cleaning purpose would be obtained from the existing boreholes close to the project sites. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have serious effect on the existing groundwater aquifer of the Project area as well as the local water use. Thus, the impact significance is considered **minor**.

Potential Impact on Infrastructure (Waste Management Facility)

Waste generated from operations and maintenance can potentially have impact on the existing waste management facility of the Project area. Waste management in the communities were mostly by open dumps or burning. However, e-wastes (panels, spent batteries, inverters, etc.) and hazardous wastes (spent oil, oily rags, etc.) will not be disposed of in such manner. These wastes shall be returned to the manufacturers based on a take-back agreement or handled by licensed waste contractors.

Other categories of waste such as domestic wastes generated during operations will be disposed by local accredited waste management contractors. It is envisaged that the quantity of office and domestic wastes designated for disposal from the power plants will be low. The impact of the project operations on waste management is considered **minor**.

Potential Impact on Occupational Health, and Safety of Workers

During routine maintenance, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries). The impact significance is considered to be **minor** primarily due to the low number of staff (1 to 2) required for maintenance activities and low frequency of maintenance associated with the project.

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

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

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

Activity	Receptor	Associated Impact	Significance
Power Generation and distribution	Air Quality	• Air emissions from the Diesel Generators • Effects of cloud cover and dust on the PV panels	Minor
	Noise	• Noise from diesel generators and inverters during power generation and evacuation	Minor
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working conditions)	Minor
	Socio-economic (visual prominence)	• Landscape alterations resulting in unpleasant changes in the visual character of the area	Negligible
	Socio-economic (health issues)	• Community health and safety impact due to electromagnetic field (EMF) radiation from the solar-hybrid power plant	Negligible
	Health, safety and welfare of staff during Plant operation	• Electric shock, injuries to personnel associated with the Power Plant operations, • Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Minor
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from spent batteries and inverters • Soil contamination from leaks and spills from the diesel generators	Minor
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor
	Infrastructure (waste	• E-waste generation	Minor

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Activity	Receptor	Associated Impact	Significance
	management facility)	• Waste disposal to existing waste management facility within the Project area	
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor

5.5.2.6 Potential Cumulative Impacts

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

The major existing activities within the Project area are farming and animal rearing. Given the nature of the activities associated with the proposed Project and the existing activities around the project area, the potential cumulative impacts of the Project on road traffic, ambient noise levels and groundwater availability is considered **low**.

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5.6 Risk and Hazard Assessment

5.6.1 Overview

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

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

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

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

Figure 5.3: Risk Assessment Matrix

5.6.2 Project Specific Risks and Hazards

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

5.6.2.1 Fire and Explosion

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

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

5.6.2.2 Electrocution

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

5.6.2.3 Occupational Hazards

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

5.7 Summary

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

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CHAPTER SIX:

MITIGATION MEASURES

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CHAPTER SIX

MITIGATION MEASURES

6.1 Introduction

Following the detailed description of the associated and potential impacts of the proposed Project in Chapter 5, the recommended mitigation measures for the identified negative impacts are presented in this chapter as well as the enhancement measures for the potential positive impacts. The implementation of all the mitigation measures shall be overseen by Engie Fenix Nigeria.

6.2 Mitigation Measures Approach

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

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

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

6.3 Mitigation Measures for the Identified Significant Negative Impacts

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

6.4 Mitigation Measures for the Identified Project Risks and Hazards

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

<u>Fire and Explosion</u>

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

<u>Electrocution</u>

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

<u>Occupational Hazards</u>

- Provision of an adequate work-positioning device system for workers shall be ensured.

- Hoisting and lifting equipment shall be rated and maintained and operators trained in their use.
- Appropriate Personal Protective Equipment shall be worn.
- Electrical installation shall be carried out by trained personnel in line with the approved procedures.

6.5 Enhancement Measures for Identified Positive Impacts

6.5.1 Reduction in Carbon Emissions

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

- An energy audit shall be conducted to determine areas within the communities that have the potential for higher power consumption (e.g. markets, shops, artisan workshops, etc.), to enable adequate distribution of power generated at the power plant.
- The Project will be designed and constructed to allow for further expansion in power generation and distribution capacity to meet the community's future demands.
- Engie Fenix shall encourage their prospective customers to implement energy conservation measures such as encouraging switching off appliances, use of energy-saving bulbs, purchase of low-energy appliances such as irons, electric cookers, televisions, refrigerators, etc.

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6.5.2 Direct Employment and Training

The Project will give rise to direct employment opportunities across different skill levels, from unskilled to highly skilled labour. Training for local people from skilled technicians shall also be carried out. The following measures shall be implemented to ensure that direct employment and training opportunities are maximized:

- A Labour and Employment Management Plan (LEMP) shall be developed prior to construction, detailing percentages and numbers of the workforce to be sourced from the local area and various demographics as well as influx management. The plan shall follow local and international employment guidelines.
- The EPC contractor shall provide notification to different groups in the community on specific jobs and skills required for the project, prior to the commencement of construction. Subsequently, the group leaders shall notify the local population prior to the commencement of construction of job opportunities and relevant skills/qualifications required to be employable on the Project.

- A Gender Action Plan shall be developed and implemented to ensure that the Project does not increase women's burden and that women not only contribute, but also benefit from it.
- The EPC contractor shall initiate training and skills development programmes prior to the commencement of construction, as a means of ensuring that members of the local workforce are up-skilled and can be employed on the Project.

During the operational phase of the Project, job opportunities will also be created. About 1-2 people will be employed at each project site as local operators. Periodic capacity building will be offered to the workforce.

6.5.3 Procurement and Indirect Employment

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

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

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Pre-construction Phase					
Site Selection	Land Use	• Displacement of temporary farmlands within three (3) sites.	Minor	▪ The affected farmers shall be allowed to harvest their crops before site clearing activities. ▪ The sites shall be fenced to avoid further encroachment by farming activities before site clearing.	Negligible
Site clearing and preparation	Soil	• Removal of top soil and soil compaction associated with site clearing • Increased erosion potential • Reduction in structural stability and percolative ability of soil	Minor	▪ Removal of vegetation and soil cover shall be restricted to the areas required for the Project. ▪ Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas. ▪ Disturbed areas will be rehabilitated as soon as possible to prevent erosion. ▪ The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. ▪ Clearing exceeding the approved working corridor shall be prohibited. ▪ Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Negligible
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor	▪ Site clearing shall be limited to the day time as much as possible (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr) ▪ Provision of adequate personal protective equipment (PPE) such as nose masks and safety boots shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Mobilization of personnel, materials and equipment to site	Workers Safety	• Injuries and accidents to workers during loading and off-loading construction materials.	Minor	▪ Mobilization of materials shall be limited to the day time as much as possible (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr) ▪ Provision of adequate PPE especially gloves and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties. ▪ Unregistered labourers and touts shall not be patronised for off-loading materials. ▪ The site shall be secured with perimeter fencing and/or security. ▪ Separate sanitary amenities and potable water facilities for men and women shall be provided.	Negligible
Construction Phase					
Civil and Electrical Works/ Installation Activities	Air Quality	• Air quality impacts due to emission from construction equipment • Increase in dust from cleared land and windblown stockpiles	Minor	▪ Regular maintenance and servicing of construction equipment /machinery shall be ensured. ▪ Only modern and well maintained equipment and machinery shall be used for construction activities. ▪ Routine water sprinkling shall be carried out to minimize dust generation during construction.	Negligible
	Ambient Noise	• Increase in noise level due to construction activities; • Disturbance to neighbouring community and local ecology	Minor	▪ Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). In the event that noisy activities are undertaken outside of the specified working hours, all noise receptors in the Project area shall be informed of such activities in advance. ▪ Construction machinery shall be turned off when not in use.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Machinery/equipment to be used for construction work shall meet industry best standard in relation to noise attenuation. ▪ Construction equipment shall be properly maintained and serviced. ▪ Major construction activities shall be limited to a particular area within the site. ▪ Construction-related vehicles shall be limited to access areas. ▪ Noise complaints related to the construction activities shall be assessed and appropriately addressed. ▪ Noise monitoring at locations with persistent noise complaints shall be maintained.	
	Soil	• Increased erosion potential as a result of construction activities such as excavation • Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor	▪ Excavation works shall not be executed under aggressive weather conditions. ▪ Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion. ▪ Disturbed areas shall be rehabilitated with erosion control plants (using native plant species) as soon as possible to prevent erosion. ▪ Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor	▪ A TMP shall be developed by the EPC Contractor and implemented. ▪ Speed limits for all construction-related vehicles shall be established and enforced. ▪ Construction related vehicles shall be regularly serviced and maintained. ▪ Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active. ▪ Drivers' competency shall be assessed and where required training shall be provided. ▪ A procedure for recording all construction related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc. ▪ A Grievance Redress Mechanism (GRM) shall be implemented for receiving complaints arising from damage to infrastructure and private property during construction activities. The EPC contractor shall receive the complaints and repair damages as quickly as possible.	Negligible
	Gender	• Discrimination during employment and training opportunities • GBV (sexual exploitation, sexual harassment, intimate partner	Minor	▪ A GBV Action Plan shall be implemented for the Project ▪ All workers on the project shall be required sign a code of conduct (CoC) to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) ▪ GBV sensitive channels for reporting in GRM shall be implemented for the Project	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		violence, poor working conditions)		▪ Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured. ▪ All workers shall be required to undergo regular training and refreshers on GBV ▪ The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	
	Construction workers safety	• Injury to construction workers during construction activities.	Minor	▪ Health and Safety Plan shall be developed and implemented by the EPC Contractor. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence ▪ Construction workers shall be sensitized and monitored on the need to be safety conscious. ▪ Daily toolbox talks prior to commencement of work activities shall be carried out. ▪ Construction activities shall be limited to daytime as much as possible. ▪ Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules. ▪ Proper safety signs and signage shall be placed at strategic locations within the site. ▪ PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers. ▪ A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented. ▪ The site shall be secured with perimeter fencing and/or security. ▪ Sanitary amenities and potable water shall be provided	
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases.	Minor	▪ Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. ▪ No person under the age of 18 shall be engaged to work on the project. The EPC Contractor shall ensure that children and minors are not employed directly or indirectly on the project ▪ Any child dropout should be reported to the relevant government agency ▪ The local community shall be informed of the Project activities prior to commencement of work. ▪ An induction and sensitization programme, including a Code of Conduct, for all construction workers shall be carried out prior to construction activities. This will increase sensitivity to local norms and customs, provide awareness to construction workers of appropriate and acceptable behaviours, and will govern worker interactions with the local community.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Awareness education about GBV/SEA/HIV/AIDS and other sexually transmitted diseases shall be created among the workforce and extended to the local community. ▪ The CoC shall include provisions to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse by workers within the local community. ▪ Public access shall be restricted to construction area via security fencing and appropriate signage. ▪ Substance abuse prevention and management programs shall be implemented for workers. ▪ Sanctions (e.g., suspension and dismissal) shall be introduced for workers involved in criminal activities ▪ Procedure for receiving and addressing community concerns shall be developed and implemented.	
Waste Disposal and Generation	Infrastructure (waste management facility)	• E-waste generation • Disposal of construction wastes to existing waste management facility in the Project area.	Minor	▪ A Waste Management Plan shall be developed by the EPC Contractor and implemented ▪ Training shall be provided for workers on safe storage, use and handling of e-waste on site. ▪ E-wastes generated shall be stored in appropriate locations set up at the Project site prior to recycling and/or disposal ▪ Waste receptacles shall be provided within a secured area for collection of solid waste. ▪ Construction vehicles and equipment shall be serviced regularly.	Negligible
	Soil	• Soil contamination from solid and	Minor	▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		liquid construction waste streams.		locations with impervious hardstanding and adequate secondary containment. ▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	
Commissioning Phase					
Plant Testing	Ambient noise	• Increase in ambient noise level	Minor	▪ The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ Strict compliance to the Standard Operating Procedures shall be ensured. ▪ The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.	Negligible
	Workers	• Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Minor	▪ Plant testing shall be carried out by experienced personnel. ▪ Adequate PPE shall be worn. ▪ The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project ▪ Strict compliance to the Standard Operating Procedures (SOPs) shall be ensured. ▪ Prior to the Plant commissioning, appropriate emergency equipment (such as first aid box, fire extinguishers) shall be provided onsite.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Plant testing shall be restricted to the daytime. ▪ Sanitary amenities and potable water shall be provided	
Operational Phase					
Power Generation and Evacuation	Air Quality	• Air emissions from the diesel generators • Effects of cloud cover and dust on the PV panels	Minor	▪ Strict compliance to the standard operating procedures for the diesel generators shall be ensured. ▪ Regular maintenance of diesel generators shall be ensured as required by the manufacturer. ▪ A cleaning schedule shall be developed and implemented for cleaning the panels installed at the project site during operations. ▪ The solar panels shall be inspected regularly for dust and rain damages and maintained according to manufacturer's instructions.	Negligible
	Noise	• Noise from diesel generators and inverters during power generation and evacuation	Minor	▪ Inverters shall be maintained as per manufacturer's recommendations and operated as per original specifications. ▪ The diesel generators shall be operated with the sound proof covers at all times. ▪ Project personnel shall use appropriate PPE (e.g. ear muffs) to reduce exposure to noise impact. ▪ Periodic maintenance of the diesel generators shall be carried out.	Negligible
	Health, safety and welfare of staff during Plant operation	• Electric shock, injuries to personnel associated with the Power Plant operations,	Minor	▪ Appropriate PPE shall be provided for workers. ▪ Training shall be provided to employees on emergency preparedness and responses. ▪ Provision of medical insurance scheme for employees shall be ensured.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		• Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions		▪ Appropriate safety signage shall be placed at strategic locations within the site. ▪ Strict compliance to the SOPs / code of conduct shall be ensured. ▪ A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	
	Gender	• Discrimination during employment and training opportunities • Gender issues	Minor	▪ Equal treatment of workers shall be ensured. ▪ Continuous implementation of the GBV Action Plan shall be sustained for the Project ▪ All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) ▪ GBV sensitive channels for reporting in GRM shall be implemented for the Project ▪ Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained. ▪ All workers shall be required to undergo regular training and refreshers on GBV ▪ Engie Fenix shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	Negligible
Routine Maintenance, Waste	Soil	• Soil contamination from fuel, used oil, spent batteries and inverters	Minor	▪ General housekeeping to ensure the site is not overgrown with grasses shall be maintained	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Generation and Disposal				▪ Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. ▪ General waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. ▪ WMP shall be implemented. ▪ Burning of waste shall be prohibited. ▪ Damaged/expired batteries, solar panels, inverters and electric components shall be returned to the manufacturer based on the Extended Producer Responsibility (EPR) model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site. ▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. ▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Operation workers shall be provided with adequate training on use, storage and handling of hazardous substances.	
	Infrastructure (waste management facility)	• E-waste generation • Waste disposal to existing waste management facility within the Project area	Minor	▪ A Waste Management Plan shall be developed by the O&M Contractor and implemented ▪ Training shall be provided for workers on safe storage, use and handling of e-waste on site. ▪ E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal ▪ Waste receptacles shall be provided within a secured area for collection of solid waste.	Negligible

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Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor	▪ Appropriate PPE shall be provided for workers. ▪ Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. ▪ Strict compliance to the SOPs shall be ensured.	Negligible
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor	▪ Water management plan shall be implemented ▪ Manual cleaning of the PV panels with water shall be regulated as much as practicable. The frequency of cleaning of PV panels with water is dependent on the rainfall pattern in the project area. During rainy season, cleaning is estimated to occur not more than thrice; however, during dry season the interval shall depend on the rate of dust accumulation. ▪ Periodic monitoring of groundwater resources in the Project's area of influence shall be implemented.	Negligible

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CHAPTER SEVEN:

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

The potential and associated impacts of the proposed solar mini-grid power projects in Niger State have been analyzed and documented in Chapter 5 of this report. The results show that if the recommended mitigation measures (presented in Chapter 6) are implemented, the identified impacts of the Project are not severe and can be reduced to as low as reasonably practicable. It is thus important that those recommended mitigation measures be translated into practical management actions, which can be adequately resourced and integrated into the Project phases.

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

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7.2 Objectives of the ESMP

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

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

The specific objectives of the ESMP are to:

- Promote environmental and social management and communicate the aims and goals of the ESMP;
- Ensure that all workers, subcontractors and others involved in the Project meet legal and regulatory requirements with regard to environmental management;
- Incorporate environmental and social management into Project design and

operating procedures;
- Serve as an action plan for environmental and social management for the Project;
- Provide a framework for implementing Project environmental and social commitments (i.e. mitigation measures identified in this report);
- Prepare and maintain records of Project environmental and social performance (i.e. monitoring, audits and non-compliance tracking).

