Draft

Environmental & Social Impact Assessment (ESIA)

Report for CNG Autogas Mother Station Project at Izom, Gwagwalada Area Council, Abuja-FCT.

By

Greenville LNG Company Limited

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ABBREVIATIONS/ACRONYMS

AfDB	African Development Bank
AEPB	Abuja Environmental Protection Board
AKK	Abuja-Kaduna-Kano Pipeline
ALARP	As Low As Reasonably Practical
BID	Background Information Document
BOD	Biochemical Oxygen Demand
BRV	Big Road Vehicles
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CBOs	Community-Based Organizations
CEO	Chief Executive Officer
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
CPR	Cardiopulmonary Resuscitation
CRO	Community Relations Officer
CSW	Commercial Sex Workers
D&A	Decommissioning and Abandonment
dB	Decibel
DO	Dissolved Oxygen
EC	Electrical Conductivity
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	Environmental Management System
EPR	Extended Producer Responsibility
ERP	Emergency Response Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FMEnv	Federal Ministry of Environment

FRN	Federal Republic of Nigeria
GBV	Gender-Based Violence
GHG	Greenhouse Gases
GIIP	Good International Industry Practice
GPS	Global Positioning System
GRU	Gas Receiving Unit
GVLNG	Greenville Liquefied Natural Gas Company Limited
HAZID	Hazard Identification
HAZOP	Hazard and Operability Study
HCHO	Formaldehyde
HOCNS	Harmonized Offshore Chemical Notification System
HR	Human Resources
HSE	Health, Safety and Environment
HSE-MS	Health, Safety and Environment Management System
HSSE	Health, Safety, Security and Environment
IFC	International Finance Corporation
IFCS	Intergovernmental Forum on Chemical Safety
ILO	International Labour Organization
INC	Intergovernmental Negotiating Committee
IPCS	International Programme on Chemical Safety
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
KASUPDA	Kaduna State Urban Planning and Development Authority
KEPA	Kaduna Environmental Protection Authority
KII	Key Informant Interview
LDAR	Leak Detection and Repair
LFN	Laws of the Federation of Nigeria
LGA	Local Government Area
LTIFR	Lost Time Injury Frequency Rate
LULC	Land Use and Land Cover
MDGIF	Midstream and Downstream Gas Infrastructure Fund
MISTDO	Minimum Industry Safety Training for Downstream Operations
MoU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
NDC	Nationally Determined Contribution

NESREA	National Environmental Standards and Regulations Enforcement Agency
NGEP	National Gas Expansion Programme
NGOs	Non-Governmental Organizations
NiMet	Nigerian Meteorological Agency
NMDPRA	Nigerian Midstream and Downstream Petroleum Regulatory Authority
NOSDRA	National Oil Spill Detection and Response Agency
NPE	National Policy on Environment
NUPRC	Nigerian Upstream Petroleum Regulatory Commission
OHS	Occupational Health and Safety
OP	Operational Policy
ORP	Oxidation-Reduction Potential
OSCP	Oil Spill Contingency Plan
OSPAR	Oslo-Paris Convention for the Protection of the Marine Environment
PAERs	People, Assets, Environment, and Reputation
PAH	Polycyclic Aromatic Hydrocarbons
PDR	Post Decommissioning Report
PHC	Primary Health Centre
PIA	Petroleum Industry Act
PM	Particulate Matter
PMP	Pest Management Plan
PMS	Premium Motor Spirit
POPs	Persistent Organic Pollutants
PPE	Personal Protective Equipment
PS	Performance Standard
PTD	Permanent Total Disability
PTW	Permit to Work
QA/QC	Quality Assurance/Quality Control
QHSE	Quality, Health, Safety and Environment
RAM	Risk Assessment Matrix
SCADA	Supervisory Control and Data Acquisition
SEA	Sexual Exploitation and Abuse
SEMP	Social and Environmental Management Plan
SH	Sexual Harassment

SOP	Standard Operating Procedure
SPM	Suspended Particulate Matter
STD	Sexually Transmitted Disease
TDS	Total Dissolved Solids
THC	Total Hydrocarbon Content
ToR	Terms of Reference
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
TVOC	Total Volatile Organic Compounds
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compound
WCN	Waste Consignment Note

EIA PREPARERS

S/No	Names	Area Covered/Specialty
1	Olufemi Jacob A.	Project Coordinator
2	Tony Z. E.	GIS Mapping and Environmental Sensitivity index expert
3	Tunde Finnih	Air Quality Index
4	Faniyi A.O	Socio-economic Expert
5	Dr Chris Ejeomo	Chemistry and environmental toxicology expert
6	Dr Folarin E.O	Soil study expert
7	Dr Babalola Oki	Plant and Animal Ecology Expert
8	Adam Usman	Public Health Expert
9.	Hussaini Omale	Baseline Study
9	Mr Mohammad A. Usman	Report Compilation

EXECUTIVE SUMMARY

ES1.1 INTRODUCTION (BACKGROUND).

Natural gas is one of the most sought energy sources globally. This is because it is a cleaner source of energy compared to diesel, coal and wood, and also cheaper than most other fossil fuels. Nigeria has abundant gas reserves in a number of gas fields, mostly in remote locations within and around the Niger Delta area. The country has not fully harnessed the economic potential of its gas resources due to various factors, which include a lack of infrastructure. Thus, useful gas resources have been either flared or remain stranded in remote areas. Gas gathering, processing and transportation infrastructure in Nigeria is grossly inadequate, which has greatly hampered the industrial growth of the country. Therefore, the implementation of the Greenville LNG Project offers an opportunity to harness Nigeria's natural resources for use across the country, particularly in locations not served by pipeline infrastructure. The project, therefore, aligns with the Federal Government's policies:

- To reduce gas flaring
- To monetize gas resources
- To improve energy availability across the country through its gas-to-power initiative.

ES 1.2 The Project Proponent

Greenville Liquefied Natural Gas Company Limited (GVLNG) was founded in 2015 and is a Nigerian private company based in Abuja, FCT, Nigeria**.** Greenville Liquefied Natural Gas Company Limited (GVLNG), formerly Greenville Oil and Gas Company Limited (GOGCL).

ES 1.3 Project Location and Accessibility

The proposed project would be sited on a 10ha of land at Izom Community, Gwagwalada Area Council., Abuja-FCT. The proposed project site falls within the following geographical coordinates: 8°48'11.4"N 6°56'57.4"E.

ES 1.4 Legal and Administrative Framework

The environment has emerged as one of the most critical issues of contemporary times, driven by the increasing negative impacts of rapid industrial development. As natural resources are exploited at unprecedented rates, environmental quality deteriorates, rendering many development projects unsustainable. This situation has necessitated the enforcement of environmental protection laws to safeguard and restore the Nigerian environment.

The requirement for an Environmental and Social Impact Assessment (ESIA) aligns with the Federal Republic of Nigeria's (FRN) laws and policies aimed at achieving sustainable development goals through environmental stewardship, public health protection, and social well-being. It also fulfills international requirements for projects of this scale, ensuring adherence to best practices in environmental and social safeguards. This section reviews relevant Nigerian legislation, guidelines, and international conventions applicable to infrastructure development. The legislative framework outlined here is drawn from federal and state laws, as well as international conventions and instruments to which Nigeria is a signatory.