7.3 Environmental and Social Management Measures

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

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

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Site Clearing and Preparation							
Removal of top soil and soil compaction	Removal of vegetation and soil cover shall be restricted to the areas required for the Project.	Inspection	Daily	Re-vegetated land	EPC Contractor	Engie Fenix Technical Manager	500
Increased erosion potential	Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Inspection	Daily	Installation of erosion prevention measures	EPC Contractor		
Reduction in structural stability and percolative ability of soil	Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas	Inspection	Daily	Stockpiles of removed soils	EPC Contractor		

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Table 7.1b: Social Management Measures for Pre-Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Site Selection							
Displacement of temporary farmlands within three (3) sites.	The affected farmers shall be allowed to harvest their crops before site clearing activities	Farmlands to be harvested before site clearing	Prior to mobilization to site / site clearing activities	Project site cleared of farming activities	EPC Contractor	Engie Fenix Technical Manager	-
	The sites shall be fenced to avoid further encroachment by farming activities before site clearing.	Erection of fence at the project sites	Prior to mobilization to site / site clearing activities	Fenced project sites			
Site clearing and preparation / Mobilization of Materials and Equipment to Site							
Injuries and accidents to workers during site clearing and preparation.	Site clearing shall be limited to the day time as much as possible (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr)	Daytime working hours	Daily	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager	500
	Provision of adequate personal protective equipment (PPE) such as nose masks and safety boots shall be ensured. All employees	Availability of PPE	Daily	PPE compliance			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	will be required to wear the appropriate PPE whilst performing their duties.						
Injuries and accidents to workers during loading and off-loading construction materials.	Provision of adequate PPE especially gloves and hard hats to workers shall be ensured. All employees shall be required to wear the appropriate PPE whilst performing their duties.	Availability of PPE	Daily	PPE compliance	EPC Contractor	Engie Fenix Technical Manager	-
	Unregistered labourers and touts shall not be patronised for off-loading materials.	Employment records of all staff on site	Once before commencement of mobilization	Labour Act			

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

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Civil and Electrical Works/ Installation Activities							
Air quality impacts due to emission from construction equipment; Increase in dust from cleared land and windblown stockpiles	Regular maintenance and servicing of construction equipment /machinery shall be ensured.	Maintenance records	Monthly during construction phase	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager	-
	Routine water sprinkling shall be carried out to minimize dust generation during construction.	Inspection	Daily during civil work activities	Adherence to measures			
Increase in noise level	Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Daytime working hours	Daily during construction phase	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager	500
	Construction machinery shall be turned off when not in use.	Inspection	Daily during construction phase	Adherence to measures			
	Construction equipment shall be properly maintained and serviced.	Maintenance records	Monthly during construction phase	Adherence to measures			
	Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly during construction phase	World Bank Good Practice Note on Addressing Grievances			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly during construction phase	FMEnv Noise limit World Bank Noise Limit	EPC Contractor	Engie Fenix Technical Manager FMEnv Niger State Ministry of Environment	200
Increased soil erosion potential; reduction in structural stability and percolative ability of soil	Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily during excavation activities	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager	-
	Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion.	Inspection	Daily during civil work activities	Adherence to measures			
	Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.	Inspection	Daily during civil work activities	Adherence to measures			
Waste Disposal and Generation							
E-waste generation	A Waste Management Plan shall be developed and implemented	Waste Management records	Weekly during construction phase	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager	200
	Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Training records	Once before commencement of construction	Certificates of completion of trainings			
	E-wastes generated shall be stored in appropriate locations on site prior to recycling and/or disposal	Waste consignment notes, waste receptacles on site	Weekly during construction phase	Adherence to measures			
Soil contamination from solid and liquid construction waste streams.	Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS Guidelines	EPC Contractor	Engie Fenix Technical Manager	200

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Training records	Once before commencement of construction	Certificates of completion of trainings			

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

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Civil and Electrical Works/ Installation Activities							
Discrimination during employment and training opportunities	Employment of workers for construction activities shall be open and fair	Employment records	Once before start of construction	Review of employment records	EPC Contractor	Engie Fenix Technical Manager	-
GBV (sexual harassment, intimate partner violence, poor working conditions)	A GBV Action Plan shall be developed and implemented for the Project	Implementation by the EPC Contractor	Once before start of construction	Evidence of implementation of the GBV action plan	EPC Contractor	Engie Fenix Technical Manager Niger State Ministry of Women Affairs and Social Development	500
	All workers shall be required to undergo regular training and refreshers on GBV	Organize regular onsite training and refreshers	Monthly during construction phase	Records of regular training and attendance	EPC Contractor		
	All workers on the project shall be required sign a code of conduct (CoC) that prohibits any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)	Develop CoC forms for workers	Once before start of construction	Signed CoC forms	EPC Contractor		
	GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish accessible GRM reporting channels	Monthly during construction	GRM records	EPC Contractor		
	Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of construction	Records of ongoing engagement and consultation with GBV service providers	EPC Contractor		

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of construction	Inspection of facilities to ensure adequacy	EPC Contractor		
Influx of people, increase in sexual transmitted diseases.	Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible.	Employment records and prepare a labour management plan	Once before start of construction	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager FMEnv Niger State Ministry of Environment	500
	The local community shall be informed of the Project activities prior to commencement of work.	Evidence of communication with local community	Once before start of construction	Adherence to measures			
	An induction and sensitization programme, including a Code of Conduct, for all construction workers shall be carried out prior to construction activities. This shall increase sensitivity to local norms and customs, provide awareness to construction workers of appropriate and acceptable behaviours, and shall govern worker interactions with the local community.	Induction records	Once before start of construction	Adherence to measures			
	Awareness education about HIV/AIDS and other sexually transmitted diseases shall be created among the workforce.	Training records	Once before start of construction	Adherence to measures			
	Public access shall be restricted to construction area via security fencing and appropriate signage.	Inspection	Daily during construction phase	Adherence to measures			
	Procedure for receiving and addressing community concerns shall be developed and implemented.	Consultations and grievance records	Weekly during construction phase	World Bank Good Practice Note on Addressing Grievances			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Road damage, traffic and safety impacts	Traffic Management Plan (TMP) shall be developed and implemented.	TMP implementation records	Daily during construction phase	Benchmarks stated in the TMP	EPC Contractor	Engie Fenix Technical Manager	500
	Speed limits for all construction-related vehicles shall be established and enforced.	Inspection	Daily during construction phase	Adherence to measures			
	Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active.	Safety signs and barriers	Once before commencement of construction	Adherence to measures			
	Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commencement of construction	Passing of competency assessment or training completion certificates			
	A procedure for recording all construction related traffic incidents/accidents shall be developed and implemented.	Incident forms	Daily during construction phase	Completed incident forms			
Injury to construction workers during construction activities	Health and Safety Plan shall be developed and implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan	EPC Contractor	Engie Fenix Technical Manager FMEnv Niger State Ministry of Environment	1000
	Construction workers, including local hire workers shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to commencement of work activities shall be carried out.	Daily toolbox records	Daily during construction phase	Benchmarks stated in Health and Safety Plan			
	Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.	Qualified and dedicated safety officer	Once before commencement of construction	Adherence to measures			
	PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored.	Availability of PPE	Daily during construction phase	PPE compliance			
	Safety training focused on safe working practices, information on specific hazards,	Training records	Once before commencement of construction	Certificates of completion of trainings			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	first aid and fire-fighting shall be included in the induction programme for workers.						
	A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented.	Completed grievance forms	Weekly during construction phase	Adherence to measures			

Table 7.3a: Environmental Management Measures for Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant testing							
Increase in ambient noise level due to Plant testing	Strict compliance to the SOPs shall be ensured.	SOPs	Once before commissioning	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager	-
	Commissioning activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily during commissioning phase	Adherence to measures			
	The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation	Inspection	Daily during commissioning phase	Adherence to measures			

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Table 7.3b: Social Management Measures for Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant testing							
Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Plant testing shall be carried out by experienced personnel.	Qualified and dedicated Engineer	Once before commissioning	Adherence to measures	EPC Contractor	Engie Fenix Technical Manager	500
	Adequate PPE shall be worn.	Availability of PPE	Once before commissioning	Adherence to measures			
	Prior to the Plant commissioning, appropriate emergency equipment such as first aid box, fire extinguishers) shall be provided onsite.	Availability of emergency response equipment	Once before commissioning	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project.	Availability of SOPs	Once before commissioning	Adherence to measures			
	The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations.	Inspection	Once before commissioning	Adherence to measures			

Table 7.4a: Environmental Management Measures for Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
Air emissions from the diesel generators,	Strict compliance to the standard operating procedures for the diesel generators shall be ensured.	Inspection	Monthly during operations	Adherence to measures	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager	500
	Regular maintenance of diesel generators shall be ensured as required by the manufacturer	Inspection	Monthly during operations	Adherence to measures			
Dust accumulation on the solar panels	A cleaning schedule shall be developed and implemented for cleaning the panels installed at the project site during operations	Inspection	Monthly during operations	Adherence to measures	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager	200
	The solar panels shall be inspected regularly for dust and rain damages and maintained according to manufacturer's instructions.	Inspection	Monthly during operations	Adherence to measures			
Noise from diesel generators and inverters during power generation and evacuation	Inverters shall be maintained as per manufacturer's recommendations and operated as per original specifications.	Inspection	Monthly during operations	Adherence to measures	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager	-
	The diesel generators shall be operated with the sound proof covers at all times.	Inspection	Monthly during operations	Adherence to measures			
	Project personnel shall use appropriate PPE (e.g. ear muffs) to reduce exposure to noise impact.	Inspection	Monthly during operations	Adherence to measures			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Routine Maintenance, Waste Generation and Disposal							
E-waste generation and disposal	Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Training records	Once before commencement of construction	Certificates of completion of trainings	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager	1000
	E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal	Waste consignment notes, waste receptacles on site	Weekly during construction phase	Adherence to measures			
	Waste receptacles shall be provided within a secured area for collection of solid waste.	Waste consignment notes, waste receptacles on site	Weekly during construction phase	Adherence to measures			
Soil contamination from spent batteries and inverters	Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. Spent batteries and inverters shall be sent to manufacturers in line with the Extended Producer Responsibility (EPR) policy.	Consignment notes for spent batteries to manufacturers for recycling	Yearly	World Bank General EHS Guidelines	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager FMEnv Niger State Ministry of Environment	1000
	WMP shall be implemented.	WMP implementation records	Quarterly during operation phase	Benchmarks stated in WMP World Bank General EHS Guidelines			
	Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment.	Inspection	Continuously during operations phase	Adherence to measures World Bank General EHS Guidelines			
	Portable spill containment and clean-up kits shall be available onsite.	Availability of spill response equipment	Quarterly during operation phase	Functional spill equipment			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
				Adherence to measures			
	Operation workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Training records	Quarterly during operation phase	Certificates of completion of trainings			
Groundwater abstraction from cleaning of PV panels	Water management / conservation plan shall be implemented	Implementation records of water management plan	Quarterly during operations	Benchmarks in water conservation plan World Bank General EHS Guidelines	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager	200

Table 7.4b: Social Management Measures for Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
GBV (sexual harassment, intimate partner violence, poor working conditions)	Continuous implementation of the GBV Action Plan shall be sustained for the Project	Implementation of the measures in the GBV action plan	Continuously during operations	Evidence to show implementation of the GBV action plan	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager	500
	All workers shall be required to undergo regular training and refreshers on GBV	Organize regular onsite training and refreshers	Monthly during operation phase	Records of attendance			
	All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)	Develop CoC forms for Engie Fenix Local Operators	Once before start of operations	Signed CoC forms			
	GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish GRM reporting channels	Once before start of operations	GRM records			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of operations	Records of ongoing engagement and consultation with GBV service providers			
	Engie Fenix shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of operations	Inspection of facilities to ensure adequacy			
Health, safety and welfare of staff during Plant operation	Provision of medical insurance scheme for employees shall be ensured.	Employment forms of employees	Quarterly during operations	Adherence to measures	Engie Fenix Local Operators	Engie Fenix Technical Manager Engie Fenix Cluster Manager	1000
	Appropriate safety signage shall be placed at strategic locations within the site.	Safety signs	Quarterly during operations	Adherence to measures			
	Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			
	A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	Completed grievance forms	Monthly during operations	Adherence to measures			
Routine Maintenance, Waste Generation and Disposal							
Electric shock, injuries to personnel during maintenance	Appropriate PPE shall be provided for workers.	Availability of PPE	Quarterly during operations	Adherence to measures	Engie Fenix Local Operators Engie Fenix Cluster Manager	Engie Fenix Technical Manager	500
	Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			

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7.4 Roles, Responsibilities and Accountabilities

The main responsibility for overseeing the implementation of the ESMP lies with the Engie Fenix Project Management Team throughout the project life span. However, conformance with the specific environmental measures detailed in Chapter Six of this report shall be ensured by the EPC Contractor during the construction phase and Engie Fenix Technical Manager at the operational phase of the Project.

7.4.1 Pre-construction Phase

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

Engie Fenix Head of Mini-Grid Activities

- Select the lands for the proposed Projects,
- Appoint a Technical Manager,
- Arrange and ensure adequate training is carried out for the Technical Manager,
- Review the ESMP from the consultant,
- Ensure the Engie Fenix commitment to the ESMP implementation.

Engie Fenix Technical Manager

- Attend adequate training on ESMP implementation,
- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures,
- Report to Engie Fenix Head of Mini-Grid Activities on ESMP compliance and non-compliance issues.

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EPC Contractor

- Familiarize with ESMP requirements,
- Ensure that all personnel are made aware of the management measures/plans that are to be implemented,
- Report to the Engie Fenix Head of Mini-Grid Activities and Engie Fenix Technical Manager on ESMP compliance and non-compliance issues,
- Implement ESMP requirements relevant to work being undertaken.

7.4.2 Construction Phase

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

Engie Fenix Head of Mini-Grid Activities

- Supervise the activities of the EPC contractor by reviewing reports on ESMP issues,

- Discuss ESMP improvements with Engie Fenix Technical Manager to address non-compliance and upcoming issues,
- Monitors the implementation of the ESMP.

Engie Fenix Technical Manager

- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures,
- Report to Engie Fenix Head of Mini-Grid Activities on ESMP compliance and non-compliance issues.

EPC Contractor

- Implement ESMP requirements relevant to work being undertaken,
- Report to the Engie Fenix Technical Manger on ESMP compliance and non-compliance issues.

Niger State Ministry of Women Affairs and Social Development and GBV/SEA service provider

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken,
- Discuss ESMP improvements with EPC contractor and Engie Fenix Technical Manager to address non-compliance and upcoming issues.

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FMEnv Representatives

- Monitor the implementation of ESMP requirements (impact mitigation monitoring) relevant to work being undertaken,
- Discuss ESMP improvements with EPC Contractor, Engie Fenix Technical Manager, and Engie Fenix Head of Mini-Grid Activities to address non-compliance and upcoming issues.

Niger State Ministry of Environment Representatives

- Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken,
- Discuss ESMP improvements with EPC Contractor, Engie Fenix Technical Manager, and Engie Fenix Head of Mini-Grid Activities to address non-compliance and upcoming issues.

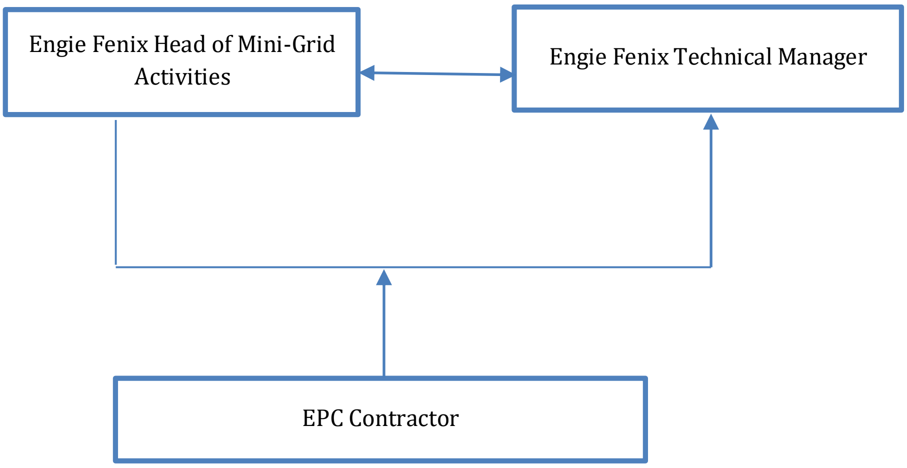

Figure 7.1: Roles and Responsibilities for the Pre Construction and Construction Phase

7.4.3 Operational Phase

Engie Fenix Head of Mini-Grid Activities

- Supervise the activities of the local operators by reviewing reports on ESMP issues,
- Suggest ESMP improvements to Engie Fenix Cluster Managers and Engie Fenix Technical Manager to address non-compliance and upcoming issues.

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Engie Fenix Cluster Manager

- Appoint local operators,
- Supervise the activities of the Local operators by reviewing reports on ESMP issues,
- Discuss ESMP improvements with Engie Fenix Technical Manager to address non-compliance and upcoming issues.

Engie Fenix Technical Manager

- Supervise the activities of the Local operators and ensure compliance ESMP with mitigation measures,
- Report to Engie Fenix Cluster Manager and Engie Fenix Head of Mini-Grid Activities on ESMP compliance and non-compliance issues.

Local Operators

- Implement ESMP requirements relevant to work being undertaken,
- Report to the Engie Fenix technical Manager and Engie Fenix Cluster Manager on ESMP compliance and non-compliance issues.

Niger State Ministry of Women Affairs and Social Development and GBV/SEA service provider

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken,

- Discuss ESMP improvements with Local operators, Engie Fenix Technical Manager, and Engie Fenix Head of Mini-Grid Activities to address non-compliance and upcoming issues.

FMEnv Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken,
- Discuss ESMP improvements with Local operators, Engie Fenix Technical Manager, and Engie Fenix Head of Mini-Grid Activities to address non-compliance and upcoming issues.

NESREA Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken,
- Discuss ESMP improvements with Local operators, Engie Fenix Technical Manager, and Engie Fenix Head of Mini-Grid Activities to address non-compliance and upcoming issues.

Niger State Ministry of Environment Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken,
- Discuss ESMP improvements with Local operators, Engie Fenix Technical Manager, and Engie Fenix Head of Mini-Grid Activities to address non-compliance and upcoming issues.

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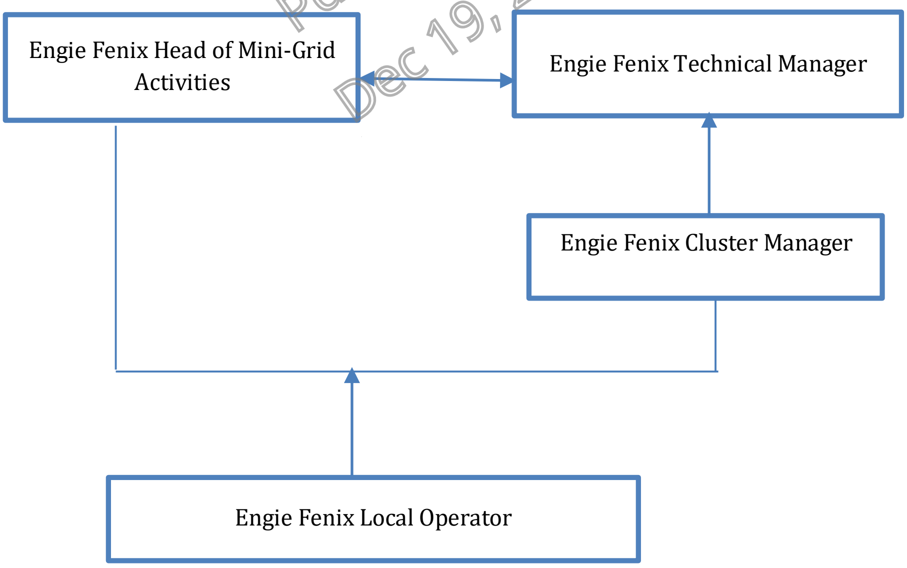

Figure 7.2: Roles and Responsibilities for the Operational Phase

7.5 Additional Management Plans

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

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

7.5.1 Stakeholder Engagement Plan

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

- Ensuring stakeholder inclusion and involvement across the various phases of the project;
- Ensuring clarity and understanding through an open, inclusive and transparent process of culturally appropriate engagement and communication undertaken to ensure that stakeholders are well informed about the proposed Project;
- Building and maintaining productive relationship between Engie Fenix and its various stakeholders through supporting open dialogue;
- Engaging vulnerable groups through an open and inclusive approach to consultation, thereby increasing the opportunity for stakeholders to provide comment and voice their concerns on the proposed Project;
- Managing expectations to ensure that the proposed Project does not create or allow unrealistic expectations to develop amongst stakeholders about proposed Project benefits. The engagement process will serve as a mechanism for understanding and managing stakeholder and community expectations, where the latter will be achieved by disseminating accurate information in an accessible way.
- Ensuring compliance with both local regulatory requirements and international best practice.
- Ensuring stakeholders are free of external manipulation or coercion.

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

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

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

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

7.5.2 Emergency Preparedness and Response Plan (EPRP)

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

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

- o Identification of the emergency scenarios and the development of appropriate and specific emergency response procedures for each scenario;
- o Training of emergency response teams on the appropriate procedures and the use of emergency response equipment;
- o Identification of emergency contacts and support services and the development of effective communication systems / protocols;
- o Emergency equipment and facilities must be provided (e.g., first aid stations, fire-fighting equipment, personal protective equipment);
- o Development of decontamination / clean-up procedures and identify critical remedial measures to contain, limit and reduce pollution;

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- Identification of potential risk relating the uncontrolled release of hazardous materials and the preparation of a spill prevention, control, and response plans including:
    - Training of operators on spill prevention.
    - Implementation of inspection programmes to confirm the integrity of secondary containment structures and equipment.
    - Development of standard operating procedures for filling containers or equipment and the transfer of hazardous materials.
    - Identification and availability of the appropriate personal protective equipment and equipment.

7.5.3 Traffic Management Plan (TMP)

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

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

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7.5.4 Waste Management Plan (WMP)

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

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

7.5.5 Occupational Health and Safety (OHS) Plan

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

- Identification of potential hazards and development of responses to eliminate sources of risk or minimize workers' exposure to hazards;

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

7.5.6 *Local and Employment Management Plan (LEMP)*

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

- Targets for employing local labour;
- Targets for work experience opportunities;
- Notification of all employment and training opportunities prior to them being advertised elsewhere;
- Measures to provide verifiable monitoring information regarding training and employment. The training status for all workers must be recorded;

7.5.7 *Water Conservation Plan*

The Plan shall address the appropriateness of water conservation, and efficient use of groundwater for construction activities and cleaning of PV panels during the operational phase of the Project.

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7.5.8 *Gender-Based Violence (GBV) Action Plan*

A Gender Action Plan (GAP) is a key gender integration tool and mechanism for ensuring gender-inclusive design and implementation of projects. GAPs give visibility to and accountability for gender inclusion by making it tangible and explicit in program and project design and implementation. Engie Fenix Nigeria shall ensure that the GAP includes quotas, targets, activities, and design features to address gender-equality issues, and to facilitate women's involvement, participation in, and tangible benefits from the project.

7.5.9 *Corporate Social Responsibility (CSR) Plan*

Engie Fenix Nigeria intends to implement the following activities as CSR for the beneficiary communities:

1. Establish a business incubation programme at the mini-grid sites, where local entrepreneurs will be trained to create new business initiatives and/or improve the existing ones. The company will be partnering with an NGO that delivers such informal trainings;
2. Employment for the locals within the communities. This will include; construction support team, security personnel and a local mini-grid operator

3. The company also plans to support health care facilities within the communities with a discounted tariff

7.5.10 Summary of Additional Management Plans

Table 7.5 summarizes the additional management plans required for the Project, including the cost estimate for developing each of the plans.

Table 7.5: Additional Management Plans and Timing for Development

S/N	Plan	Timing for Development	Cost Estimates (US Dollars)
1.	Emergency Preparedness and Response Plan	Pre-construction	2000
2.	Traffic Management Plan	Pre-construction	2000
3.	Waste Management Plan	Pre-construction	3000
4.	Occupational Health and Safety	Pre-construction	2000
5.	Local and Employment Management Plan	Pre-construction	1500
6.	Water Conservation Plan	Pre-construction	1000
7.	Gender Action Plan	Pre-construction	2000
Total			13,500

7.6 Environmental Monitoring Programme

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Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Table 7.6 summarizes the environmental monitoring programme for the Project.

Table 7.6: Environmental Monitoring Programme for the proposed Project

Environmental Components/ Matrix	Sampling Locations	Sampling Method	Environmental/ Social Parameters to be monitored	Compliance Requirement	Frequency of Monitoring	Responsible Party	Project Development Phase	Estimated Cost (US Dollars)
Atmosphere (Air Quality & Noise)	• Project Site • Project site AoI	• Air Quality Monitoring Equipment • Sound level meter	TSP, CO, NO_x, SO_x, Noise Level (dBA)	FMEnv/ WHO/ World Bank	Monthly monitoring; Monthly reporting	EPC Contractor	• Construction Phase	1000
Groundwater Quality	Borehole/well close to the project sites	Thermometer, Water sampler, Turbidity meter, pH meter, AAS etc.	Temperature, pH, salinity, TDS, conductivity, DO, BOD, TOC, COD, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals, TSS and Turbidity	FMEnv/ WHO	Quarterly monitoring and reporting	EPC Contractor Engie Fenix Technical Manager	• Construction Phase • Operations Phase	2000
Soil	Unpaved sections of the Plant	Composite soil samples collection for laboratory analysis.	pH, Moisture, TOC, THC, TPH, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals.	NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor Engie Fenix Technical Manager	• Construction Phase • Operations Phase	2000
Solid Waste	Operational areas	Monitor the handling and disposal of solid wastes generated onsite; waste tracking documentation.	Operational solid wastes including used packaging waste.	FMEnv/NESREA/ World Bank	Monthly monitoring; Quarterly reporting	EPC Contractor Engie Fenix Technical Manager	• Construction Phase • Operations Phase	500
Health and Safety	Workers and Operational areas	Observe compliance to PPE and unsafe working conditions	Health and Safety Plan	FMEnv/NESREA/ World Bank	Daily monitoring; Quarterly reporting	EPC Contractor Engie Fenix Technical Manager	• Construction Phase • Operations Phase	2000
Training	Workers	Observe compliance with existing training plan	Training plan and records	FMEnv/NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor Engie Fenix Technical Manager	• Construction Phase • Operations Phase	2000
General Housekeeping	Construction sheds and operational areas	Observe cleanliness and aesthetics of Plant	Cleanliness and aesthetics of Plant	FMEnv/NESREA/ World Bank	Daily monitoring; Quarterly reporting	EPC Contractor Engie Fenix Technical Manager	• Construction Phase • Operations Phase	500
Stakeholder Engagement	• Local community • Regulatory agencies	Observe evidence of stakeholder consultations	Stakeholder Engagement Plan	FMEnv/NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor Engie Fenix Technical Manager	• Construction Phase • Operations Phase	1000

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7.7 Training, Awareness and Capacity Building

Engie Fenix Nigeria shall identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environmental or social conditions. The Project recognizes that it is important that employees at each relevant phase of the Project are aware of the potential impacts of their activities; and roles and responsibilities in achieving conformance with the management measures documented in this ESMP. This shall be achieved through a formal training process.

In addition, training for local community on general environmental awareness and ESMP mitigation measures pertaining to community health, safety and security shall as be provided as indicated in Table 7.7 below.

Table 7.7: Institutional Capacity Strengthening Plan

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

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7.8 Implementation Schedule and Reporting

The implementation of the ESMP shall take place from the planning stages to ensure quality equipment and support services is sourced, through construction, commissioning, operation to decommissioning phases. Once monitoring of the ESMP begins the officers responsible shall report all issues identified to respective authorities in Engie Fenix Nigeria and corrective/ remedial actions taken without delay to ensure optimal performance of the Project while promoting environmental sustainability.

Also, Engie Fenix Nigeria shall keep the regulatory authorities (FMEnv, NESREA, Niger State Ministry of Environment) informed of the Project performance with respect to E&S related matters through reports that shall be made available to the regulators when required. Engie Fenix Nigeria shall provide appropriate documentation of HSE related activities, including internal inspection records, training records, and reports to the relevant authorities.

7.9 ESMP Costing

Table 7.8 below provides the summary of cost estimate required to effective and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed Project.

Table 7.8: ESMP Costing

S/N	Fundamental ESMP Activities	Cost Estimates (US Dollars)
1.	Pre-construction phase E&S management activities	1,000
	Construction phase E&S management activities	3,600
	Commissioning phase E&S management activities	500
	Operational phase E&S management activities	4900
2.	Preparation of additional management plans	13,500
3.	Institutional Capacity Strengthening Programme	1,500
4.	Monitoring and Evaluation Programme	11,000
Total		**36,000**

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CHAPTER EIGHT:

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

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CHAPTER EIGHT

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

8.1 Introduction

This chapter discusses the activities associated with the decommissioning of the proposed solar mini-grids at each project sites, including the potential impacts associated with the decommissioning activities as well as the environmental and social measures to address the issues. In addition, the overview of remediation plan after the decommissioning/closure of the Project is provided.

8.2 Decommissioning Activities

Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle. The average life span of the solar Photovoltaic (PV) power plant to be provided as part of the proposed Project is 25 years (which can be extended through regular maintenance) while the training centre can last for 40 years or more. Even after the 25 years, the PV panels can still generate up to 90% of the design capacity.

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The decommissioning activities will typically include the following:

- Dismantling and removal of PV panels and associated infrastructure (mounting structure, power evacuation route, inverters, transformers, batteries, etc.);
- Removal of any sub-surface installations (e.g. underground cables);
- Waste generation and management;
- Rehabilitation of any impacted environmental component (e.g. soil).

8.3 Management of Decommissioning Activities

In the event of decommissioning, the management of Engie Fenix Nigeria, shall ensure that the Project site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be invoked. The tasks will include, amongst others:

- Evacuation of the dismantled PV panels and other related items (such as inverters, and control devices) to the manufacturers for recycling;
- Transportation of spent batteries to recycling facilities;
- Restoration of the Project site to baseline conditions (as much as practicable) in line with legislative and regulatory requirements.
- Assessing the residual impact, if any, the project has on the environment.

- Monitoring the abandoned project environment as necessary.

Decommissioning activities will only begin after due consultation with the relevant stakeholders including the regulatory authorities. The decommissioning activities shall be carried out in line with the relevant provisions of the National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the FMEnv.

Typically, the following actions shall be undertaken for decommissioning:

- An updated plan which takes into account the most cost-effective and best practicable methods, legal requirements and industry practices at that time for the facility decommissioning shall be developed and submitted to the FMEnv and other relevant regulatory authorities for approval. The plan shall include, but not limited to the following:
    - Description of the site and components to be decommissioned.
    - Description of the decommissioning scope, objectives, end state and strategy;
    - Activities to be performed during the decommissioning;
    - Schedule of decommissioning activities;
    - Estimate of the decommissioning cost;
    - Estimated inventory of waste streams to be generated during the decommissioning and handling techniques;
    - Decommissioning team (qualifications, roles and responsibilities)
- To ensure that due consideration is given to all options a detailed evaluation of facility decommissioning options shall be carried out. The options will include facility mothballing, partial facility decommissioning or complete site decommissioning. The evaluation will consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environment friendly options for the Project decommissioning.
- A risk assessment shall be conducted to ensure that nothing, which could be constituted as a hazard for other users of the site or for the environment in general, will be left at the site. The Project site shall be left in a safe and environmentally acceptable condition.
- Hazard identification and analysis shall be conducted to determine special safety concerns to be addressed.
- An appropriate Health, Safety and Environment (HSE) plan shall be implemented to ensure that the decommissioning activities are carried out in an environmentally sound manner and in conformity with relevant laws and regulations guiding such operations
- Third party notifications shall be carried out before any demolition and shall be conducted in a phased sequence.

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- Socio-economic considerations of facility decommissioning shall be carried out. These will include assessment of potential effects associated with termination of employment (at the end of operational phase) and the measures to minimize the effects by:
    - Ensuring that employees are fully informed about the decommissioning and how it will affect them before the project finally closes.
    - Building community capacity to manage opportunities and impacts arising from the decommissioning and post-decommissioning phase of the Project.
    - Providing training to build local skills tailored to project decommissioning and post-decommissioning activities (e.g. equipment dismantling, rehabilitation activities, monitoring, etc.).
    - Providing training to transfer project-learned skills to alternative and secondary industries tailored to respond to market economy.
- An effective waste management plan shall be developed for the decommissioning activities. The decommissioning options for redundant structures and equipment will include: the complete dismantling of structures and equipment and the return of all components to the equipment manufacturer for recycling. A detailed record of all suitable recycling materials shall be maintained.

The environmental and social management measures for the identified potential impacts of the decommissioning activities are presented in Table 8.1.

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8.4 Abandonment Plan

Prior to site abandonment, Engie Fenix Nigeria shall establish a standard procedure for incorporating the following practices:

- Identification of the components of the Project that will be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the Project equipment/material applicable;
- Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and
- Appropriate site rehabilitation programs (including re-vegetation of the site with native plant species) to return the Project site to its original status (as much as possible).

The decommissioning, abandonment and/or closure programme shall generally be managed by a team of competent personnel from Engie Fenix Nigeria Project Management Team (PMT), the Federal Ministry of Environment and the Niger State

Ministry of Environment. A close out report shall be prepared and archived for future reference.

8.5 Roles, Responsibilities and Accountabilities for Decommissioning Phase

The key personnel and institutions with major roles in the implementation and monitoring of environmental and social measures for the Project decommissioning/closure are as follows:

Contractor(s) Engaged for Decommissioning Activities

- Implement environmental and social measures and management actions put in place for the decommissioning activities.

ENGIE FENIX NIGERIA-PMT

- Supervise the activities of the contractor(s) engaged for decommissioning purpose by ensuring that the recommended environmental and social measures and management actions are implemented.
- Discuss environmental and social management plan improvements with the Engie Fenix Technical Manager to address non-compliance and upcoming issues.

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Engie Fenix Local Operator

- Directly monitor the activities of the contractor(s) engaged for decommissioning and ensure compliance to the implementation of environmental and social measures and management actions put in place to address potential impacts and risks associated with the decommissioning activities.
- Report to the Engie Fenix Technical Manager on contractor's performance regarding the implementation of environmental and social measures.