National Legislation

National Policy on Environment

Environmental management in Nigeria is based on the National Policy on the Environment (1988), revised in 1999 and 2016. The Policy states that Nigeria is committed to safeguarding the country's natural and built environment for the use of present and future generations. This commitment demands that efficient resource use and the reduction of environmental impacts be a core requirement of all developmental activities. The National Policy on the Environment aims to achieve sustainable development in Nigeria, and in particular to:

- Secure a quality of environment adequate for good health and well-being;
- Conserve and use the environment and natural resources for the benefit of present and future generations;
- Restore, maintain and enhance the ecosystem and ecological processes essential for the functioning of the biosphere to preserve biological diversity, and the principle of optimum sustainable yield in the use of living natural resources and ecosystems;

Raise public awareness and public understanding between the environment and development and encourage individual and community participation in environmental improvement efforts.

Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004

The Act makes EIA mandatory for all new major public and private projects in Nigeria. It sets out to:

- ✓ Consider the likely impacts and the extent of these impacts on the environment before embarking on any project or activity.
- ✓ Promote the implementation of appropriate policies in all federal lands consistent with all laws and decision-making processes through which the goal of this Act may be realized; and

- ✓ Encourage the development of procedures for information exchange, notification and consultation between organizations and persons when the proposed activities are likely to have significant environmental effects.

National Environmental Standards and Regulation Enforcement Agency (NESREA)

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

The Petroleum Industry Act (2021)

The Petroleum Industry Act (PIA) was passed into law in August 2021. It provides a comprehensive framework for the legal, governance, regulatory and fiscal matters of the Nigerian Petroleum Industry (upstream, midstream, and downstream) as well as the development of Host Communities. The Act repeals the following six (6) laws:

- the Associated Gas Reinjection Act 1979
- the Hydrocarbon Oil Refineries Act,
- Motors Spirit Returns Act,
- Nigerian National Petroleum Corporation (Projects) Act,
- Nigerian National Petroleum Corporation Act,
- the Petroleum Products Pricing Regulatory Agency (Establishment) Act

Nigerian Oil and Gas Industry Content Development Act, 2010

The Nigerian Local Content law was created to enhance utilization of the country's human and material resources for the provision of goods and services to the petroleum industry by ensuring that:

- Nigerians are given first consideration in the award of oil blocks, oil field licenses, oil lifting license and shipping service as well as projects for which contracts are to be awarded in the industry;
- there is exclusive consideration for Nigerian indigenous services to the oil and gas industry subject to the fulfilment of specified conditions;

National Gas Policy, 2017

The Nigerian gas policy was developed to encourage sustainable development and use of the Nigerian gas. The policies developed are listed below:

- the nation's gas resources shall be harnessed and optimally integrated into the national economy, energy mix and industrial processes;

- the nation shall engage intensively in gas exploration and development with a view to increasing the reserve base to the highest level possible;
- the nation shall put in place necessary infrastructure and incentives to encourage indigenous and foreign companies to invest in the industry; and
- the nation shall put in place necessary infrastructure and incentives to ensure adequate geographical coverage of the gas transmission and distribution network.

Land Use Act Cap L5 LFN 2004

The Land Use Act Cap L5 LFN 2004 states that "it is public interest that the rights of all Nigerians to use and enjoy land in Nigeria and the natural fruits thereof in sufficient quality to enable them to provide for the sustenance of themselves and their families be assured, protected and preserved".

Harmful Waste Act

The Harmful Waste (Special Criminal Provisions) Act Cap H1, LFN 2004 prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

Section 6: provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.

Section 7: makes provision for the punishment accordingly, of any conniving, consenting or negligent officer where the offence is committed by a company.

Section 12: defines the civil liability of any offender. He would be liable to persons who have suffered injury as a result of his offending act.

Penal Code Act of Nigeria 2004

The Act makes it an offence punishable with up to 6 month's imprisonment for any person who:

- Violates the atmosphere in any place to make it noxious to the health of persons in general dwelling or carry on business in the neighborhood, or passing along a public way; or
    - Does any act which is, and which he knows or has reason to believe to be, likely to spread the infection of any disease dangerous to life, whether human or animal.

Climate Change Act, 2021

The Climate Change Act, 2021 is a landmark legislation in Nigeria aimed at addressing climate change and promoting sustainable development. It establishes the National Council on Climate Change (NCCC) to coordinate national climate actions and introduces a Climate Change Fund to finance climate resilience

projects. The Act mandates carbon budgeting, sectoral emission targets, and the development of a National Climate Change Action Plan.

State Regulations

The Project site falls within the jurisdiction of Kaduna State Government. The key State administrative authorities and legal instruments that apply to the Project are briefly described below.

Federal Capital Territory Administration (FCTA)

The Federal Capital Territory Administration (FCTA) is the administrative authority responsible for the governance, development and management of the Federal Capital Territory pursuant to the provisions of the Constitution of the Federal Republic of Nigeria and the Federal Capital Territory Act. The FCTA is responsible for ensuring that all public and private developments within the Territory are undertaken in accordance with approved planning standards, environmental requirements and sustainable urban development principles.

Federal Capital Development Authority (FCDA)

The Federal Capital Development Authority (FCDA) is the principal agency responsible for the planning, development and physical implementation of infrastructure within the Federal Capital Territory. The FCDA is mandated to implement the Abuja Master Plan, coordinate physical development, provide engineering infrastructure and ensure orderly urban growth within the Territory as well as supervise development projects to ensure consistency with approved layouts, infrastructure corridors, zoning regulations and engineering standards.

Abuja Environmental Protection Board (AEPB)

The Abuja Environmental Protection Board (AEPB) is the principal environmental regulatory agency of the Federal Capital Territory Administration (FCTA), established to protect and improve the quality of the environment within the Federal Capital Territory. The Board is responsible for implementing environmental policies, enforcing environmental regulations, monitoring environmental quality, promoting sustainable waste management, controlling environmental pollution, regulating sanitation services, and ensuring compliance with environmental standards throughout the FCT. The AEPB collaborates with the Federal Ministry of Environment (FMEnv), the Federal Capital Territory Administration (FCTA), Area Councils within the FCT and other relevant institutions to ensure that development projects are implemented in an environmentally responsible manner.

The proposed project is subject to the environmental oversight responsibilities of the

Abuja Environmental Protection Board to ensure continued compliance with applicable environmental standards within the FCT.

Gwagwalada Area Council

Gwagwalada Area Council is one of the six Area Councils established within the Federal Capital Territory to administer local government functions within its jurisdiction. Gwagwalada is responsible for the provision and coordination of certain municipal services including environmental sanitation, waste management, public health administration, local roads, markets, community liaison, and other statutory local government functions.

Izom Community

Izom Community is situated within the jurisdiction of the Gwagwalada Area Council. Accordingly, implementation of the proposed project will require appropriate coordination with the Area Council regarding environmental sanitation, construction waste management, public health, traffic management and other municipal services that may be affected during project implementation.

International Regulatory Framework

In addition to national and state laws/regulations, Nigeria is signatory or party to several International Conventions and treaties that support the use of EIA as key tool for achieving sustainable development in executing projects.