Engie Fenix Technical Manager

- Jointly supervise the activities of the contractor(s) engaged for decommissioning
- Suggest environmental and social management plan improvements to Engie Fenix Nigeria PMT to address non-compliance issues and upcoming issues.

FMEnv/Niger State Ministry of Environment Representatives

- Approve the decommissioning plan for the Project
- Monitor the implementation of environmental and social measures and management actions documented in the decommissioning plan.
- Discuss environmental and social management plan improvements to Engie Fenix Nigeria PMT to address non-compliance issues and upcoming issues.

Table 8.1: Environmental and Social Management Measures for Decommissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Removal of PV panels, batteries and inverters; demolition of buildings and associated facilities							
Soil contamination due to waste generation; soil compaction;	Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	Engie Fenix Nigeria PMT Engie Fenix Cluster Manager FMEnv Niger State Ministry of Environment	5000
	Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion	Inspection	Daily	Adherence to measures			
	Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment (bund wall). Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily	Adherence to measures World Bank General EHS Guidelines			
	PV panels, batteries and inverters shall be collected and returned to the manufacturer for recycling.	Consignment notes for batteries to recycling plants	Daily	World Bank General EHS Guidelines			
	All impacted soil area shall be re-vegetated with native plant species	Inspection	Daily	Re-vegetated land			
	A decommissioning plan approved by the relevant regulatory authorities shall be developed and implemented.	Implementation records of decommissioning plan	Daily	Benchmarks in decommissioning plan			
Air quality impact; increase in dust level.	Dust suppression measures shall be implemented.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	Engie Fenix Nigeria PMT	1000
	Decommissioning equipment shall be properly serviced and maintained.	Inspection; Maintenance records	Before commencement of	Adherence to measures			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
			decommissioning activities			Engie Fenix Cluster Manager FMEnv Niger State Ministry of Environment	
Discomforting noise from decommission-ing equipment and related activities	Noise suppression equipment (e.g. mufflers) shall be fitted on decommissioning equipment / machinery.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	Engie Fenix Nigeria PMT Engie Fenix Cluster Manager FMEnv Niger State Ministry of Environment	2000
	Decommissioning activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily	Adherence to measures			
	Equipment shall be turned off when not in use.	Inspection	Daily	Adherence to measures			
	Equipment shall be properly maintained and serviced.	Inspection; Maintenance records	Once before commencement	Adherence to measures			
	Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly	World Bank Good Practice Note on Addressing Grievances			
	Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly	FMEnv Noise limit World Bank Noise Limit			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Groundwater and surface water contamination due to waste generation	Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Training records	Once before commencement	Certificates of completion of trainings	Contractor(s) engaged for facility decommissioning	Engie Fenix Nigeria PMT Engie Fenix Cluster Manager FMEnv Niger State Ministry of Environment	1500
	Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily	Adherence to measures World Bank General EHS Guidelines			
	Waste Management Plan shall be implemented.	WMP implementation records	Daily	Benchmarks stated in WMP World Bank General EHS Guidelines			
Traffic due to transportation of dismantled equipment and materials from site including wastes	TMP shall be implemented.	TMP implementation records	Daily	Benchmarks stated in the TMP	Contractor(s) engaged for facility decommissioning	Engie Fenix Nigeria PMT Engie Fenix Cluster Manager FMEnv Niger State Ministry of Environment	2500
	Appropriate barriers and signage shall be provided to demarcate areas in which traffic is active.	Safety signs and barriers	Once before commencement	Adherence to measures			
	Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commencement	Passing of competency assessment or training completion certificates			

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	**Frequency**	**Performance Indicator**	**Implementation**	**Monitoring**	
	A procedure for recording all decommissioning related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc.	Incident forms	Daily	Completed incident forms			
Exposure to injuries, electrical shock, slip, trip and fall	All workers involved in the decommissioning activities shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to commencement of work activities shall be carried out.	Daily toolbox records	Daily	Benchmarks stated in Health and Safety Plan	Contractor(s) engaged for facility decommissioning	Engie Fenix Nigeria PMT Engie Fenix Cluster Manager FMEnv Niger State Ministry of Environment	2500
	Appropriate PPE shall be provided for workers.	Availability of PPE	Daily	PPE compliance			
	Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.	Qualified and dedicated safety officer	Once before commencement	Adherence to measures			
	Health and safety plans shall be implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan			

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CHAPTER NINE:

CONCLUSION AND RECOMMENDATIONS

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CHAPTER NINE

CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion and Recommendations

The ESIA of the proposed solar mini-grid projects in Niger State has been conducted in accordance with the relevant requirements of FMEnv guidelines and the applicable World Bank Safeguard Policies, specifically the Operational Policy 4.01 triggered by the proposed Project.

The ESIA study consists of a number of key steps including: desktop review, scoping, consultations with relevant stakeholders including relevant government authorities and potentially affected community in the Project's area of influence, field data gathering, laboratory analysis of field samples, potential impact identification and evaluation, development of mitigation measures and environmental management plan, report writing and disclosure.

The essence of the ESIA process is aimed at ensuring informed decision-making and environmental accountability, and to assist in achieving environmentally sound operation and social acceptance throughout the life cycle of the proposed Project.

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Consistent with the regulatory standards, the assessment of the environmental status and the socio-economic aspects of the proposed Project's area of influence have been carefully carried out using accepted scientific methodology. Evaluation of associated and potential impacts of the proposed Project identified both positive and negative interactions with the receiving biophysical and socio-economic environment.

The identified negative impacts of the proposed Project were mostly of minor to moderate significance, and they are largely site-specific and localized. The preferred sites for the proposed Project within the beneficiary communities do not trigger any major physical and economic displacement. In addition, there are no cultural resources within and around any of the Project sites that would be affected during the Project development and operation. The identified potential negative impacts include:

- Decreased in ambient air quality due to construction and decommissioning activities.
- Increase in ambient noise level due to construction and decommissioning activities.
- Decrease in soil quality due to improper management of generated wastes during construction, operation and decommissioning.

- Minimal loss of terrestrial flora species during site preparation for construction activities.
- Environmental nuisance due to improper disposal of e-waste including spent/damaged batteries.
- Occupational health and safety issues during construction, operation and decommissioning.

Based on the nature and extent of the proposed Project and the findings of this study, it is believed that the potential negative impacts associated with the proposed Project can be mitigated to as low as reasonably practicable through the implementation of the proffered mitigation measures documented in Chapter 6 of this report, while the positive impacts can also be enhanced. In addition, an ESMP has been established (refer to Chapter 7 of this report) to assess the efficiency and effectiveness of the recommended mitigation measures and ensure long-term monitoring of the Project.

9.2 Recommendations

The ESIA study recommends the following:

1 Engie Fenix Nigeria, through its Project Management Team (PMT), shall ensure that the proposed Project is developed and operated in an environmentally sustainable manner by properly managing the processes/activities that may bring about disturbances to the environment through the implementation of the recommended mitigation measures and the ESMP.

2 Continuous monitoring of environmental and social performance of the Project shall be ensured, including periodic consultation with the relevant regulatory authorities, the potentially affected community, and other relevant stakeholders throughout the Project life cycle.

3 Implementation of the Project's Stakeholder Engagement Plan (including grievance redress mechanism) shall be maintained.

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APPENDICES

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APPENDIX 4.1

Photo Log of Baseline Survey Activities

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Photo Log of Baseline Data gathering Activities within the Communities

Community Name	Dokoji Community
AIR QUALITY AND NOISE SAMPLING 	SOIL SAMPLING 
GROUNDWATER SAMPLING 	
SOCIOECONOMIC SURVEY	
	
	

Community Name	Gbangba Community
SOIL SAMPLING	**GROUNDWATER SAMPLING**
	
SOCIOECONOMIC SURVEY	
	
	

Community Name	Raggida Hausawa Community
AIR QUALITY AND NOISE SAMPLING  	**SOIL SAMPLING** 
GROUNDWATER SAMPLING 	
SOCIOECONOMIC SURVEY	
	
	

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Community Name	Kuchitagi Community
AIR QUALITY AND NOISE SAMPLING	SOIL SAMPLING
	
GROUNDWATER SAMPLING	
	
SOCIOECONOMIC SURVEY	
	
	

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Community Name	Nakoko Siyidi Community
AIR QUALITY AND NOISE SAMPLING	GROUNDWATER SAMPLING
	

SOIL SAMPLING

SOCIOECONOMIC SURVEYS

	
	

Community Name	Sheshimandiko Community
AIR QUALITY AND NOISE SAMPLING	**SOIL SAMPLING**

GROUNDWATER SAMPLING

SOCIOECONOMIC SURVEY

Community Name	Mashigi Community
AIR QUALITY AND NOISE SAMPLING	**SOIL SAMPLING**
	
GROUNDWATER SAMPLING	
	
SOCIOECONOMIC SURVEYS	
	
	

Community Name	Dakpan Community
AIR QUALITY AND NOISE SAMPLING 	**SOIL SAMPLING** 
GROUNDWATER SAMPLING 	
SOCIOECONOMIC SURVEYS	
	
	

<table>
<tr><th>Community Name</th><th>Kpanje Community</th></tr>
<tr><td>AIR QUALITY AND NOISE SAMPLING
</td><td>GROUNDWATER SAMPLING
</td></tr>
<tr><td colspan="2">SOIL SAMPLING
</td></tr>
<tr><td colspan="2">SOCIOECONOMIC SURVEYS</td></tr>
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Community Name	Mayaki Community
AIR QUALITY AND NOISE SAMPLING 	**SOIL SAMPLING** 
GROUNDWATER SAMPLING 	
SOCIOECONOMIC SURVEYS	
	
	

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APPENDIX 4.2

Biophysical Baseline Results

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AIR QUALITY AND NOISE MEASUREMENTS

Dakpan Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m³								dB(A)
DakA1	<0.01	<0.01	<0.01	<0.01	<0.001	0.085	803	<0.01	50.7
DakA2	<0.01	<0.01	<0.01	<0.01	<0.001	0.038	838	<0.01	51.4
DakA3	<0.01	<0.01	<0.01	<0.01	<0.001	0.071	930	<0.01	53.2
DakA4	<0.01	<0.01	<0.01	<0.01	<0.001	0.045	721	<0.01	55.3
DakA5	<0.01	<0.01	<0.01	<0.01	<0.001	0.049	812	<0.01	50.3

Sheshimandiko Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m³								dB(A)
SheA1	<0.01	<0.01	<0.01	<0.01	<0.001	0.036	938	<0.01	59.0
SheA2	<0.01	<0.01	<0.01	<0.01	<0.001	0.078	938	<0.01	52.1
SheA3	<0.01	<0.01	<0.01	<0.01	<0.001	0.056	988	<0.01	52.1
SheA4	<0.01	<0.01	<0.01	<0.01	<0.001	0.053	904	<0.01	51.4
SheA5	<0.01	<0.01	<0.01	<0.01	<0.001	0.040	819	<0.01	52.5

Kuchitagi Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m³								dB(A)
KucA1	<0.01	<0.01	<0.01	<0.01	<0.001	0.055	819	<0.01	55.5
KucA2	<0.01	<0.01	<0.01	<0.01	<0.001	0.035	888	<0.01	56.7
KucA3	<0.01	<0.01	<0.01	<0.01	<0.001	0.026	838	<0.01	57.0
KucA4	<0.01	<0.01	<0.01	<0.01	<0.001	0.068	738	<0.01	51.3
KucA5	<0.01	<0.01	<0.01	<0.01	<0.001	0.052	688	<0.01	54.1

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Gbangba Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m³								dB(A)
GbaA1	<0.01	<0.01	<0.01	<0.01	<0.001	0.035	853	<0.01	54.5
GbaA2	<0.01	<0.01	<0.01	<0.01	<0.001	0.039	878	<0.01	51.3
GbaA3	<0.01	<0.01	<0.01	<0.01	<0.001	0.046	862	<0.01	50.7
GbaA4	<0.01	<0.01	<0.01	<0.01	<0.001	0.038	830	<0.01	53.9
GbaA5	<0.01	<0.01	<0.01	<0.01	<0.001	0.042	818	<0.01	48.1

Dokogi Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m³								dB(A)
Dok A1	<0.01	<0.01	<0.01	<0.01	<0.001	0.041	798	<0.01	47.1
Dok A2	<0.01	<0.01	<0.01	<0.01	<0.001	0.048	835	<0.01	46.4
Dok A3	<0.01	<0.01	<0.01	<0.01	<0.001	0.055	863	<0.01	48.3
Dok A4	<0.01	<0.01	<0.01	<0.01	<0.001	0.021	898	<0.01	53.3
Dok A5	<0.01	<0.01	<0.01	<0.01	<0.001	0.039	888	<0.01	57.9

Ragidda Hausawa Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m^3								dB(A)
Rag A1	<0.01	<0.01	<0.01	<0.01	<0.001	0.015	769	<0.01	42.9
Rag A2	<0.01	<0.01	<0.01	<0.01	<0.001	0.011	768	<0.01	46.1
Rag A3	<0.01	<0.01	<0.01	<0.01	<0.001	0.019	760	<0.01	47.2
Rag A4	<0.01	<0.01	<0.01	<0.01	<0.001	0.025	801	<0.01	54.2
Rag A5	<0.01	<0.01	<0.01	<0.01	<0.001	0.042	838	<0.01	55.6

Nakoko Siyidi Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m^3								dB(A)
Nak A1	<0.01	<0.01	<0.01	<0.01	<0.001	0.033	818	<0.01	53.9
Nak A2	<0.01	<0.01	<0.01	<0.01	<0.001	0.038	823	<0.01	54.3
Nak A3	<0.01	<0.01	<0.01	<0.01	<0.001	0.029	820	<0.01	56.1
Nak A4	<0.01	<0.01	<0.01	<0.01	<0.001	0.044	868	<0.01	52.5
Nak A5	<0.01	<0.01	<0.01	<0.01	<0.001	0.027	818	<0.01	50.2

Mashigi Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m^3								dB(A)
Mas A1	<0.01	<0.01	<0.01	<0.01	<0.001	0.041	808	<0.01	45.5
Mas A2	<0.01	<0.01	<0.01	<0.01	<0.001	0.039	844	<0.01	46.7
Mas A3	<0.01	<0.01	<0.01	<0.01	<0.001	0.032	827	<0.01	51.1
Mas A4	<0.01	<0.01	<0.01	<0.01	<0.001	0.068	849	<0.01	49.5
Mas A5	<0.01	<0.01	<0.01	<0.01	<0.001	0.041	886	<0.01	50.8

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Kpanje Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m^3								dB(A)
Kpj A1	<0.01	<0.01	<0.01	<0.01	<0.001	0.072	853	<0.01	56.1
Kpj A2	<0.01	<0.01	<0.01	<0.01	<0.001	0.063	878	<0.01	55.9
Kpj A3	<0.01	<0.01	<0.01	<0.01	<0.001	0.075	869	<0.01	55.2
Kpj A4	<0.01	<0.01	<0.01	<0.01	<0.001	0.045	812	<0.01	57.2
Kpj A5	<0.01	<0.01	<0.01	<0.01	<0.001	0.049	801	<0.01	52.5

Mayaki Community and AoI

In-Situ Air Quality Noise Measurements

Sampling Location	VOC	H_2S	NO_2	SO_2	CO	TSP	CO_2	NH_3	NOISE LEVEL
	mg/m^3								dB(A)
May A1	<0.01	<0.01	<0.01	<0.01	<0.001	0.029	747	<0.01	52.8
May A2	<0.01	<0.01	<0.01	<0.01	<0.001	0.082	879	<0.01	50.1
May A3	<0.01	<0.01	<0.01	<0.01	<0.001	0.055	893	<0.01	55.1
May A4	<0.01	<0.01	<0.01	<0.01	<0.001	0.064	813	<0.01	53.5
May A5	<0.01	<0.01	<0.01	<0.01	<0.001	0.021	741	<0.01	51.5

Laboratory analysis results for Soil Samples from the Project Area

Topsoil (0-15cm)

ID	ENGGBAS01	ENGGBAS02	ENGGBAS03	ENGDOKS01	ENGDOKS02	ENGDOKS03	ENGNAKS01	ENGNAKS02	ENGNAKS03	ENGRAGS01	ENGRAGS02	ENGRAGS03	EBGMASS01	ENGMASS02	ENGMASS03
pH	7.53	7.64	7.18	6.81	6.60	7.83	6.69	6.50	6.39	7.48	6.09	6.69	6.81	6.70	7.20
TOC %	2.03	1.73	2.10	2.77	2.60	2.50	3.15	2.65	1.97	2.31	1.96	2.12	2.45	2.33	2.23
Moisture Content	3.07	3.15	2.57	4.22	2.65	2.20	2.85	2.23	2.00	1.16	3.03	3.45	2.75	1.90	3.55
Chloride mg/Kg	26.76	31.26	18.76	5.27	1.27	5.27	7.27	4.85	9.27	7.27	26.26	8.27	5.27	2.13	26.26
Nitrate mg/Kg	0.40	0.66	0.88	0.44	0.51	0.46	0.42	0.27	0.49	0.50	0.88	0.61	0.59	0.71	0.76
Sulphate mg/Kg	12.620	12.410	3.730	6.530	4.740	5.080	1.310	5.310	1.310	19.000	19.000	8.810	10.560	6.510	3.460
Phosphate mg/Kg	0.790	0.290	0.780	0.560	0.420	0.940	0.540	0.890	1.170	1.230	0.300	0.930	1.580	0.790	0.430
Oil and Grease mg/Kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu mg/Kg	0.500	0.900	0.063	0.050	0.016	0.079	1.461	0.018	0.259	0.994	0.655	1.891	1.776	0.644	0.518
Pb mg/Kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Fe mg/Kg	47.404	13.088	37.696	29.374	64.442	62.523	56.942	73.540	78.870	52.262	58.272	61.100	84.962	77.680	73.733

ID	ENGSHES01	ENGSHES02	ENGSHES03	ENGDAKS01	ENGDAKS02	ENGDAKS03	ENGKUCS01	ENGKUCS02	ENGKUCS03	ENGKPAS01	ENGKPAS02	ENGKPAS03	ENGMAYS01	ENGMAYS02	ENGMAYS03
pH	7.81	5.92	7.43	6.48	6.76	6.72	3.92	7.61	6.75	7.58	7.69	6.57	6.79	7.70	6.79
TOC %	1.87	1.76	1.60	2.92	2.70	1.88	2.33	2.23	1.87	2.75	1.96	2.26	1.76	1.60	2.77
Moisture Content	3.12	1.07	2.05	2.61	1.53	3.50	3.15	2.00	4.22	3.12	1.07	2.05	2.65	2.20	2.85
Chloride mg/Kg	4.21	5.46	3.23	1.27	7.26	3.22	8.25	4.21	9.22	9.36	6.27	2.38	7.25	13.25	7.24
Nitrate mg/Kg	0.39	1.59	0.61	0.21	0.89	1.21	1.21	0.81	0.67	0.40	0.69	0.53	1.21	0.61	0.89
Sulphate mg/Kg	2.980	0.780	4.010	6.390	3.470	4.680	5.610	2.890	2.360	0.016	1.352	5.700	3.632	0.182	5.610
Phosphate mg/Kg	0.710	1.030	0.780	2.040	0.660	0.150	0.540	0.470	0.510	0.116	0.430	0.470	1.110	0.730	1.810
Oil and Grease mg/Kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu mg/Kg	0.636	0.787	0.888	0.040	0.807	1.324	0.013	0.179	2.615	1.314	0.925	0.475	0.390	0.923	0.982
Pb mg/Kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Fe mg/Kg	56.324	62.117	46.184	36.056	63.894	99.354	32.438	44.012	75.295	78.342	50.998	60.472	62.411	43.013	39.483

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ID	ENG GBA S01	ENG GBA S02	ENG GBA S03	ENG DOK S01	ENG DOK S02	ENG DOK S03	ENG NAK S01	ENG NAK S02	ENG NAK S03	ENG RAG S01	ENG RAG S02	ENG RAG S03	EBG MAS S01	ENG MAS S02	ENG MAS S03
Zn mg/Kg	0.101	0.098	0.046	0.195	1.104	0.104	0.260	0.065	0.090	0.106	0.122	0.031	0.132	0.105	0.109
Cd mg/Kg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cr mg/Kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ni mg/Kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn mg/Kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ba mg/Kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Hg mg/Kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
V mg/Kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Na mg/Kg	69.491	62.378	72.396	63.554	51.635	73.752	59.484	67.590	66.285	61.485	74.392	67.425	52.291	61.045	71.445
K mg/Kg	34.292	4.210	21.642	19.452	5.158	0.885	44.249	12.612	21.110	16.190	16.667	40.088	43.940	41.830	22.410
Ca mg/Kg	8.319	8.842	8.204	9.076	7.880	7.245	6.221	6.697	5.833	6.755	8.485	6.233	6.797	8.109	6.005
Mg mg/Kg	2.614	3.137	2.499	3.371	2.175	1.540	0.516	0.992	0.128	1.050	2.780	0.528	1.092	2.404	0.300
%Sand	17.15	11.17	12.81	9.22	10.06	19.79	16.59	6.53	30.02	26.81	34.74	19.04	21.96	13.01	26.84
%Silt	4.47	14.68	7.84	2.42	1.97	2.26	5.78	7.90	4.18	1.36	4.42	6.85	4.86	7.84	3.79
%Clay	78.38	74.15	79.35	88.36	87.97	77.95	77.63	85.57	65.80	71.83	60.84	74.11	73.18	79.15	69.37
THB cfu/ml	3.2 X 10^7	9.2 X 10^6	1.9 X 10^7	2.7 X 10^7	6.1 X 10^6	2.7 X 10^6	3.4 X 10^6	1.7 X 10^7	3.3 x 10^6	5.4 x 10^6	2.8 x 10^6	6.7 x 10^6	3.5 x 10^6	2.8 x 10^6	3.7 x 10^6

ID	ENG SHE S01	ENG SHE S02	ENG SHE S03	ENG DAK S01	ENG DAK S02	ENG DAK S03	ENG KUC S01	ENG KUC S02	ENG KUC S03	ENG KPA S01	ENG KPA S02	ENG KPA S03	ENG MAY S01	ENG MAY S02	ENG MAY S03
Zn mg/Kg	0.051	0.092	0.088	0.226	0.096	0.094	0.106	0.076	0.294	0.350	0.433	0.681	0.066	0.245	0.853
Cd mg/Kg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cr mg/Kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ni mg/Kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn mg/Kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ba mg/Kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Hg mg/Kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
V mg/Kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Na mg/Kg	82.792	71.484	70.586	61.192	57.347	69.485	56.510	82.843	70.590	61.045	71.445	82.794	74.391	67.425	52.291
K mg/Kg	18.026	60.610	58.676	19.380	18.960	14.702	13.886	20.211	36.093	41.627	7.654	42.459	35.175	74.452	37.799
Ca mg/Kg	5.613	7.241	6.056	6.452	7.861	8.170	5.930	5.454	5.870	7.936	8.459	7.822	6.864	7.252	6.813
Mg mg/Kg	0.092	1.536	0.351	0.747	2.156	2.465	0.225	0.251	0.165	2.231	2.754	2.117	1.159	1.547	1.108
%Sand	21.18	11.00	16.08	29.74	20.94	14.09	22.41	24.31	18.51	10.51	10.02	12.24	6.00	25.08	12.09
%Silt	5.75	6.74	3.85	8.59	4.87	1.63	5.18	3.18	4.65	6.56	3.25	6.76	4.31	5.08	2.18
%Clay	73.07	82.26	80.07	61.67	74.19	84.27	72.41	72.51	76.84	82.93	86.74	81.00	89.68	69.84	85.73
THB cfu/ml	4.4 x 10^6	3.6 x 10^6	4.1 x 10^6	5.7 x 10^7	2.09 x 10^6	2.7 x 10^7	8.6 x 10^6	7.8 x 10^6	5.5 x 10^6	2.8 x 10^7	5.1 x 10^7	8.7 x 10^6	5.8 x 10^6	5.5 x 10^6	6.5 x 10^6

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THFcfu/g	2.7 X 10^5	5.2 X 10^4	7.0 X 10^4	3.2 X 10^4	7.1 X 10^4	1.7 X 10^4	1.4 X 10^4	5.8 X 10^4	5.2 x 10^4	2.9 x 10^4	2.9 x 10^4	8.4 x 10^3	2.0 x 10^6	1.0 x 10^4	1.5 x 10^4	3.8 x 10^4	3.0 x 10^4	2.3 x 10^4	3.4 x 10^5	7.1 x 10^4	2.5 x 10^4	5.9 x 10^4	5.6 x 10^4	4.8 x 10^4	3.5 x 10^4	2.5 x 10^4	1.8 x 10^4	3.9 x 10^4	4.1 x 10^4	5.9 x 10^4
THUB cfu/g	4.5 X 10^4	7.1 X 10^4	5.1 X 10^4	2.4 X 10^4	8.9 X 10^4	2.4 X 10^4	4.3 X 10^4	1.3 X 10^4	1.2 x 10^4	5.1 x 10^4	5.2 x 10^4	8.4 x 10^3	1.3 x 10^2	1.0 x 10^3	1.3 x 10^3	2.5 x 10^4	1.0 x 10^4	2.1 x 10^4	3.9 x 10^4	6.3 x 10^4	3.2 x 10^4	2.1 x 10^4	7.8 x 10^3	2.8 x 10^4	4.2 x 10^4	1.3 x 10^3	4.2 x 10^4	4.2 x 10^3	5.8 x 10^3	8.1 x 10^3
THUF cfu/g	3.2 X 10^3	3.5 X 10^2	1.8 X 10^3	1.0 X 10^3	3.0 X 10^3	4.9 X 10^2	4.5 X 10^2	2.8 X 10^3	3.8 x 10^3	3.5 x 10^3	1.8 x 10^2	3.2 x 10^2	1.0 x 10^2	2.0 x 10^2	3.0 x 10^2	3.0 x 10^2	1.0 x 10^4	1.0 x 10^2	2.4 x 10^3	2.7 x 10^3	1.9 x 10^3	1.5 x 10^2	1.0 x 10^2	1.0 x 10^2	1.5 x 10^2	1.5 x 10^2	1.0 x 10^2	2.0 x 10^2	2.5 x 10^2	2.0 x 10^2

Subsoil (15 – 30 cm)

ID	ENG GBA S01	ENG GBA S02	ENG GBA S03	ENG DOK S01	ENG DOK S02	ENG DOK S03	ENG NAK S01	ENG NAK S02	ENG NAK S03	ENG RAG S01	ENG RAG S02	ENG RAG S03	ENG MAS S01	ENG MAS S02	ENG MAS S03	ENG SHE S01	ENG SHE S02	ENG SHE S03	ENG DAK S01	ENG DAK S02	ENG DAK S03	ENG KUC S01	ENG KUC S02	ENG KUC S03	ENG KPA S01	ENG KPA S02	ENG KPA S03	ENG MAY S01	ENG MAY S02	ENG MAY S03
pH	7.33	6.79	7.07	6.43	6.69	7.51	6.59	6.70	6.62	7.58	6.55	7.53	6.67	6.63	7.37	6.72	6.23	7.61	6.63	6.64	6.75	6.14	7.52	6.70	7.54	7.63	7.58	6.64	7.68	6.53
TOC %	2.11	1.95	1.98	2.76	2.61	2.76	2.88	2.39	1.95	2.50	2.09	1.95	2.29	2.26	2.76	1.98	1.72	1.95	2.77	2.75	1.96	2.26	2.76	1.98	1.88	2.33	2.23	1.72	1.95	2.70
Moisture Content	4.02	4.08	3.50	4.44	3.42	3.21	3.67	3.62	3.02	2.31	3.27	3.99	3.33	2.71	4.27	4.16	2.60	3.55	3.65	3.02	3.26	4.08	3.50	4.44	4.16	2.60	3.55	3.42	3.21	3.67
Chloride mg/Kg	22.76	21.18	21.26	8.26	1.33	3.27	1.47	3.53	5.27	8.73	21.25	9.27	2.22	2.27	31.26	1.27	3.27	2.73	3.27	5.27	5.27	7.27	5.27	7.27	7.06	4.27	3.27	3.27	10.77	5.74
Nitrate mg/Kg	0.35	0.92	0.47	0.68	0.49	0.28	0.61	0.11	0.59	0.36	0.58	0.89	0.61	1.12	0.44	0.26	0.79	0.39	0.68	0.07	1.39	1.36	0.76	0.59	0.56	0.71	0.49	0.59	0.63	0.59
Sulphate mg/Kg	10.352	7.670	5.310	9.760	3.390	10.460	0.780	3.370	0.730	16.410	4.940	13.550	8.670	5.370	2.170	1.210	1.310	2.990	4.410	2.680	1.270	3.790	1.360	6.710	0.014	1.140	4.140	1.310	0.107	9.500
Phosphate mg/Kg	1.000	0.320	1.000	0.480	0.540	0.780	0.360	0.430	0.780	0.670	0.390	0.390	2.110	0.790	0.340	0.160	1.210	-0.120	1.540	0.790	0.400	0.210	0.530	0.160	0.160	0.960	0.540	0.490	0.870	1.190

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ID	ENGGBAS01	ENGGBAS02	ENGGBAS03	ENGDOKS01	ENGDOKS02	ENGDOKS03	ENGNAKS01	ENGNAKS02	ENGNAKS03	ENGRAGS01	ENGRAGS02	ENGRAGS03	ENGMASS01	ENGMASS02	ENGMASS03	ENGSHES01	ENGSHES02	ENGSHES03	ENGDAKS01	ENGDAKS02	ENGDAKS03	ENGKUCS01	ENGKUCS02	ENGKUCS03	ENGKPAS01	ENGKPAS02	ENGKPAS03	ENGMAYS01	ENGMAYS02	ENGMAYS03
Oil and Grease mg/Kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu mg/Kg	0.535	0.682	0.194	0.006	0.013	0.068	0.954	0.014	0.018	0.623	0.917	1.145	1.489	0.287	0.332	0.238	0.895	0.447	0.034	0.529	0.536	0.010	0.086	3.213	1.659	0.850	0.908	0.817	0.913	1.030
Pb mg/Kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Fe mg/Kg	46.418	51.676	53.173	36.983	16.479	23.798	48.952	87.658	44.501	67.975	55.806	70.448	89.181	67.934	68.932	47.844	49.764	60.760	43.341	76.201	84.736	17.288	49.167	73.732	95.156	23.347	63.766	81.824	41.023	44.812
Zn mg/Kg	0.051	0.114	0.079	0.224	0.083	0.127	0.031	0.094	0.134	0.090	0.030	0.067	0.086	0.089	0.051	0.0498	0.037	0.060	0.055	0.077	0.064	0.293	0.028	0.116	0.238	0.415	0.738	0.011	0.921	0.773
Cd mg/Kg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cr mg/Kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ni mg/Kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn mg/Kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ba mg/Kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Hg mg/Kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
V mg/Kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Na mg/Kg	63.392	62.790	61.485	60.383	60.477	72.443	58.740	62.391	64.392	61.295	72.386	53.479	55.443	59.590	75.291	83.846	73.258	70.856	60.286	62.844	62.682	63.496	81.292	72.385	59.591	75.292	83.846	72.389	53.483	55.444
K mg/Kg	15.102	2.232	16.514	21.306	2.345	1.539	38.430	16.106	8.395	7.147	6.831	36.177	36.392	50.250	21.692	43.533	74.364	33.438	12.728	13.727	17.782	10.637	18.110	39.009	30.612	4.567	46.879	49.120	71.507	38.797

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ID	ENG GBA S01	ENG GBA S02	ENG GBA S03	ENG DOK S01	ENG DOK S02	ENG DOK S03	ENG NAK S01	ENG NAK S02	ENG NAK S03	ENG RAG S01	ENG RAG S02	ENG RAG S03	ENG MAS S01	ENG MAS S02	ENG MAS S03
Ca mg/Kg	7.215	9.019	7.311	8.164	6.430	7.705	6.647	6.889	6.153	6.532	8.477	6.832	6.317	6.957	6.783
Mg mg/Kg	1.510	3.314	1.606	2.459	0.725	2.000	0.942	1.184	0.448	0.827	2.772	1.127	0.612	1.252	1.078
%Sand	16.48	12.09	10.51	3.58	9.29	22.57	24.13	13.10	31.45	28.80	28.27	25.10	28.16	12.41	27.93
%Silt	7.48	8.18	7.89	3.02	2.37	2.76	4.93	7.82	3.92	1.75	3.85	5.96	5.86	6.74	4.59
%Clay	76.04	79.73	81.60	93.40	88.34	74.67	70.94	79.08	64.63	69.45	67.88	68.94	65.98	80.85	67.48
THB cfu/ml	3.0 X 10^{7}	5.7 X 10^{6}	9.2 X 10^{6}	1.9 X 10^{7}	1.2 X 10^{6}	2.5 X 10^{6}	2.9 X 10^{6}	2.3 x 10^{7}	3.0 x 10^{6}	5.1 x 10^{6}	2.6 x 10^{6}	3.5 x 10^{7}	5.1 x 10^{6}	5.8 x 10^{6}	5.0 x 10^{6}
THFc fu/g	1.8 X 10^{4}	4.8 X 10^{4}	5.2 X 10^{4}	2.5 X 10^{4}	4.3 X 10^{4}	9.0 X 10^{3}	2.0 X 10^{4}	4.6 x 10^{4}	4.1 x 10^{4}	2.5 x 10^{6}	2.4 x 10^{4}	2.6 x 10^{4}	1.6 x 10^{4}	1.4 x 10^{4}	1.7 x 10^{4}
THUB cfu/g	4.2 X 10^{4}	6.2 X 10^{4}	5.0 X 10^{4}	2.3 X 10^{4}	5.1 X 10^{4}	2.2 X 10^{4}	3.6 X 10^{4}	2.3 x 10^{4}	1.3 x 10^{4}	4.7 x 10^{4}	5.0 x 10^{4}	2.6 x 10^{3}	2.1 x 10^{3}	3.3 x 10^{3}	2.3 x 10_{3}
THUF cfu/g	1.5 X 10^{3}	1.2 X 10^{2}	1.2 X 10^{3}	1.0 X 10^{3}	2.2 X 10^{3}	4.2 X 10^{2}	3.5 X 10^{2}	1.1 x 10^{3}	3.1 x 10^{3}	3.0 x 10^{3}	1.6 x 10^{2}	2.4 x 10^{2}	2.0 x 10^{2}	4.0 x10^{2}	2.0 x 10^{2}