International conventions to which Nigeria is signatory-to include, *but not limited to***:**

- The Vienna Convention on the Protection of the Ozone Layer;
- Montreal Protocol on Substances that deplete the Ozone Layer;
- The United Nations Guiding Principles on the Human Environment
- The Basel Convention on the Control of Tran boundary Movements of Hazardous Wastes and their disposal;
- Protocol on the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.
- Convention on the Conservation of Nature and Natural Resources, 1986
- Convention on Occupational Safety and Health and the Working Environment
- Stockholm Convention Against Persistent Organic Pollutants of 2004
- United Nations Framework Convention on Climate Change (1992)
- International Best Practices

ES2 PROJECT JUSTIFICATION

Proposed Project Justification

The establishment of a Compressed Natural Gas (CNG) Mother/Daughter station

network is a highly viable strategic project. The business and economic justification relies on four primary pillars:

- Proximity to Feedstock and Existing Infrastructure
- Virtual Pipeline Efficiency via Daughter Stations
- Immediate Commercial Demand
- Direct Policy Alignment

Need for the Project

The oil and gas industry plays an important role in the Nigerian economy, and this CNG Compression is one such.

- The project will reduce dependence on PMS and diesel, lower greenhouse-gas and particulate emissions. This shift supports improved air quality and public health outcomes.
- Stimulate local economic activity and boost living conditions
- Enhance energy security in line with Nigeria's Decade of Gas policy.
- Improve the health of society and the environment
- Conservation of energy
- Provide resources for industrial production at lower cost and increase productivity
- Create employment opportunities for Nigerians

Benefits of the Project

The proposed CNG mother/daughter station will deliver significant environmental, economic, and energy-security benefits.

- It will reduce greenhouse-gas and air-pollutant emissions by providing a cleaner alternative to petrol and diesel, thereby improving local air quality and supporting Nigeria's energy-transition goals.
- The project enhances regional energy security by supplying a stable, locally sourced fuel and extending gas access to areas without pipeline infrastructure.
- It will stimulate economic growth through job creation, lower fuel costs for transport and industrial users, and increased business activity.

Value of the Project

The value of the proposed project is highlighted by the desire to enhance local environment cleanliness and health in the oil and gas operational areas. The project estimated cost is N1 billion, to be independently funded. The project lifespan shall be 25 - 30years.

PROJECT SUSTAINABILITY

The project's sustainability is addressed under its economic, technical, social and environmental sustainability potentials. The project proponent will ensure that the project is in compliance with the universally accepted Sustainability Model. The universally accepted model of sustainability is one which focuses on preserving the environment, ensuring economic profitability and protecting the society.

Economic Sustainability

The project is economically sustainable as it leverages Nigeria's abundant natural gas resources to provide a cheaper and more stable alternative to petrol and diesel. The station will reduce fuel costs for transport operators, SMEs, and industrial users, thereby improving business competitiveness. It will generate direct and indirect employment during construction and operation, stimulate local supply chains, and support long-term economic diversification in Abuja-FCT.

Technical Sustainability

The project is technically sustainable due to the use of proven CNG compression, storage, and transportation technologies widely adopted globally. The modular mother/daughter configuration allows phased expansion based on demand, reducing technical risk. The proximity to existing gas infrastructure ensures reliable feedstock supply, while modern safety systems—pressure relief devices, gas detection, automated shutdowns—enhance operational reliability. The design complies with relevant engineering standards, ensuring long-term functionality and maintainability.

Environmental Sustainability

CNG is a cleaner-burning fuel that significantly reduces CO_2, NOx, SOx, and particulate emissions compared to conventional liquid fuels. The project will contribute to improved air quality and reduced greenhouse-gas emissions in line with Nigeria's climate commitments. CNG poses minimal risk of soil or water contamination because it dissipates rapidly when released. Identified environmental impacts—noise, construction disturbance, waste generation—are limited in scale and can be effectively mitigated through standard environmental management practices, making the project environmentally viable.

Social Sustainability

The project supports social sustainability by creating employment opportunities, enhancing local skills, and improving access to affordable energy. Lower fuel costs will benefit transport operators and commuters, contributing to improved mobility and reduced cost of living. The project promotes safer fuel handling and reduces community exposure to pollutants associated with diesel and petrol. Engagement with

host communities ensures inclusion, transparency, and alignment with local development priorities.

Project Options and Alternatives

As required by law in Nigeria, some reasonable options and alternatives to the various elements of the proposed project shall be considered and examined. Accordingly, a number of alternatives have been weighed up for the construction and operation of the proposed CNG Mother/Daughter Station using economic, technical and environmental considerations.

No- Project Option

The no-project option means the development of the planned CNG Station shall not take place. As a direct consequence, this would result in no effect on the environment in the area as this option would result in no change of environmental features. A key implication of this option is that the project area which is suitable for the CNG operations, will be under-utilized.

Delayed Project

Delaying the project involves moving the project to a later date. This situation is unlikely, and can only be considered if existing circumstances are highly un-favourable or risky for the execution of the project. Conflicts, war, hostilities, communities deeply resentful of the project or unacceptable/unattractive economics are some of the reasons this option can be adopted. In contrast, the economics and the political environment favour the execution of the project.

"Go Ahead Project Option"

The justification of this project outweighs other negative variables; therefore the "go ahead" option is proposed for the project at the present location. It is therefore recommended that the project be carried out as planned, since adequate mitigation measures shall be incorporated into the project plan to minimize or eliminate potential negative environmental and social impacts of the proposed project.

Alternate Site/ Locations

Alternative site locations were considered early on by the board of GVLNG Limited. Other location alternatives were considered before deciding on the present location but the current site is best suited for the project.

ES 3 PROJECT AND PROCESS DESCRIPTION

Project Background

The proposed project entails the establishment of a Compressed Natural Gas (CNG) mother/daughter station in Izom Community, Gwagwalada Area Council, Abuja-FCT. The gas source for the CNG Compression Station comes from the AKK Pipeline. The designed flow rate is 5000 Nm3/h, with an inlet gas pressure ranging from 5 to 6 MPa. The hydrogen sulfide content is no more than 15 mg/m3, and the total sulfur content is no more than 100 mg/m3. A control ball valve is installed on the pressure regulating and metering skid, which serves as the emergency shut-off valve for the inlet gas.

Facilities Description

The proposed CNG Compression Station is an industrial energy facility comprising two integrated zones: a compression section and a retail section.

- **Gas Receiving Unit (GRU):** Receives natural gas from an upstream pipeline or gas supplier.
- **Compression System:** High-pressure compressors that raise gas pressure to CNG standards (typically 200–250 bar).
- **Cascade Storage System:** High-pressure storage cylinders arranged in banks for efficient loading and unloading.
- **Dispenser Units:** For direct vehicle fueling (if applicable) and for loading CNG into daughter-station transport modules.
- **Control Room & SCADA System:** For monitoring pressure, flow, safety systems, and operational parameters.
- **Fire & Safety Infrastructure:** Fire-suppression systems, gas detectors, emergency shutdown systems, and safety signage.
- **Ancillary Facilities:** Administrative building, workshop, security post, internal roads, drainage, and utilities.