ID	ENG SHE S01	ENG SHE S02	ENG SHE S03	ENG DAK S01	ENG DAK S02	ENG DAK S03	ENG KUC S01	ENG KUC S02	ENG KUC S03	ENG KPA S01	ENG KPA S02	ENG KPA S03	ENG MAY S01	ENG MAY S02	ENG MAY S03
Ca mg/Kg	6.100	7.259	8.152	6.566	6.812	8.864	5.864	5.349	5.035	6.833	8.637	6.929	7.992	7.868	6.619
Mg mg/Kg	0.395	1.554	2.447	0.861	1.107	3.159	0.159	-0.356	-0.670	1.128	2.932	1.224	2.287	2.163	0.914
%Sand	26.27	23.00	35.84	27.03	11.41	25.69	20.22	21.96	5.18	12.42	8.85	15.38	17.15	21.74	12.81
%Silt	7.71	8.64	2.86	7.59	4.29	2.08	4.45	3.22	5.15	5.89	3.18	4.87	8.61	4.11	1.84
%Clay	66.02	68.36	61.30	65.38	84.30	72.23	75.33	74.82	89.67	81.69	87.97	79.75	74.25	74.15	85.35
THB cfu/ml	4.3 x 10^{6}	2.5 x 10^{6}	1.8 x 10^{6}	2.5 x 10^{7}	2.0 x 10^{6}	5.6 x 10^{6}	7.7 x 10^{6}	9.1 x 10^{6}	6.7 x 10^{6}	8.6 x 10^{6}	6.2 x 10^{7}	6.2 x 10^{6}	6.9 x 10^{6}	4.2 x 10^{6}	3.3 x 10^{6}
THFc fu/g	1.1 x 10^{4}	1.8 x 10^{4}	7.0 x 10^{3}	4.2 x 10^{4}	5.7 x 10^{4}	1.4 x 10^{4}	5.0 x 10^{4}	5.1 x 10^{3}	4.3 x 10^{4}	3.2 x 10^{4}	5.6 x 10^{4}	1.0x 10^{4}	2.5 x 10^{4}	2.4 x 10^{4}	5.0 x 10^{4}
THUB cfu/g	2.2 x 10^{3}	2.5 x 10^{3}	1.5 x 10^{4}	3.4 x 10^{4}	5.1 x 10^{4}	3.0 x 10^{4}	1.1 x 10^{4}	2.8 x 10^{3}	2.0 x 10^{4}	3.8 x 10^{4}	1.5 x 10^{3}	4.0 x 10^{4}	3.2 x 10^{3}	3.7 x 10^{3}	5.3 x 10^{3}
THUF cfu/g	2.0 x 10^{2}	1.0 x 10^{2}	2.0 x 10^{2}	2.2 x 10^{3}	2.2 x 10^{3}	1.1 x 10^{3}	1.0 x 10^{2}	1.0 x 10^{2}	1.0 x 10^{2}	1.5 x 10^{2}	1.5 x 10^{2}	1.0 x 10^{2}	2.0 x 10^{2}	2.0 x 10^{2}	2.0 x 10^{2}

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APPENDIX 4.3

Stakeholder Engagement letters and BID

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Stakeholder Engagement Letter to Ministry of Works and Infrastructural Development

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...superior sustainability solutions

7th October, 2020

The Honourable Commissioner
Niger State Ministry of Works and Infrastructural Development
Block E, Abdulkareem Lafene Secretariat Complex
Paiko Road
Minna, Niger State

ACCEPTED
SIGN.
DATE 9/10/2020

Attention: The Director, Mechanical/Electrical Department

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) OF ENGIE MINI-GRID SOLAR POWER PROJECTS IN TEN (10) LOCATIONS WITHIN NIGER STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Engie Africa to carry out an Environmental and Social Management Plan (ESMP) for the proposed mini-grid Solar Projects to be constructed in 10 locations within Niger State.

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

Date: October 13, 2020

Time: 11 a.m. prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project. Please kindly contact the ESMP Project Manager on +2348075331833 or via email on aolaitan@envaccord.com for further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Environmental Scientist

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

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

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Stakeholder Engagement Letter to Niger State Ministry of Environment

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7th October, 2020

The Honourable Commissioner
Niger State Ministry of Environment
Government House
Minna, Niger State

Min. of Environment & Forestry
RECEIVED
P.M.B. 21 Minna, Niger State

Attention: The Director, Environmental Impact Assessment Department

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) OF ENGIE MINI-GRID SOLAR POWER PROJECTS IN TEN (10) LOCATIONS WITHIN NIGER STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Engie Africa to carry out an Environmental and Social Management Plan (ESMP) for the proposed mini-grid Solar Projects to be constructed in 10 locations within Niger State.

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

Date: October 13, 2020

Time: 10 a.m. prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project. Please kindly contact the ESMP Project Manager on +2348075331833 or via email on aolaitan@envaccord.com for further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Environmental Scientist

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

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Stakeholder Engagement Letter to Niger State Environmental Protection Agency

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P.A TO G.M NISEPA

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7th October, 2020

Niger State Environmental Protection Agency
RECEIVED
9/10/2020

The General Manager
Niger State Environmental Protection Agency
NISEPA Office
Besides FRSC office, Bosso road
Minna, Niger State

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) OF ENGIE MINI-GRID SOLAR POWER PROJECTS IN TEN (10) LOCATIONS WITHIN NIGER STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Engie Africa to carry out an Environmental and Social Management Plan (ESMP) for the proposed mini-grid Solar Projects to be constructed in 10 locations within Niger State.

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

Date: October 13, 2020

Time: 12 p.m. prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project. Please kindly contact the ESMP Project Manager on +2348075331833 or via email on aolaitan@envaccord.com for further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Environmental Scientist

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

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

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Stakeholder Engagement Letter to Gbako Local Government

Recieved on behalf of Mr. Chairman. 08036499243.
Hon. Hussaini Aliyu Lemu.
12/10/2020. ~~090 08082~~

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7th October, 2020

The Honourable Chairman
Gbako Local Government Area
Gbako LGA Secretariat
Lemu
Niger State

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) OF ENGIE MINI-GRID SOLAR POWER PROJECTS IN TEN (10) LOCATIONS WITHIN NIGER STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Engie Africa to carry out an Environmental and Social Management Plan (ESMP) for the proposed mini-grid Solar Projects to be constructed in 10 locations within Niger State. Four (4) of the locations are sited within Gbako Local Government Area (LGA).

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

Date: October 13, 2020

Time: 2 p.m. prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project. Please kindly contact the ESMP Project Manager on +2348075331833 or via email on aolaitan@envaccord.com for further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Environmental Scientist

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Environmental Accord Limited
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Tel: +234-802- 360 - 9591
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Website: www.envaccord.com

Stakeholder Engagement Letter to Mashegu Local Government

original copy
Collected by me
Council Secretary Mashegu
local government
09/10/2020

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7th October, 2020

The Honourable Chairman
Mashegu Local Government Area
Mashegu LGA Secretariat
Mashegu, Niger State

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) OF ENGIE MINI-GRID SOLAR POWER PROJECTS IN TEN (10) LOCATIONS WITHIN NIGER STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Engie Africa to carry out an Environmental and Social Management Plan (ESMP) for the proposed mini-grid Solar Projects to be constructed in 10 locations within Niger State. Three (3) of the locations are sited within Mashegu Local Government Area (LGA).

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

Date: October 15, 2020

Time: 12 p.m. prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project. Please kindly contact the ESMP Project Manager on +2348075331833 or via email on aolaitan@envaccord.com for further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Environmental Scientist

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

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

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Stakeholder Engagement With Dokoji Village Head

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

ENGIE MINI-GRID SOLAR POWER PROJECTS IN NIGER STATE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

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

You can make additional comments for the study team to record on a separate page or on the reverse side of this form. Please post this comment sheet to the address below as soon as possible and preferably on or before October 30, 2020 so that we can take your comments into consideration in the ESMP. The comments could also be emailed to the address below.

Please fill in your details	
Name: MOHAMMED MOHAMMED	Organization: DOKOGI VILLAGE
Telephone: 07067445448	Position: VILLAGE HEAD
Cell phone: 08035867857	Email:
Address:	

Please post or fax this form to the address below:

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

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COMMENTS FORM

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

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

(1) ~~They~~ They are happy about the Project Coming to their community
(2) Light that can have enough capacity for their appliances and support their business
(3) Power that can be able to support business activities
(4) ~~Stable~~ They want the light to be stable at all times
(5) The Company to employ them in the project.
(6) They ~~want~~ need electrical appliances that can work with solar e.g fan, fridge, television,
(7) They want the project to be developed quickly
(8) They want the power ~~for~~ for project to be able to support the appliances they have already.

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

(1) They want the Solar project to have Security - Security may be from ~~[illegible]~~ indigenes ~~[illegible]~~ of Community
(2) No Concerns about the project.

Many thanks for your participation

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Stakeholder Engagement with Gbangba Village Head

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

ENGIE MINI-GRID SOLAR POWER PROJECTS IN NIGER STATE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

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

You can make additional comments for the study team to record on a separate page or on the reverse side of this form. Please post this comment sheet to the address below as soon as possible and preferably on or before October 30, 2020 so that we can take your comments into consideration in the ESMP. The comments could also be emailed to the address below.

Please fill in your details	
Name: ALHAJI IBRAHIM	Organization: Gbangba Village
Telephone: 09028850283	Position: Village head.
Cell phone: 08140664528	Email:
Address:	

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Please post or fax this form to the address below:

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

COMMENTS FORM

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

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

I as a village head of Gbangba I want the company to employed my peoples in to this Company when the project is started and I want with this is Company that he should not disappoint my Community with this ~~community~~ project

I want with this Company to provide us with what my people never have such as, freezer, TV, worn, engine, should be base on loan.

As the leader of the community I don't want anything with the Company that will bring scatering in the Community

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

I want to warning this Company that we the Community we are living here peace we want with Company to add more peacefully to our Community the reason why I said is that peoples of Nowadays are not trusted because Some people will enter local village known they say that this is there business and after the day they will ~~set~~ Stake another bissness which you will not be able to drive them away again

am very appre glad with Company for I Have doing this project in my Community may God protect and give us long life.

Many thanks for your participation

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Stakeholder Engagement with Nakoko Siyidi Village Head

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

ENGIE MINI-GRID SOLAR POWER PROJECTS IN NIGER STATE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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You can make additional comments for the study team to record on a separate page or on the reverse side of this form. Please post this comment sheet to the address below as soon as possible and preferably on or before October 30, 2020 so that we can take your comments into consideration in the ESMP. The comments could also be emailed to the address below.

Please fill in your details	
Name: USMAN MOHAMMED	Organization: NAKOKO SIYIDI COMMUNITY
Telephone: 07085145355	Position: DISTRICT HEAD/COMMUNITY LEADER
Cell phone:	Email:
Address:	Usman

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IFC
Dec 19, 2023, 4:59 AM EST

Please post or fax this form to the address below:

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

COMMENTS FORM

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

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

(1) He his happy about the Project coming to their Community

(2) He hopes that they will be able to establish other business when the project comes

(3) They will be happy to get job opportunities for their youth from the project

(4) For good relationship between community and Company, they wish that their people get employed

(5) They are willing to have a good relationship with the Community.

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

(1) There are no farms within the project site

Many thanks for your participation

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Stakeholder Engagement with Mashigi Village

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

ENGIE MINI-GRID SOLAR POWER PROJECTS IN NIGER STATE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

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You can make additional comments for the study team to record on a separate page or on the reverse side of this form. Please post this comment sheet to the address below as soon as possible and preferably on or before October 30, 2020 so that we can take your comments into consideration in the ESMP. The comments could also be emailed to the address below.

Please fill in your details	
Name: Alhaji Hamidu	Organization: ~~Vat~~ Mashigi Village
Telephone: 08147698864	Position: Village head
Cell phone:	Email:
Address:	Saidu

Please post or fax this form to the address below:

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

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COMMENTS FORM

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

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

①

② Job opportunities for their youth

③ They need network and good roads

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

Many thanks for your participation

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Stakeholder Engagement with Ragidda Hausawa Village Head

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

ENGIE MINI-GRID SOLAR POWER PROJECTS IN NIGER STATE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

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You can make additional comments for the study team to record on a separate page or on the reverse side of this form. Please post this comment sheet to the address below as soon as possible and preferably on or before October 30, 2020 so that we can take your comments into consideration in the ESMP. The comments could also be emailed to the address below.

Please fill in your details	
Name: UMARU [illegible]	Organization: RAGIDDA HAUSAWA
Telephone: 08158[illegible]99781	Position: VILLAGE HEAD.
Cell phone:	Email:
Address:	

Please post or fax this form to the address below:

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

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COMMENTS FORM

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

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

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

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Background Information Document (BID) Sent to Stakeholders

BACKGROUND INFORMATION DOCUMENT (BID)

FOR

THE PROPOSED

ENGIE MINI GRID SOLAR POWER PROJECTS IN NIGER STATE

OCTOBER 2020

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ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) FOR THE PROPOSED ENGIE MINI-GRID SOLAR POWER PROJECTS IN NIGER STATE

A1.1 Introduction

The Federal Government of Nigeria (FGN), as part of efforts to increase electricity access in remote, low density and traditionally underserved areas of the country initiated the Nigeria Electrification Project (NEP). The NEP is a private sector driven initiative that seeks to provide electricity access to households, micro, small and medium enterprises in off-grid communities across the country through renewable power sources. NEP is being implemented by the Rural Electrification Agency (REA) in collaboration with the World Bank, African Development Bank (AfDB) and other partners.

One of the major components of the NEP is the development of solar hybrid mini-grids for Rural Economic Development. This component is aimed at serving about 300,000 households, and 30,000 local enterprises, with mini grid operators. The component will be implemented by private sector partners to provide electricity to the households on a commercial basis. Some communities within Niger State have been selected to benefit from this component. Engie Africa, in collaboration with the REA will develop and operate the projects in Niger State.

Engie Africa is a subsidiary of the Engie Group, a French multinational electricity utility company which operates in the fields of energy transition, electricity generation and distribution, natural gas, nuclear, renewable energy and petroleum. The company intends to develop and operate solar power mini-grid projects in some selected communities in Niger State, Nigeria. The project will be developed as part of the Performance Based Grant sub-component of the World Bank-sponsored Nigeria Electrification Project (NEP) being implemented by the Rural Electrification Agency (REA).

In compliance with the provisions of the Nigeria Environmental Impact Assessment (EIA) Act No 86 of 1992 (now codified as the EIA Act CAP E12 Law of the Federal Republic of Nigeria, LFN, 2004) as well as the requirements of relevant international standards and guidelines such as the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability, Engie Africa has commissioned an Environmental and Social Management Plan (ESMP) study for the proposed mini-grid solar power Projects. The ESMP study is to be conducted by Environmental Accord Nigeria Limited (EnvAccord), an accredited environmental and sustainability consulting firm). The study is also in line with the corporate policies of Engie Group on the protection of the environment and human health.

The aim of this document is to provide background information about the solar power projects to be developed in Niger State and to receive comments on any issues you may have, as one of the identified key stakeholders.

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A1.2 Project Location

The mini-grid solar power Projects will be developed at ten (10) different sites in Niger State. The proposed power generation capacity and land size for the solar plants to be installed at the beneficiary communities in Niger State are presented in Table 1.1 below, while a cluster map of the proposed sites is shown in Figure 1 below.

Table 1.1: Beneficiary communities in Niger State

S/N	Community/Site name	Local Government Area (LGA)	Power Capacity (kWp)	Land size (ha)
1.	Gbangba (Pilot)	Gbako	85	0.26
2.	Sheshimandiko	Gbako	85	0.26
3.	Kuchitagi	Gbako	85	0.26
4.	Dakpan	Gbako	85	0.26
5.	Dokogi	Lavun	85	0.26
6.	Mayaki	Lapai	85	0.26
7.	Nakoko-Siyidi	Mashegu	85	0.26
8.	Ragidda Hausawa	Mashegu	85	0.26
9.	Mashiyi	Mashegu	85	0.26
10.	Tapaini	Wushishi	85	0.26

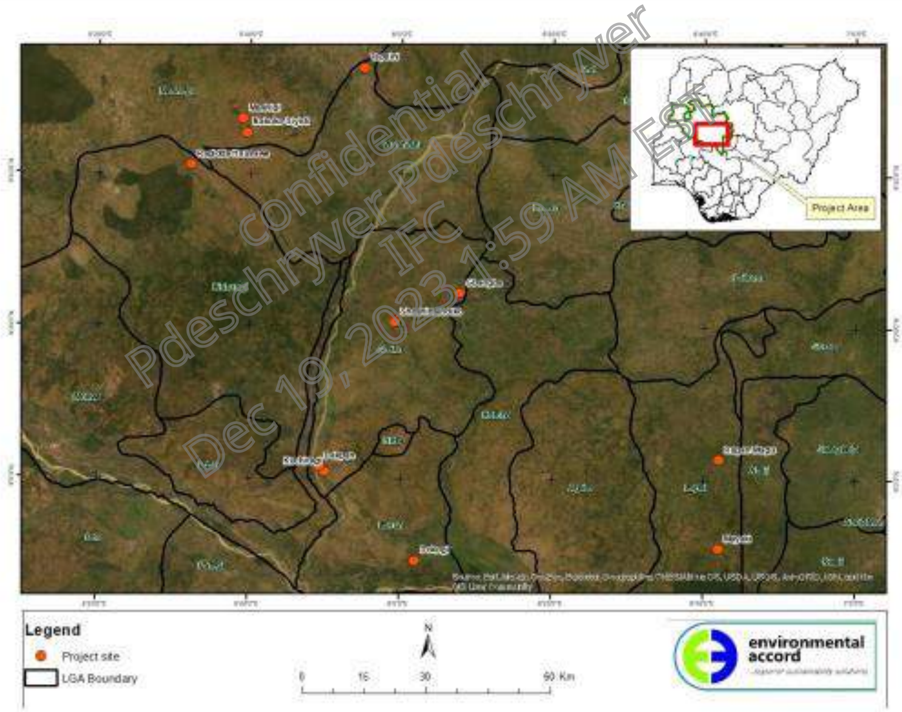

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Figure 1: Cluster Map showing the location of the proposed Project sites in Niger State.

A1.3 Overview of the Project

The project will involve the construction and operation of solar photovoltaic (PV) panel systems in the ten (10) locations distributed within Niger State. The solar panels will be installed on the sites using piling foundations, and the power generated will be distributed to the local communities close to the site. A building will be constructed within the site to house the inverters, batteries and associated components installed for the proposed projects. A diesel generator is planned to be installed at each site, to serve as backup source of power to charge batteries during project operation. The customers (i.e. households connected to the project) will be fitted with electricity meters to measure their power consumption for billing. The proposed project will ensure the provision of safe, reliable and affordable power supply to the beneficiary communities.

A1.4 Project Justification

In the past two decades, there have been significant investments in the power infrastructure across Nigeria. However, about 80 million Nigerians still lack access to grid electricity, which has slowed down economic development and progress. The majority of the underserved and unserved people live in rural areas and rely on candles and flashlights for lighting. Energy access to rural communities in Nigeria has been limited to date by significant power deficits, low generation capacity, as well as inadequacies in transmission and distribution. Therefore, the situation requires innovative solutions such as NEP. The NEP is an initiative of the FGN which is being implemented by the REA. The deployment of off-grid power solutions to the underserved and unserved communities will provide significant benefits such as enhancement in the standard of living, health, and wellbeing of people in rural communities across Nigeria.

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A1.5 Project Activities

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

Pre-Construction/construction Phase Activities:

- Site clearing and preparation
- Mobilization of personnel and materials to site
- Construction of piling foundations and project facilities
- Solar PV panels and ancillary component installation
- Demobilization of construction personnel and equipment

Operation Phase Activities:

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

Decommissioning Phase Activities:

- Dismantling of equipment and associated facilities
- Scrapping and dismantling of equipment.

A1.6 Preliminary Impacts Identification and Mitigation Measures

Preliminary Potential Impacts

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

Air Quality

- Vehicular emissions during mobilization of personnel and equipment to the site. (impact would be localized)
- Dust from site clearing and land preparation activities

Noise Emissions

- Noise from vehicles, site clearing equipment, construction activities
- Noise emissions during the panel installation and fixture of other ancillary components (impact is site-specific)

Groundwater Quality

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

Flora and Fauna

- Clearing of flora and fauna within the site

Waste Generation

- Wastes from the construction activities may arise from a range of sources including the following: packaging materials; wastes from workers, equipment, and materials (impact would be localized)
- E-waste generation (damaged/discarded solar panels, electrical components, etc.) during operations
- General and hazardous wastes produced as a result of the construction and operational activities (impact is site-specific)

Transport and Access

- Increased road traffic during installation of the project.

Occupational Health and Safety

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

Community Health and Safety

- Increase in risk factors associated with communicable diseases as a result of influx

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of workers to the communities

Peoples Way of Life and Business

- Provision of clean, affordable and steady power supply to selected beneficiary communities within the project AoI
- Reduction of human health risk (respiratory diseases, eye strain, etc.) associated with CO_2 emission from generators and use of Kerosene lamps, typically used indoors by the rural communities
- Enhancement in standard of living of the local communities
- Positive impacts to the local and national economy
- Employment opportunities during construction and operations
- Acquisition of new skill due to technology transfer
- Stimulation of socio-economic activities in the communities

Mitigation Measures

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

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

ENGIE MINI-GRID SOLAR POWER PROJECTS IN NIGER STATE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

Please post or fax this form to the address below:

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

COMMENTS FORM

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

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

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

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Many thanks for your participation

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APPENDIX 4.4

Records of Consultations with the communities

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Attendance of Meetings with Members of Dokogi Community

DOKOGI YOUTHS

ENVIRONMENTAL ACCORD NIGERIA LIMITED 36B, Oguntona Crescent, Gbagada (Phase 1), Lagos 0813-636-3762; 0802-360-9591 info@envaccord.com http://www.envaccord.com	Attendance (Engie Mini-Grid Solar Power Projects)	environmental accord ...superior sustainability solutions

Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	TOWNHALL MEETING FGD WITH YOUTHS
Date	14-10-2020
Venue	DOKOGI COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	Baba Idris	Dokogi	Youths	08161671525		
2	Idris Alhaji	✓		0[illegible]65975287		
3	Usman Mohammed	✓		[illegible]8[illegible]715295		
4	Mohammed	✓		0[illegible]6388410		
5	Alhaji Dokogi	✓		—		
6	Mohammed Mohammed D	✓		08[illegible]438385		
7	Bagudu Baba	✓		—		
8	Baba Mohammed	✓		0814[illegible]53730		
9	Abubakar Alhaji	✓		—		
10	Baba Mohammed (2)	✓		0[illegible]6465878		
11	Ibrahim Dokogi	✓		—		
12	Alhaji Idris	✓		—		
13	Abubakar Barachimokun	✓		—		
14	Alhaji Idris (2)	✓		—		
15	Abiola Balogun	EnvAccord	Social Scientist	0[illegible]64655291	[illegible]@envaccord.com	[signature]

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Dokogi Female

ENVIRONMENTAL ACCORD NIGERIA LIMITED 36B, Oguntona Crescent, Gbagada (Phase 1), Lagos 0813-636-3762; 0802-360-9591 info@envaccord.com http://www.envaccord.com	Attendance (Engie Mini-Grid Solar Power Projects)	environmental accord ...superior sustainability solutions

Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	Focus Group Discussion with Women in Dokoji
Date	14 — 10 — 2020
Venue	Dokoji Community

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	Maryam Isah					
2	Hadijatu Ibrahim					
3	Hajara Abdullahi					
4	Sa'adiya Umar					
5	Fati Ibrahim					
6	Aisha Mohammed					
7	Fati Musa					
8	Aisha Mohammed					
9	Fati Mohammed					
10	Fati Musa					
11	Amina Ibrahim					
12.	Rhoda Omotosho	EnvAccord	Social Scientist		romtosho@envaccord.com	

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Pokogi man

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	Town Hall meeting in Pokogi
Date	14 — 10 — 2020
Venue	Pokogi Community

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	Mohammed Ndagi			08136715367		
2	Mohammed Lawal					
3	Ali Mohammed			07068734785		
4	Muhammad Zhitsu			09038415669		
5	Abdullahi Haruna			08159484400		
6	Ndako Yusuf			07037973541		
7	Alhaji Usman			08063661167		
8	Mohammed Shaba			07030096062		
9	Maryam Isah					
10	Hadizatu Ibrahim					

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Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	Interview with Dakogi village head
Date	13 — 10 — 2021
Venue	Dakogi village head House

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1.	MOHAMMED MOTI'D	08035947857				
2.	Mohamed Waziri	08032609014				
3.	Mohamed Baba	07067445445				
4.	Ndakoddo bangi					
5.	yandagi babatadi	08108180676				
6.	Yamadu dogo					
7.	Yakubu Idrisu					
8.	Liman Ibrahim					
9.	Abisola Bolanwa	EnvAccord ~~08164455201~~	Social Scientist	08164455201	abolanwa@envaccord.co	

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Attendance of Meetings with Members of Gbangba Community

ENVIRONMENTAL ACCORD NIGERIA LIMITED
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Lagos 0813-636-3762; 0802-360-9591
info@envaccord.com
http://www.envaccord.com

Attendance
(Engie Mini-Grid Solar Power Projects)

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...superior sustainability solutions

Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	Town Hall Meeting in Gbangba Village
Date	13 — 10 — 2020
Venue	Gbangba Community

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	Alh. Ibrahim Alhassan	GBANGBA Community	Village Head	09036850282		[signature]
2	Abubakar G. Mohd		member	09066700208		
3	Ibrahim Sitti		Scribe	08140664528		[signature]
4	Abubakar Mohd		member			
5	Alhassan Ginda		member			
6	Aliyu Yakubu		member			
7	Idrisu Yunusa		member			
8	Sule Ibrahim		member			
9	Musa Idyelane		member			
10	[illegible] Ibrahim		member			
11	Ndagi Ibrahim		member			
12	Bala Ndalu		member			
13	Mohd Ibrahim		member			
14	Ndalu Ibrahim		member			
15	Adma Yunusa		member			
16	Yusufu Ibrahim		member			

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Lagos 0813-636-3762; 0802-360-9591
info@envaccord.com
http://www.envaccord.com

Attendance (Engie Mini-Grid Solar Power Projects)

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...superior sustainability solutions

Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	Town Hall meeting on Gbangba village
Date	13 – 6 – 2020
Venue	Gbangba village

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S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
17	mohd Abdullahi		member			
18	Abdula Idrisu	Gbangba	member			
19	mohd Kolo		member			
20	Adamu A. Shehu		member	08039372932		[signature]
21	mohd A. Shehu		member			
22	Katsu Ndagi		member			
23	Ndagungi Gidi		member	08100978007		[signature]
24	mohd. mohd		member			
25	mohd Aliyu	Community	member			
26	Ali Umar Abdulrazaq		member			[signature]
27	mohd. A. Mamudu		member			[signature]
28	Isah mohd		member			[signature]
29	mohd. A. Isah		member			[signature]
30	mohd Ndahagi		member			[signature]
31	mohd Aliyu		member			[signature]
32	mohd Sabe		member			[signature]

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	Focus Group Discussion with Women in Gbangba village
Date	13 — 10 — 2020
Venue	Gbangba village

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
	Aisle mohd	Gbangba Community Woman				
	Fati mohd					
	Azara musa					
	Fatima mohd					
	Amina mohd					
	Fati adamsa					
	Aisha mohd					
	Amin Isah					
	Fati Abubakar					
	Fati yabagi					
	Ramatu yabagi					
	Hawa Ibrahim					
	Fatima Ibrahim					
	Mamma musa					
	Jumai Idris					
	Hadizatu mohd					

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	Town Hall meeting of Youth engagement in Gbangba village
Date	13 — 10 — 2020
Venue	Gbangba village

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	ABUBAKAR MOH'D	GBANGBA	YOUT	08044702748		[illegible]
2	MOH'D-G-MOH'D	GBANGBA	YOUT	09061300549		[illegible]
3	SAIDU SABA	GBANGBA	YOUT	08144569853		[illegible]
4	ALH A. SABA	GBANGBA	YOUT	08066728647		[illegible]
5	MOH'D SABA	GBANGBA	YOUT	07019518399		MMM
6	UMARU MOH'D	GBANGBA	YOUT	08150994613		[illegible]
7	ABUBAKAR ISAH	GBANGBA	YOUT	09063534364		[illegible]
8	MOH'D N' JIBRIN	GBANGBA	YOUT	08100978007		[illegible]
9	SHEHU MOH'D	GBANGBA	YOUT	08141934159		[illegible]
10	MAMUD U IDIRIS	GBANGBA	YOUT	08166968007		MID
11	MOH'D KOLO	GBANGBA	YOUT	08064194962		[illegible]
12	GIMBA USMAN	GBANGBA	YOUT	07035167878		UGM
13	ADAMU MOH'D D	GBANGBA	YOUT	07038784708		AMD
14	MOH'D AUD	GBANGBA	YOUT	08133271986		[illegible]
15	ALIYU B ALIYU	GBANGBA	YOUT	09066272569		
16	CHAD'D UMARU	GBANGBA	YOUT			

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Attendance of Meetings with Members of Ragidda Hausawa Community

Ragidda Hausawa

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	Town Hall meeting in Raggida Hausawa village
Date	15 — 10 — 2020
Venue	Raggidau Hausawa village

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	UMARU MARAFA	Raggida Hausawa	Village Head			
2	Abdurrahman Ladan					
3	Sarkin Rurabullah					
4	Usman Aliyu					
5	Shuaibu Muhammad S.					
6	Saliu Sani					
7	Danlandi Mallam.					
8	Hussaini Machere.					
9	Salisu Abdulla					
10	Bashir Suleiman.					
11	Usman Usman.					
12	Abubakar Usman.					
13	Denedu. Sani					
14	Bello Ibrahim					
15	Isaral Salihu.					
16	Aliyu Polotti.					

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	Focus Group Discussion with women in Raggi'za Hawa...
Date	15 — 10 — 2020
Venue	Raggi'za Hawa...

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S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	FATIMA GARBA.					
2	RABI ABUBAKAR					
3	FATIMA AMINU					
4	AMINA MARAFA.					
5	HAJARA IBRAHIM.					
6	HASHEERU ABUBAKAR					
7	RABIU ABDULLAHI					
8	HUSSAINI Aliyu.					
9	Isah Damladi					
10	Sani Hamma.					
11	MUKTAR ABUBAKAR					
12	Suleiman Abdulrahman					
13	ABUBAKAR ABDULLAHI			07054190361		
14	KABIRU					
15	Rhoda Omotosho	EnvAccord	Social Scientist		Romotosho@envaccord.com	[signature]
16						

Attendance of Meetings with Members of Nakoko Siyidi Community

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	Targeted Town Hall meeting in Nakoko
Date	17th/10/2020
Venue	NAKOKO SE-IEGDI

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	USMAN MOHAMMED					
2	MOHAMMED DANBAGA					
3	AHMADU BANAU			07014899190		
4	UMAR MOHAMMED			09027501961		
5	Alh. ABDULMUMINI			07049365792		
6	INUWU MUSA.					
7	AMINU DAUDU			08153635849.		
8	MURTALA SOJA.					
9	NURA MOHAMMED			09078662459		
10						
11						

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Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	Town Hall meeting in Mashegi village
Date	18/10/2020
Venue	MASHEGI

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	SAIDU ALI. HARUNA			08147698804		
2	ZAYANU ADAMU			09048786355		
3	RABIU SALEH			08117924909		
4	ABDULLAHI HARUNA					
5	SHEHU SAIDU					
6	MUAZU HARUNA					
7	SAIDU MATANGUWA					
8	BAWALLU USMAN					
9	MAI SAMARI			09059616313		
10	ABDUSALAM SAIDU					
11	MUSA HARUNA					
12	ALIYU HARUNA					
13	ABDULRAHMAN USMAN					
14	MAHMOOD MUSA					
15	IBRAHIM ABUBAKAR					
16	SANI FRANCE					
17	Abiola Bolanle	EnvAccord	Social Scientist	08164155291	abolanle@envaccord.com	

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Attendance of Meetings with Members of Kuchitagi Community

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Attendance
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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	TOWN HALL MEETING
Date	14-10-2020
Venue	KUCHITAGI COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	ETSU YANKP MUH'D I.		VILLAGE HEAD	08063416912		
2	YAKUBU M. LIMAN			09031871157		
3	MUHAMMAD GANA					
4	ALHAJI KATAMBA					
5	NDANA MUHAMMAD			0[illegible]231252		
6	USMAN ABDULLAHI			[illegible]0883283 16		
7	MAHMOOD MOHAMMED			[illegible]06433 1679		
8	Alhassan MOHAMMED			07084516127		
9	MUHAMMADU KOTSU			0814[illegible]198179		
10	NDABA MAHMOOD			0811[illegible]87962		
11	NDABIDA USMAN			07045531076		
12	MOHAMMED AUDU			08133741431		
13	USMAN MOHAMMED					
14	MUHAMMAD BABA		08120538631	~~08120~~5353		
15	MOHAMMED MAHMOOD			09036947019		
16	LADAN ALHAJI			07032447820		
17	BABA YAHD KUCHITAGI					

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Attendance (Engie Mini-Grid Solar Power Projects)

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD WITH WOMEN
Date	10-10-2020
Venue	KUCHITAGI COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
01	AMINA		Women			
02	HAWAWU		"			
03	AMINA		"			
04	FATIMA		"			
05	AYESHA		"			
06	FATIMA.		"			
07	AISHA		"			
08	AMINA		"			
09	ADAMA		"			
10	SAUMATU		"			
11	Abiola Bolarinwa	EnvAccord	Social Scientist	08164155291	abolarinwa@envaccord.com	[illegible]
12.	Rhoda Onotoshe	EnvAccord	Social Scientist	08164155291	ronotoshe@envaccord	