Project Development Activities

Pre-Construction Activities: The activities in the pre-construction stage shall primarily be made up of:

- Concept development,
- Feasibility studies
- Site acquisition
- Site survey and geotechnical investigations

Construction Phase: The construction of the facility would involve:

- Topographic Surveys
- Soil Investigation Surveys
- Mobilization of equipment and labour
- Site clearing and grading

- Installation of facilities that shall be fitted within the storage terminal e.g., piping, valves, loading hoses/nozzles, and safety alarms.
- Construction and installation of an administrative block, etc.
- Installation of Installation of foundations, equipment, and storage systems
- Construction of buildings and utilities
- Provision of Parking spaces.
- Painting of facilities
- Erection of safety signs around the facility
- Designation of Muster Stations
- Testing and commissioning of mechanical and electrical systems

Operations Phase: The operational activities shall include the following:

- Continuous gas compression, storage, and distribution
- Routine maintenance of compressors, storage banks, and safety systems
- Monitoring of environmental and safety parameters
- Good housekeeping
- Engagement with host communities and regulatory agencies

Decommissioning Activities

- Removal of equipment and structures
- Site remediation and restoration
- Waste disposal in accordance with regulatory standards

Maintenance Activities

Periodic checks of the pipeline, valves, compressors and dispensers shall be carried out. All leaks and spills shall be reported to the safety personnel who shall recommend and take appropriate actions. In addition, security personnel shall man the facility round the clock. Informal inspections shall be done on a daily basis noting the overall facility condition however formal inspections shall be conducted on a monthly basis. Piping must be maintained in sound condition and hydrostatically tested yearly. Sagging and cracking pipes as well as rusting or rotten pipe supports shall be checked for routinely. Maintenance activities shall also include repainting pipes; and repairing and replacement of defective pipes and valves. The hydrant tanks shall be checked for peeling, blistering or chipping periodically. The storage tanks shall be emptied, cleaned and the inside examined for holes and corrosion. The nozzles shall be checked for any signs of leaks from the valves and they shall be checked to see if they can be completely turned on and turned off to stop product flow.

Record keeping is a key aspect of maintenance and this would be kept for inspections, maintenance activities, training and product inventory.

Waste Management

According to the Basel Convention, wastes are substances or objects that are disposed or are intended to be disposed of, or are required to be disposed of by the provisions of national laws. Wastes include any items that people no longer have any use for, which they either intend to get rid of, or have already discarded. In addition, wastes also include such items which are required by law to be discarded, because of their hazardous properties.

In the light of this, Greenville LNG Limited recognize the implications of the ineffective handling and final disposal of generated wastes. GVLNG intends to be practical, systematic and efficient in the handling of waste materials during the construction and operation phases at the petroleum products terminal.

As a result, a stand-alone Waste Management Plan will be developed to conform to the universal principles of minimize/reduce at source (waste generation); reuse (components); recycle (before disposal) and responsible disposal – the 4 Rs Principle. GVLNG has developed and is implementing a Waste Management Plan (WMP) for all wastes generated from its operational areas. The plan documents waste streams, sources of generation, segregation and disposal methods. Approved waste handling facilities and technologies have also been indicated for the various waste streams as appropriate. The WMP is also used to manage all types of wastes that are generated during various phases of the proposed development. The WMP is operated on the principles of reducing (waste generation), reusing (components), or recycling (before disposal).

It is anticipated that the following wastes will be generated during the site preparation and construction phase:

- Construction wastes (minimal cleared and cut vegetation, unwanted soil, dunnage, packaging material, waste oils, etc.);
- Domestic waste (including sanitary wastes generated from on-site accommodation facilities); and
- Hydrotest water from the linkage pipeline and the CNG Tank.

Some of the above listed waste types have been categorized into:

- Sanitary Wastes;
- Project-Worker Camp Refuse (e.g., packaging, kitchen waste);
- Project Refuse (e.g., packing materials, spent PPE);
- Project Dunnage (e.g., wooden crating, metal scraps); and

- Hazardous Waste

Project Workforce

Each phase of the planned expansion will be staffed in line with activity requirements. Project activities commence with site preparation as described in earlier sections. This phase is estimated to require about 30 workers. Construction activities follow site preparation and will require about 39 workers comprising skilled, unskilled Nigerians and expatriates at peak periods. It is envisaged that a number of the workers will have permanent residence outside the plant site. Pre-commissioning and operations workforce are estimated at 20 and 38, respectively.

ES4 DESCRIPTION OF THE PROJECT ENVIRONMENT

Environmental baseline study of the CNG Compression Station is undertaken in order to establish the situation of the physical, biological, social and health environment of the study area prior to the commencement of the project development. This serves as baseline or benchmark to assess and monitor the impacts of the proposed CNG Mother Station at Izom, Gwagwalada Area Council, Abuja-FCT.

Consequently, upon completion of the environmental baseline study, the results generated would serve as a benchmark against which any potential beneficial or non- beneficial impact of the proposed project on the environment and socio-economics of the project area would be identified and assessed.

The main environmental components considered in the environmental baseline study include:

- **Physical components**: soil, surface/ground water resources, water/air quality and climatology;
- **Biological environment**, which includes: flora, (i.e trees, grasses, forest, fauna i.e, fish, Mega fauna, birds, mammal), threatened, and/or endangered species (plant/animals), species diversity, overall ecosystem stability etc.
- **Cultural** and **socio-economic components**: pollution trends, distribution of socio-economic resources indicative of human welfare, i.e. educational system, transportation/land use networks, and other infrastructures like water supply, waste water/domestic disposal, solid waste management, public services, fire protection, medical facilities and health impacts.

The baseline field data gathering was carried out in one season (dry season) from 16th to 17th June, 2026 as approved by the Federal Ministry of Environment (FMEnv)).

Climate and Meteorology

The Federal Capital Territory (FCT), Abuja, experiences two distinct seasons annually, the wet and dry seasons. The wet season typically spans from late March to October, while the dry season extends from October to early March. During the dry season, conditions are generally characterized by low humidity, dusty Harmattan winds (especially from December to February), and higher daytime temperatures.

Relative Humidity: Long-term relative humidity data for Abuja were sourced from World Weather Online, based on approximately 30 years of historical climate records, which are considered representative of prevailing climatic conditions in the Federal Capital Territory. According to these data, relative humidity in Abuja exhibits clear seasonal variation:

- During the wet season (April–October), average relative humidity typically ranges between 60% and 85%, with peak values occurring between July and September.
- During the dry season (November–March), relative humidity values are considerably lower, generally ranging from 20% to 40%, particularly during the Harmattan period (World Weather Online, n.d.).

Wind Speed: Wind direction in the project area shows a clear seasonal pattern, with prevailing south-westerly winds during the wet season and north-easterly winds during the dry season. Field measurements conducted during the dry season recorded wind speeds between 0 and 1.2 m/s, consistent with historical climatological records. These relatively low wind speeds, combined with predictable seasonal directions, present no significant operational or structural constraint for the proposed project. Nonetheless, consideration of wind forces will be incorporated into the structural design of mounting systems and any elevated infrastructure to ensure long-term durability and safety.

Rainfall: Rainfall generally occurs from March to November with peak period (highest rainfall values from August to September). Towards the end of the wet season or beginning of the dry season (late October to November), heavy thunderstorms commonly accompany the rains.

The rainfall regime is characterized by a maximum in the month of July with a short 'August Break'. The dry season lasts between mid - December to late March. Rainstorms in the wet season are characterized by thunder and lightning. The Average annual number of days with thunderstorms is between 45 and 70 days. The highest number is about 5-9 days usually occurs between April and May and towards the end

of the rainy season around October when rainfall is accompanied by greater frequency of thunderstorms, line squalls and disturbance lines.

Temperature: Historical temperature data for Abuja were obtained from NIMET and World Weather Online, covering a 30-year period, which provides a robust representation of prevailing thermal conditions in the Federal Capital Territory (World Weather Online, n.d.). Key observations include:

- Mean annual temperature: 26°C to 34°C
- Hottest months: February to April, with peak daily maximums occasionally exceeding 36°C
- Coolest period: December to January, influenced by the Harmattan wind, with minimum temperatures occasionally dropping below 20°C.

Air Quality and Noise Levels

The pollutants commonly monitored in relation to air quality are; nitrogen dioxide (NO_2), sulphur dioxide (SO_2), suspended particulate matter (SPM), ammonia (NH_3), hydrogen sulphide (H_2S), carbon dioxide (CO_2), carbon monoxide (CO), and volatile organic compounds (VOCs). Sulphur Dioxide (SO_2), Nitrogen dioxide (NO_2) and Ammonia (NH_3) levels in the study area and control station were below equipment detection limit.

Carbon Monoxide (CO): concentrations ranged between 0.7 and 1.0 ppm, which are substantially lower than the FMEnv ambient air quality limit of 10 ppm and the WHO guideline value. These very low concentrations indicate that combustion-related emissions within the study area are minimal and that there are currently no significant sources of incomplete fuel combustion. The observed concentrations are characteristic of rural and peri-urban environments with relatively low traffic density.

Carbon Dioxide (CO_2): concentrations ranged from 410 to 430 ppm, which closely correspond to present-day global atmospheric background concentrations. These values indicate that there are presently no significant anthropogenic carbon dioxide emission sources affecting the project area. The uniformity of the measured concentrations across both project and control locations further confirms that atmospheric conditions remain largely unaffected by industrial activities.

Nitrogen Dioxide (NO_2)

concentrations ranged from 0.01 to 0.03 ppm. These concentrations are below the FMEnv ambient air quality limit of approximately 0.04–0.06 ppm, indicating compliance with national regulatory standards. Although the highest values approach or marginally exceed the more stringent WHO guideline, the concentrations remain

relatively low and are typical of locations influenced primarily by light vehicular movement rather than intensive industrial operations.

Sulphur Dioxide (SO_2): concentrations ranged between 0.003 and 0.006 ppm, remaining well below the FMEnv limit of 0.01 ppm and the WHO guideline value. These low concentrations indicate the absence of significant sulphur-containing fuel combustion or industrial emissions within the study area. Similarly, hydrogen sulphide was not detected at any sampling location, demonstrating that there are currently no emissions from sewage decomposition, petroleum contamination or other sulphide-generating sources.

Ammonia (NH_3): concentrations varied from 0.01 to 0.03 ppm, while methane concentrations ranged between 1.8 and 2.4 ppm. Both parameters occurred at very low concentrations consistent with natural atmospheric background conditions. The methane values indicate that there is currently no leakage of natural gas or accumulation of combustible gases within the project area prior to project implementation. This observation is particularly important because methane monitoring will become a key environmental performance indicator during operation of the proposed CNG facility.

Formaldehyde concentrations ranged from 0.002 to 0.003 mg/m³, while total volatile organic compounds (TVOCs) varied between 0.018 and 0.024 mg/m³. Both parameters are substantially lower than internationally accepted health-based guideline values, indicating negligible emissions from hydrocarbon evaporation, solvent use or industrial activities. These low concentrations further demonstrate that the proposed project site has not experienced pre-existing contamination from petroleum products or volatile chemical compounds.

Temperature, Relative Humidity and Wind Speed

ranged from 28.3°C to 33.5°C, while relative humidity varied between 51% and 70%. These values are characteristic of the prevailing wet season climatic conditions within the Guinea Savannah zone of the Federal Capital Territory. The prevailing meteorological conditions are favourable for atmospheric dispersion of pollutants, thereby reducing the likelihood of pollutant accumulation within the project area.

Ambient Noise Level: ranged from 45 to 55 dB(A) across the project area, while the control stations recorded values between 45 and 50 dB(A). These values comply with the FMEnv permissible daytime noise limit of 55 dB(A) for residential environments and are also consistent with the WHO environmental noise guideline. The measured noise levels reflect a relatively quiet rural environment with only minor contributions from local vehicular traffic and community activities. The results indicate that the proposed project site is currently free from significant noise pollution.

Overall, the baseline air quality assessment demonstrates that the proposed Greenville LNG CNG Mother Station site currently possesses good to excellent ambient air quality. Virtually all measured gaseous pollutants, including carbon monoxide, sulphur dioxide, methane, hydrogen sulphide, ammonia, formaldehyde and volatile organic compounds, complied with FMEnv and WHO guideline values. Particulate matter, particularly $PM_{2.5}$, represents the only parameter requiring attention, as concentrations at several locations exceeded the more stringent

Geology: The study area is located within the Central Nigeria Precambrian Basement Complex. (Figure 4.12) The geology of the area has been studied and discussed by previous publications like Oyawoye (1972), McCurry (1976) etc. They described the rocks as comprising mostly granite, gneisses, mica schists, hornblende and feldspathic schists and migmatites. The rocks are highly fractured and jointed showing essentially two fracture patterns, NE – SW and NW – SE. These fractures control the drainage and flow patterns of rivers in the area. However, minor Cretaceous deposits of Nupe sandstones occur in the southern part of FCT between Gwagwalada and Abaji, extending to Rubochi and the border with Nasarawa State. Similarly, metasediments have also been mapped along a general NNE-SSW direction through the west of Kusaki (in the south) and east of Takushara (in the north) (USGS 1977).

Hydrology: The region's topography is predominantly undulating, with elevations ranging from about 76 meters above sea level in the southwestern floodplains of the River Gurara to over 1,000 meters in the northwestern highlands. The landscape features broad plains interspersed with hills and prominent inselbergs such as Zuma Rock. Hydrologically, Abuja is defined by a complex network of surface and groundwater systems that are vital to the region's water resources. The Gurara River originates from the highlands in Kaduna State, cutting course through parts of Kaduna and Niger States before joining the River Niger. Along its journey, the river passes the well-known Gurara Waterfalls, a major natural attraction in Niger State. A portion of the Gurara River's flow is channeled into the Federal Capital Territory (FCT), where it serves as a vital water source.

Within the FCT, it feeds into and sustains several smaller streams, including the Rubia, Gwagwalada, and Usmanu streams, which traverse different districts of the territory, supporting local ecosystems and providing water for domestic and agricultural use.

Groundwater and Surface Water Quality

The baseline water quality assessment was undertaken to determine the existing condition of groundwater and surface water resources within and around the proposed Greenville LNG CNG Mother Station at Izom, Gwagwalada Area Council, FCT Abuja. Six (6) groundwater samples, three (3) surface water samples and one (1)

control groundwater sample were analysed for physicochemical characteristics, major ions, heavy metals, organic contaminants and microbiological parameters. The analytical results were compared with the applicable Federal Ministry of Environment (FMEnv) permissible limits to determine the suitability of the water resources and establish baseline environmental conditions prior to project implementation.

Overall, the groundwater quality was found to be considerably better than the surface water quality. Surface water exhibited elevated suspended solids, microbial contamination and elevated concentrations of some heavy metals, whereas groundwater generally complied with FMEnv and WHO standards except for isolated parameters such as iron. The results from the laboratory were analyzed and the interpretations are summarized as follows;

pH and Temperature The pH values ranged from 6.5 to 6.9, while surface water recorded values between 6.7 and 7.1. The control sample had a pH of 7.3. All measured values fall within the FMEnv acceptable range of 6.5 to 8.5, indicating neutral to slightly acidic conditions that are favourable for aquatic life and domestic water supply. The results suggest that the water resources have not been affected by acidification or alkaline contamination and that the natural geochemical conditions of the aquifer remain largely intact.