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Attendance of Meetings with Members of Dakpan Community

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD WITH WOMEN
Date	14-10-2020.
Venue	DAKPAN COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
01	Hajia Salimat		Women			
02	Hajia Hemirat		Women			
03	" Rahina		Women			
04	" Aishatu		Women			
05	" Fatima		"			
06.	Hajia Aisha		"			
07	Hajia Yakhe		"			
08.	" Fatima		"			
09.	" Aisha		"			
10.	" Fatima		"			
11.	" Salinatu.		"			
12	" Zainab		"			
13.	" Aminat		"			
14.	" Aishatu.		"			
15.	" Fatima		"			
16.	Rhoda Omotosho	EnvAccord	Social Scientist	08109438110	romotosho@envaccord.com	[signature]

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Attendance (Engie Mini-Grid Solar Power Projects)

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Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	TOWN HALL MEETING
Date	14-10-2020
Venue	DAKPAN COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
01	Rhoda Onoshe	EnvAccord	Social Scientist	08109438110		
02	Abdulmalik M. Awwal	F.M.H. BDOA	10/L10	08064451363	awwal2034@gmail.com	
03	Alh. Yakubu					
04	Alh, Usman			07086316424		
05	Alh Manssin					
06	Alh Tsuwa			09014434281		
07	Alh Korong,			08082885740		
08	Alh Sulasun			07020579880		
09	Ndagi Yahaya			08124548590		
10	Yasode Idrisu			07084575892		
11	Dunjuma Yakubu			07085144532		
12	Ndagi buji			07013791055		
13	Umaru Bala			08121880774		
14	Afa Yakubu			08125527614		
15	Baba Yanda			08027370237		
16	Idrisu Umaru			08080334211		

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Attendance of Meetings with Members of Sheshimandiko Community

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD with Women
Date	13-10-2020
Venue	SHESHIMADIKO COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	HAJIYA FATIMA 'S'					
2	FATI MOHAMMED					
3	AMINA MOHAMMED					
4	HAWAWU BABA					
5	ADISATU ABDULLAHI					
6	ADISATU ABUBAKAR					
7	HAZAIN YUSUF					
8	AISHETU IBRAHIM					
9	FATI TAUHEED					
10	HALIMATU MOHAMMED					
11	RAMATU SODI					
12	ADISATU AMINU					
13	FATIMA ISAH					
14	ADAMA ISAH					
15	FATIMA 'A' BABA					
16	AMINA 'A' JIYA					
17	Rhoda Omotosho	EnvAccord	Social Scientist	08109438110	romotosho@envaccord.com	

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Attendance
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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD with Community head
Date	13/10/2020
Venue	Sheshimadko Community

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1.	MOHAMMADU SHESHI	SHESHIMADKO	Head of Community	08109579898	//	
2.	Abiola Bolowa	EnvAccord	Social Scientist	08164155291		

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD with Men group / Town Hall meeting
Date	13/10/2020
Venue	Sheshi Madako Community

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	Mohammed Abbah			08065710611		
2	A. Beni Sheshi			07064777658		
3	Adamu Baba			08068610922		
4	A - Abubakar			09033555504		
5	Moh'd Abdullahi			08136218858		
6	Baba Adamu			08161870787		
7	Abubakar Moh'd			07086467402		
8	Moh'd Aliyu			07036521065		
9	Aliyu Moh'd			08048589372		
10	Usifu Moh'd			08066437151		
11	Dauladi Baba			08063168443		
12	Abdullahi Moh'd			08136218858		
13	Saini Tukugi			07039172261		
14	Baba Ndako			08139200292		
15	Ibrahim Moh'd			08109579898		
16	Tanko Moh'd			09065090139		

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	TOWN HALL MEETING
Date	13-10-2021
Venue	SHESHI MADDINA COMMUNITY.

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1	MOHAMMED SHESHI					
2	MOHAMMED KEDI					
3	ALHAJI BABA'E.					
4	NMA-N' ABDULLAHI					
5	ALHAJI ABUKAR SABO					
6	ALHAJI ADAMU BAKE					
7	JALIKALI SABO				runofugho@envaccord.com	[signature]
8.	Rhoda Onofugho	EnvAccord	Social Scientist	08168458110		

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Attendance of Meetings with Members of Mayaki Community

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD WITH FARMERS
Date	17-10-2020
Venue	MAYAKI COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1.	moH-d yarima			08108111229		
2	Adamu moHd			07066898455		
3	Ndahiru moH-d			07067940232		
4	Musa gimba			08130240650		
5	Sadiq musa			08069386901		
6	Ibrahim Isah			07040459445		
7	dauda Isah			07042704684		
8	Isiyaku Isah			07079602025		
9	Sulemon Yusif			07049602025		
10	Abubakar Sale			07038440713		
11	Musa Abubakar			07057901149		
12	Abubakar Isah			07042704684		
13	Abdul-rahaman Saliu			07065999122		
14	mustafa umar			07064772454		
15	Abdul-rahaman Suleman			09069409252		
16	Isiyaku moh-d.			09055041135		
17	Abiola Bolanwe	EnvAccord	Social Scientist	08164155291	abolanwe@envaccord...	

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD With WOMEN
Date	19-10-2020.
Venue	MAYAKI Community

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
01	RAKIYA ISAH					
02	Kande Tanko					
03	HABIBA HARUNA					
04	Habiba Bukhri					
05	fatima Yusuf					
06	Aisha Dandu					
07	Zaku musa					
08	Atika musa					
09	Amina Saidu					
10	Hauwa Saidu					
11	Ramatu Abu					
12	Saratu Gariba					
13	Salamatu Yahaya					
14	Salamatu Abdul					
15	Aisha Bako					
16	Amina Mallan					

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	TOWN HALL MEETING
Date	17-10-2020
Venue	MAKAN COMMUNITY

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1.	HARUNA, MUSA		Community Head	08169808655		
2.	Idirisu YARIMA		Community member			
3.	GARBA Ibrahim		"	08077017662		
4.	YAHAYA Moh,d.		"	08113109275		
5.	Saidu Magaji		"	08026218537		
6.	Dauda Teila		"	08051795011		
7.	Adamu Abubakar		"	08153521845		
8.	Garba Jirigi		"			
9.	Hassan Suleman		"	08148485094		
10	Saidu bala		"			
11.	dantadi Mo,hd.		"	07059142620		
12.	Awal Abdullahi		"	09065795281		
13	Mustapha Isah		"	08131526663		
14	Mo,hd. Adamu		"	08163008210		
15	Abu Isah		"	07066669259		
16	Adamu bauda		"	08145533607		
17	Abiola Bolanwe	Env Accord	Social Specialist	08164155291	abolanwe@envaccord.com	

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Attendance of Meetings with Members of Kpanje Community

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Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	FGD WITH WOMEN
Date	19-10-2022
Venue	KPANJE VILLAGE

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
1.	Lafi Haruna					
2	fati Usman					
3	Jagi Isah					
	fati Usman					
	Hassana Isah					
	Aisha Kabiru					
	Leni Kostu					
	Hawa Mohd					
	fati A'hassan					
	fati Mohd					
	Maryam Kolo					
	Lami Mohd					
	Lara Jiya					
	Amina Mohd					
	Bida Umar					
	fati Isah					

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Attendance
(Engie Mini-Grid Solar Power Projects)

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Project Title	**Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State**
Purpose	TOWN HALL MEETING
Date	19-10-2020
Venue	KAPA KPANTE VILLAGE

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S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
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3	KPOTUN ALHAJI					
4	NAKODI ISAK					
5	DEFYAN JIYA					
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11	ISAH DEJI					
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13	KPADA UMARU			07037160486		
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Attendance
(Engie Mini-Grid Solar Power Projects)

Project Title	Environmental and Social Management Plan (ESMP) for the Proposed Engie Mini Grid Solar Power Projects in Niger State
Purpose	Town Hall meeting in Kpanjo community
Date	19—10—2020
Venue	Kpanjo community

S/N	Name	Organisation	Designation	Phone Number	Email Address	Signature
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11	Aliyu Abubakar			09064705854		
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REFRENCES

1. Agbalajobi , D. (2009). Women's participation and the political process in Nigeria: Problems and prospects. *African Journal of political science and International relations,* ***4***, 075-082.
2. CIA World Factbook. (2020, November 18). *Nigeria World Fackbook Archive*. Retrieved from CIA: https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html
3. Cochran, W.G. (1963) Sampling Techniques, Wiley, New York.
4. Espinosa, D. C. R. and Tenorio, J. A. S. (2006). Recycling of nickel–cadmium batteries-Thermogravimetric behavior of electrodes. *Journal of Power Sources* **160**(1): 744-751
5. Gender Monitoring Office. (2018, August). Gender-Based Violence (GBV) Indicators. *GenderAccountability for Sustainable Development*.
6. Geophysical Service Incorporated (GSI) (2003). *St Lawrence Survey. Environmental Assessment Report*. Prepared by Canning & Pitt Associates Inc. and assisted by Robert Hamelin & Associates. 198 pp.
7. http://documents1.worldbank.org/curated/en/630671538158537244/pdf/The-World-Bank-Annual-Report-2018.pdf
8. https://rea.gov.ng/wp-content/uploads/2019/04/Michael-NEP-ES-.pdf
9. https://www.icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf
10. https://www.who.int/whr/2007/en/
11. International Energy Agency (IEA) (2014). *Technology Roadmap. Solar Thermal Electricity*. IEA. 52 pp.
12. International Energy Agency (IEA) (2014). *Technology Roadmap. Solar Thermal Electricity*. IEA. 52 pp
13. International Finance Corporation (IFC) (2012). *International Finance Corporation Performance Standards*. World Bank Group. 196 pp.
14. International Organisation for Migration. (2016). *Migration in Nigeria: A Country Profile*
15. Geneva. *2014*: International Organisation on Migration. Retrieved November 18, 2020, from https://publications.iom.int/system/files/pdf/mp_nigeria.pdf
16. Idris–Nda, A., Dodo, U., Jimada, A. M. (2014). Challenges Facing the Attainment of the Millennium Development Goals (MDG's) in the Water Sector: The Niger State Example, Central Nigeria. Journal of Scientific Research & Reports **3**(7): 973-984
17. Isah, A., & Nafiu, L. (2013). Women empowerment as an essential tool for national transformation:Niger State, Nigeria xperience. *American Journal of theoretical and Applied Statistics, 2*(2), 12-14.
18. Kandemir , A., & Budd, R. (2018, May). Using Vignettes to Explore Reality and Values with Young People. *FORUM: QUALITATIVE SOCIAL RESEARCH, 19*.

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Dec 19, 2023 1:59 AM EST

19. Liang, Y., Su, J., Xi, B., Yu, Y., Ji, D., Sun, Y., Cui, C. and Zhu, J. (2017). Life cycle assessment of lithium-ion batteries for greenhouse gas emissions. *Resources, Conservation and Recycling* **117:**285-293
20. MacroTrends. (2020, November 18). *Nigeria Net Migration Rate 1950-2020*. Retrieved November 18, 2020, from Macrotrends: https://www.macrotrends.net/countries/NGA/nigeria/netmigration#:~:text=The%20curent%20net%20migration%20rate,a%202.82%25%20decline%20from%202017.
21. Muhammad, U. N. (2012). *Muslims of Niger State: A Survey.* Oxford: Oxford Department of International Development, Queen Elizabeth House, University of Oxford. Retrieved November 18, 2020, from https://www.qeh.ox.ac.uk/sites/www.odid.ox.ac.uk/files/BP6Ndagi.pdf
22. National Bureau of Statistics. (2012). *Annual Abstract of Statistics.* Abuja: NBS.
23. National Bureau of Statistics. (2017). *Crime Statistics: Reported Offences by Type and State.*Abuja: NBS.
24. Niger State Bureau of Statistics. (2011). *Facts and Figures on Niger State.* Niger State: State
25. Bureau of Statistics, Niger State Planning Commission. Retrieved November 18, 2020, from https://nairametrics.com/wp-content/uploads/2013/05/Facts-and-FiguresaboutNigerState1.pdf
26. Nigeria Bureau of Statistics. (2019). *Statistical Report on Women and Men in Nigeria.* Lagos: Nigeria Bureau of Statistics. Retrieved from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjzpAhUF2uAKHRR8CVUQFjAAegQIARAB&url=https%3A%2F%2Fnigerianstat.gov.ng%2Fownload%2F952.&usg=AOvVaw0K4wYfUHmmYXOOkofV5qoA
27. Nigeria Demographic and Health Survey. (2018). *Nigeria Demographic and Health Survey.*Abuja: National Population Commission.
28. PricewaterhouseCoopers. (2020). *Nigeria Economic Alert: October 2020.* Lagos: PwC. Retrieved November 21, 2020, from https://www.pwc.com/ng/en/assets/pdf/economicalert-october-2020.pdf
29. SE4ALL Africa Hub & African Development Bank. (2018). Mini-Grid Market. African Development Bank. Retrieved from https://africa-energy-portal.org/sites/default/files/2019-04/GMG_Nigeria_4.pdf
30. Shukla, A. K. and Hariprakash, B. (2009). Secondary batteries – nickel systems. Electrodes: Cadmium. *Chemistry, Molecular Sciences and Chemical Engineering*412-417
31. Sun, Z., Cao, H., Zhang, X., Lin, X., Zheng, W., Cao, G., Sun, Y. and Zhang, Y. (2017). Spent lead-acid battery recycling in China – A review and sustainable analyses on mass flow of lead. *Waste Management* **64:** 190-201.
32. Uzoma, C. C., & Amadi, K. C. (2019). Energy Access: A Key to Rural Development in Nigeria. Research & Reviews: Journal of Social Science, 452 – 456

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33. Wang, Y., Lee, C., Lee, L., Tung, L., Hsieh-Li, H., Lee-Chen, G., & Su, M. (2011). Mitochondrial Dysfunction and Oxidative Stress Contribute to the Pathogenesis of Spinocerebellar Ataxia Type 12 (SCA12). Journal of Biology Chemical, 286(24). doi:10.1074/jbc.M110.160697
34. Whitehead, A. H., Rabbow, T. J., Trampert, M. and Pokorny, P. (2017). Critical safety features of the vanadium redox flow battery. *Journal of Power Souces* **351** (31): 1-7.
35. Zhang, J., Chen, C., Zhang, X. and Liu, S. (2016). Study on the Environmental Risk Assessment of Lead-Acid Batteries. *Procedia Environmental Sciences* **31:**873-879.

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TECHNICAL COMMENTS ON THE DRAFT ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT (ESIA) REPORT ON THE PROPOSED SOLAR MINI-GRID POWER PROJECTS IN NIGER STATE UNDER THE NIGERIA ELECTRIFICATION PROJECT BY ENGIE FENIX NIGERIA

S/N	COMMENTS	RESPONSE	REFERENCE
	COVER PAGE		
1.	Cover Page for the Final report should be presented as follows; FINAL Environmental & Social Impact Assessment (ESIA) Report For PROPOSED SOLAR MINI-GRID POWER PROJECTS IN NIGER STATE. By ENGIE FENIX NIGERIA SUBMITTED TO THE FEDERAL MINISTRY OF ENVIRONMENT HEADQUARTERS, MABUSHI, ABUJA Month/YEAR	The Cover page of the report has been updated.	Cover Page
	EXECUTIVE SUMMARY		
2.	The Executive Summary should be revised to clearly present: - • The Phases and timelines for the development; • Waste Management specific to the project, presenting the types of waste to be generated throughout the development and operational phases;	• The phases and timelines for the project are presented in the executive summary • The waste management section of the executive summary has been updated.	• ES-6, Para 3 • ES-6, Para 1
	CHAPTER THREE – PROJECT DESCRIPTION		
3.	Pg 3-44, last paragraph stated that "……… each PV panel would require approximately 5 litres of water per cleaning cycle". ○ The number of solar panels per site should be stated here to ascertain the anticipated volume of water required per cleaning circle. Please update in the revised report.	The number of panels and estimated volume of water has been updated in the report	Chapter 3, Page 3-44, Para 5
4.	Chapter Three should be updated as follows: - • Facilities/Third-Party structures and environmental medium proximate to the proposed project site. • Site acquisition method should be stated, is it on lease, outright purchase or rent.	A description of Facilities/Third party structures has been updated in the report	Chapter 3, Page 3-42, Section 3.3.4

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S/N	COMMENTS	RESPONSE	REFERENCE
		The details about site acquisition has been updated in the report	Chapter 3, Page 3-2, Para 4
General Comments:			
5.	• The pages of the Table of Contents should tally with those in the main report. • The entire report should be edited for all typographical, grammatical and spelling errors • List all symbols/Abbreviations and Acronyms used in the text accurately. • All sources of information used should be acknowledged/cited and listed (in REFERENCES). • All poorly presented figures and tables should be corrected in the updated report and convey relevant information e.g. legible Legend, scales used, North Pole for maps, etc. Expunge irrelevant figures, passages, etc. Title Figures at the base using Fig. while Tables are titled above. Cite the sources too.	The report has been revised accordingly	
6.	Engie Fenix should specify the Corporate Social Responsibility for the project's host communities and present in the updated report.	The CSR plans have been updated in the final report.	Chapter 7, Page 7-22, section 7.5.9

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