Water temperatures varied from 25.9 to 27.9°C, reflecting the prevailing tropical climatic conditions within the project area. These temperatures are typical of natural groundwater and surface water systems in the Guinea Savannah ecological zone and indicate that the water bodies have not been subjected to thermal pollution. Stable temperature conditions are important because they influence dissolved oxygen availability, biological activity and aquatic ecosystem productivity.

Electrical Conductivity (EC): values ranged between 350 and 460 µS/cm in groundwater and 165 to 235 µS/cm in surface water, all of which are substantially below the FMEnv limit of 1,000 µS/cm. The relatively low conductivity indicates that the water contains low concentrations of dissolved ionic substances and has not been significantly influenced by saline intrusion, industrial discharges or excessive mineralization. The lower conductivity observed in the surface water further reflects dilution by rainfall and continuous stream flow.

Turbidity values ranged from 0 to 2 NTU in groundwater and 15 to 19 NTU in surface water, remaining well below the FMEnv limit of 50 NTU. The exceptionally low groundwater turbidity demonstrates the effective filtration capacity of the underlying

geological formations, while the relatively higher values recorded in surface water reflect the influence of suspended sediments, runoff and organic matter commonly associated with natural streams.

Total Dissolved Solids (TDS): ranged from 190 to 255 mg/L in groundwater and 105 to 155 mg/L in surface water, all significantly below the FMEnv permissible limit of 500 mg/L. These low concentrations indicate that both groundwater and surface water possess low mineralization and are free from excessive dissolved salts. Similarly, electrical conductivity values ranged from 345 to 445 µS/cm in groundwater and 185 to 265 µS/cm in surface water, remaining well below the FMEnv limit of 1,000 µS/cm. The low TDS and conductivity values indicate that the water resources have not been impacted by saline intrusion, industrial effluents or excessive mineral dissolution and are generally of good chemical quality.

Total suspended solids (TSS) were very low, ranging from 0 to 1 mg/L in groundwater and 9 to 11 mg/L in surface water, which are substantially below the FMEnv limit of 20 mg/L. These results indicate limited particulate loading and confirm that the groundwater is naturally well filtered, while the surface water remains relatively clear despite receiving sediments through natural runoff processes. Dissolved oxygen concentrations ranged from 4.9 to 6.0 mg/L in groundwater and 6.5 to 7.8 mg/L in surface water, falling within the FMEnv acceptable range of 2 to 8 mg/L.

Sulphate concentrations ranged between 14 and 35 mg/L in groundwater and 59 to 67 mg/L in surface water. All groundwater samples complied with the FMEnv limit of 50 mg/L, whereas the surface water samples exceeded this standard. The elevated sulphate concentrations in surface water may be attributed to natural weathering of sulphate-bearing minerals, agricultural runoff or decomposition of organic matter transported into the streams during surface runoff.

Phosphate concentrations ranged from 0.03 to 0.62 mg/L in groundwater and 1.12 to 1.86 mg/L in surface water, compared with the FMEnv guideline value of 0.2 mg/L. Several groundwater samples and all surface water samples exceeded the regulatory limit. Elevated phosphate concentrations are commonly associated with fertilizer application, domestic wastewater discharge and natural decomposition of organic materials.

Iron concentrations ranged from 0.029 to 1.006 mg/L in groundwater and 1.008 to 2.963 mg/L in surface water. These values exceed the FMEnv guideline value of 0.3

mg/L in several groundwater samples and in all surface water samples. Elevated iron concentrations are common in groundwater derived from crystalline basement rocks because of natural weathering of iron-bearing minerals. Although iron is not generally considered a major toxic contaminant at these concentrations, excessive levels may impart an unpleasant metallic taste, cause reddish-brown staining of plumbing fixtures and promote the growth of iron bacteria in water distribution systems.

Nickel was not detected in groundwater but ranged from 0.09 to 0.13 mg/L in surface water, exceeding the FMEnv permissible limit of 0.07 mg/L. This localized exceedance may result from natural geological sources or diffuse anthropogenic inputs such as runoff from surrounding land uses.

The microbiological assessment revealed clear differences between groundwater and surface water quality. E. coli was absent in all groundwater samples, demonstrating that the aquifer is microbiologically protected. In contrast, surface water contained 1 to 4 cfu/mL of E. coli, exceeding the FMEnv requirement of zero detectable organisms. Similarly, total coliform concentrations ranged from 0 to 4 cfu/mL in groundwater but increased to 19 to 126 cfu/mL in surface water, exceeding the FMEnv guideline value of 10 cfu/mL. These results indicate faecal contamination of the surface water, most likely resulting from livestock activities, surface runoff and other diffuse sources within the watershed. Consequently, untreated surface water from the study area is unsuitable for direct domestic consumption without adequate treatment and disinfection.

Generally, the baseline water quality assessment indicates that the groundwater resources within the proposed Greenville LNG CNG Mother Station are generally of good quality, complying with FMEnv standards for most physicochemical parameters, major ions, heavy metals and organic contaminants. However, localized exceedances of iron and phosphate were observed in some groundwater samples. Surface water quality also demonstrates generally acceptable physicochemical characteristics, but elevated concentrations of sulphate, phosphate, iron, nickel, E. coli and total coliform indicate nutrient enrichment, naturally elevated iron content and microbiological contamination. The absence of BTEX, mercury and lead confirms that the project area has not experienced petroleum hydrocarbon contamination or hazardous metal pollution before project development. These results provide a robust baseline dataset against which any future impacts arising from the construction and operation of the proposed CNG Mother Station can be evaluated

Soil Quality Assessment

The baseline soil quality assessment was undertaken to determine the existing environmental condition of soils within the proposed Greenville LNG CNG Mother Station at Izom, Gwagwalada Area Council, FCT Abuja. Thirty (30) soil samples were collected across the project site, while three (3) additional samples served as control locations outside the proposed development area. The laboratory analyses covered soil physicochemical properties, exchangeable cations and anions, heavy metals, organic contaminants, soil texture and microbiological characteristics. The analytical results provide a reliable baseline against which future changes arising from construction and operation of the proposed facility can be evaluated.

Soil Reaction (pH): ranged from 5.79 to 8.89, while the control locations recorded values between 7.56 and 8.35. The results indicate that the project area consists of soils varying from slightly acidic through neutral to moderately alkaline conditions. Most sampling locations recorded pH values between 6.0 and 8.5, which fall within the range generally regarded as suitable for agricultural productivity, microbial activity and engineering applications. The few locations with pH values above 8.5 represent localized alkaline conditions that are likely attributable to natural variations in parent geological materials rather than contamination.

Electrical Conductivity (EC): ranged from 386 to 2,964 µS/cm, while the control soils recorded values between 964 and 1,341 µS/cm. These values indicate low to moderate concentrations of soluble salts within the soils. Although some locations exhibited relatively higher conductivity, none approached the salinity levels typically associated with degraded or saline soils. The results therefore indicate that salt accumulation is not presently an environmental concern and that the soils remain suitable for vegetation establishment and engineering construction.

Exchangeable anions also occurred at relatively low concentrations. Sulphate ranged from 21 to 84 mg/kg, nitrate from 2.2 to 7.3 mg/kg, nitrite from 0.00 to 0.26 mg/kg, phosphate from 1.1 to 8.4 mg/kg, and chloride from 0.3 to 5.1 mg/kg. These values are characteristic of natural tropical soils and indicate moderate nutrient availability without evidence of excessive nutrient enrichment or chemical contamination. The relatively low nitrate concentrations suggest limited accumulation of nitrogenous wastes, while the moderate phosphate concentrations indicate adequate phosphorus availability for vegetation without suggesting significant fertilizer contamination. Overall, the anion concentrations reflect stable soil chemical conditions suitable for sustaining vegetation and supporting the proposed development.

Exchangeable Cations

exchangeable cations demonstrate that the soils possess moderate nutrient status. Ammonium concentrations ranged from 0.026 to 3.083 mg/kg, indicating relatively low nitrogen accumulation and minimal influence from anthropogenic nitrogen inputs. Calcium concentrations varied between 2.01 and 6.21 mg/kg, while magnesium ranged from 0.90 to 1.96 mg/kg. These nutrients contribute to favourable soil structure, nutrient availability and root development. Sodium concentrations ranged from 3 to 36 mg/kg, remaining relatively low and indicating that the soils are non-sodic and therefore not susceptible to structural deterioration caused by excessive sodium accumulation. Potassium concentrations varied from 0.4 to 6.3 mg/kg, reflecting moderate potassium availability capable of supporting natural vegetation. Collectively, these results indicate that the soils possess balanced exchangeable cation concentrations and have not been significantly altered by industrial contamination or excessive fertilizer application.

The heavy metal assessment indicates that the project area has not been affected by significant metal contamination. Iron concentrations ranged from 0.04 to 3.68 mg/kg, representing natural background levels commonly associated with ferruginous tropical soils. Zinc concentrations ranged from 0.021 to 2.863 mg/kg, copper from 0.01 to 1.00 mg/kg, chromium from 0.00 to 0.64 mg/kg, nickel from 0.000 to 0.024 mg/kg, cobalt from 0.002 to 0.411 mg/kg, while mercury and lead were not detected in any sample. These concentrations are substantially lower than the target and intervention values specified under the Department of Petroleum Resources (now Nigerian Upstream Petroleum Regulatory Commission) Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN, 2018).

The concentrations of organic contaminants were generally very low. Phenol concentrations ranged from 0.00 to 1.47 mg/kg, indicating only minor organic inputs within the study area. Oil and grease concentrations varied between 0 and 1.6 mg/kg, demonstrating the absence of significant petroleum contamination. BTEX compounds were not detected in the majority of samples, although isolated detections of 2.3 mg/kg and 7.0 mg/kg occurred at a few sampling locations

Soil Microbiology

analysis revealed E. coli concentrations ranging from 2 to 96 cfu/100 kg, while fungal counts ranged from 10 to 356 cfu/100 kg. These microbial populations are typical of productive tropical soils where active decomposition of organic matter occurs. The presence of soil microorganisms reflects healthy biological activity and contributes to

nutrient cycling, organic matter mineralization and soil fertility. The observed microbial counts are therefore indicative of natural ecological processes rather than environmental degradation.

Generally, the baseline soil quality within the proposed Greenville LNG CNG Mother Station is good and suitable for the proposed development. The soils exhibit favourable physicochemical characteristics, balanced nutrient status, low salinity and predominantly loamy textures that provide suitable conditions for construction activities. Heavy metals occur at concentrations consistent with natural background levels and are substantially below the applicable EGASPIN (2018) guideline values, while mercury and lead were not detected. Organic contamination is minimal, with only isolated low-level BTEX detections and negligible oil and grease concentrations, indicating the absence of widespread hydrocarbon pollution. Consequently, the results establish that the project area has not been significantly impacted by previous industrial activities and provides a robust environmental baseline against which future construction and operational impacts of the proposed CNG Mother Station can be monitored and evaluated.

Terrestrial Flora and Fauna

The proposed project area falls within the guinea savannah ecological zone of Nigeria. In a broader perspective, the vegetation unit within the ecoregion is characterized by large wooded savannah trees and shrubs, with patches of fallow land interspersed within agricultural fields. Habitat in this ecoregion has been reduced, degraded and fragmented by agricultural activities, fire and other changes to the land use. There are considerable pressures on the land from seasonal farming, grazing animals, cutting trees and bushes for wood, burning woody material for charcoal, and from wild fires.

Biodiversity and Conservation

Some relevant datasets have been considered and reviewed to provide a suitable description of the project area, whilst also considering the surrounding areas. Key among this is the dataset of Protected Areas across Nigeria based on the IUCN and UNEP-WCMC (2016) categorization. This dataset displays areas that are legally protected according to various designations and managed to achieve conservation objectives. The project area is not located in a protected area, but a number of areas classified as Forest reserve and "not reported" are located in the larger region. Based on this, the nearest protected area within proximity to the proposed project area are the Odu and Galadima Forest reserve, located approximately 15 km-south-east and north of the project area, and is not relevant to the project.

Flora Assessment

The flora study covered the assessment of all the vegetation units and habitat types within the project AoI. The assessment was focused on the proposed area for the development, with special attention to habitat types as well as occurrence of any IUCN red list-data species. A literature review was conducted as part of the assessment to identify the potential habitats present within the project area. The flora species expected in the project area was based on review of research articles covering the project area. This was further complimented with the review of flora species list on the IUCN (2025) site covering the project area.

As part of the floristic survey, a rapid floristic assessment was adopted which entailed traversing the proposed project area by motor-bike and on foot. The floristic diversity and search for flora Species of Conservation Concern (SCC) was conducted through timed meandering of the project footprint and surrounding AoI within a 1km buffering created from the project footprint boundary. The species encountered were recorded within a specified amount of time, with additional time added based on complexity of accessing some sections the project area. The approach is 'plotless' and therefore requires no pre-determined points. In addition, opportunistic observations were made while moving through the project area. Species identification was done in the field when possible, using the flora field guides.

All the species recorded were non-endemic and there were no Species of Conservation Concern (SCC). This finding is indicative of some level of habitat disturbance, likely resulting from loss of primary forest and ongoing anthropogenic activities such as farming, mining, and fuelwood harvesting within the project area. A selection of some of the flora species observed during the field survey are shown in Plate 4.5 below.

The wet season survey revealed a more luxuriant and diverse vegetation cover compared to the dry season. Herbaceous species such as Chromolaena odorata, Ageratum conyzoides, and Panicum maximum exhibited vigorous growth due to increased soil moisture, while annual weeds were in full bloom and contributed to the green canopy observed across the area. Several ephemeral herbs were recorded only during this period, highlighting the seasonal dynamics of the vegetation.

Tree species such as Daniellia oliveri, Parkia biglobosa, and Vitellaria paradoxa exhibited new flushes of leaves and flowering, providing important ecosystem services such as shade, fodder, and nectar sources for pollinators. The wet season also promoted regeneration of fallow lands and the growth of grasses that serve as grazing fodder for livestock. Overall, the wet season data suggest that the ecosystem demonstrates moderate resilience, with active regeneration potential despite anthropogenic pressures.

Faunal Assessment

Understanding the habitat requirements (habitat utilization) of a species at the project site is important for the prediction of environmental impact and any mitigation measure that can be predicted for the conservation of such endemic species. To effectively understand the faunal species composition, present in the proposed project area, a desktop review was undertaken, utilizing research articles and dataset of faunal composition within the project area. The desktop review and assessment approach involved undertaking various activities such as; review of expected species lists and identification of any red-list data or species of conservation concern (SCC) present or potentially occurring in the area. This was done with emphasizes on the probability of occurrence of species of conservation importance.

The fauna field survey approach for the proposed project was undertaken by adopting the direct and indirect approach. The direct survey techniques include but not limited to recording species based on visual observation with eyes. Calls as well as binoculars digital cameras were utilised for especially for avifauna survey. Field guides were utilised to aid in proper identification of the different fauna species within the project area. The herpetofauna survey was undertaken based on a variety of active and passive techniques, as the cryptic nature and habits of herpetofauna species implies that certain species within the project area could not have been recorded. This necessitated approach such as diurnal active hand search especially for reptile species that shelter in or under micro-habitats such as the rocks, woody debris, leaf litter, etc. On the other hand, the indirect survey approach involved recording of fauna species based on identification of faecal droppings, trails, burrows. Local knowledge of fauna species within the area was obtained through interviews with members of local community especially hunters and farmers.
A large portion of the project area is made up of modified forest, which results in more occurrence of terrestrial species. During field observations a greater number of fauna species comprised of avifauna, with fewer numbers of mammal and herpetofauna species. The scarcity of mammal species result of the field observations is likely due to the habitat conditions and the disturbed nature of the area from farming and mining activities as well as other anthropogenic activities in the area.

Socio-economic and Health Studies

The socio-economic survey collated baseline socio-cultural, economic and infrastructural indices of the study areas, while the consultation process elicited responses on stakeholders' concerns and expectations from the proposed project. This

study is an integral part of the environmental and social impacts management and overall sustainable development arrangement. The objectives of the socio-economic survey include:

- Study and documentation of the socio-economic and cultural situation of the project area.
- Determining the impacts of the project on settlements, cultural treasures, population, social and physical infrastructures, predominant economic structures and the baseline health status of the people.
- Documenting the views of the affected population, industries and other relevant institutions/agencies in terms of environmental problems, perceived community problems and needs; and
- The engagement of stakeholders, with a view:
    - to enabling the stakeholders, understand the project processes and cycle;
    - to consider the views and opinions of stakeholders concerning the construction, operation and decommissioning of the project.
    - to developing and maintaining a robust relationship among the GVLNG Limited and the project affected communities
    - to prevent any form of social unrest among various levels of stakeholders that might arise from the development of the proposed project.

Consultations

It involves information dissemination and interaction/dialogues with identified stakeholders (including communities within the project vicinity) on the EIA of the proposed project. Interaction with people and eliciting feedback allows the affected populations to influence the decision-making process by raising issues that should be considered in project design; mitigation; monitoring and management plans; and the analysis of alternatives.

Methodology

This section describes the research design, study area, sampling strategy, data collection methods, and analytical techniques employed in the socioeconomic assessment of Izom Community, Gwagwalada Area Council, Abuja-FCT. The methodology was designed to ensure comprehensive coverage of the community

and to generate reliable and representative data for the ESIA.

Study Area

The study area covers Izom Community, located within Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja. Izom is a predominantly rural agrarian settlement situated along the Abuja-Kaduna-Kano (AKK) Gas Pipeline corridor where the proposed Compressed Natural Gas (CNG) Mother Station Project is planned.

Data Collection

Data for this socioeconomic assessment was collected through multiple methods to ensure triangulation and validation of findings. The primary methods employed were household surveys, key informant interviews, direct field observations, and secondary data review.

Key Informant Interviews: In addition to household surveys, key informant interviews were conducted with community leaders and stakeholders.

Direct Field Observations: The study team conducted direct observations of the community's physical environment, housing conditions, infrastructure, and daily activities.

Demographic Characteristics

Izom Community is located within Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja. The community lies along the Abuja-Kaduna highway corridor and serves as one of the major settlements situated along the Abuja-Kaduna-Kano (AKK) Natural Gas Pipeline route. The proposed Compressed Natural Gas (CNG) Mother Station Project is planned within the Izom axis, making the community part of the project's area of influence.

Izom occupies a strategic location along the boundary between the Federal Capital Territory and Niger State. While the principal settlement falls within Gwagwalada Area Council of the FCT, portions of the wider Izom settlement extend into Gurara Local Government Area of Niger State. This unique location has encouraged social and economic interactions between residents of both administrative areas. The community is predominantly inhabited by the Gbagyi ethnic group, who constitute the indigenous population. Farming remains the dominant economic activity, while trading, fishing, transportation services, and small-scale businesses provide supplementary sources of livelihood.

Administratively, Izom falls under the authority of Gwagwalada Area Council and operates a traditional governance system recognized by the local population.

Community affairs are coordinated through the traditional institution headed by the Dagacin of Izom, who serves as the principal custodian of culture, customs, and community administration.

Traditional Governance Structure: The traditional institution remains an important component of governance and social organization within Izom Community. The system provides leadership, conflict resolution, cultural preservation, and liaison between the community and government agencies.

The traditional leadership structure is headed by the Dagacin of Izom, who is supported by other traditional title holders, elders, youth leaders, women leaders, and community representatives. During stakeholder consultations conducted for this study, the Dagacin of Izom, community elders, youth representatives, women leaders, and other traditional authorities actively participated in discussions relating to the proposed project.

The current traditional ruler of Izom Community is Hon. Judge Abubakar Lado Ahmad, who serves as the Dagacin of Izom.

Ethnicity and Cultural Heritage: The population of Izom Community is predominantly composed of the Gbagyi ethnic group, one of the major indigenous ethnic nationalities within the Federal Capital Territory and parts of Niger State. The Gbagyi people are widely known for their agricultural heritage, communal lifestyle, respect for traditional authority, and strong attachment to ancestral land.

The Gbagyi language is the primary means of communication among community members, although Hausa and English are also spoken, particularly among traders, government workers, and younger residents

Population Size and Households

The demographic characteristics of a community provide important information for understanding the social environment within which a project will be implemented. Information obtained from the household survey revealed that Izom Community is a growing rural settlement with relatively large household sizes, reflecting the prevailing family structure and cultural practices of the Gbagyi people. Based on reconnaissance surveys, stakeholder consultations, and field observations, the community is estimated to contain approximately 1,200 households. To ensure adequate representation of the population, a total of 300 respondents were sampled during the socioeconomic survey.

Religion: The community is predominantly Muslim. Findings from the socioeconomic survey revealed that approximately 86% of respondents practice Islam, while Christianity accounts for about 13% of the population. Traditional religious practices are observed by a small proportion of residents, often alongside mainstream religious beliefs.

Gender Distribution

Gender distribution is an important demographic indicator that assists in understanding population structure and potential project impacts on different social groups. The survey results indicate that males constituted the majority of respondents, accounting for 62.7% of the total sample, while females accounted for 37.3%.

Age Distribution

Age distribution provides insight into the productive capacity of the population and helps identify the dominant age groups within the community. The survey revealed that the majority of respondents (57.0%) were within the age range of 18 to 40 years. Respondents aged between 41 and 60 years accounted for 33.0%, while those above 60 years represented 10.0% of the sample population.

Marital Status

Marital status influences household responsibilities, income distribution, and social support systems. Results from the survey show that married respondents constitute the largest category, accounting for 79.0% of the total respondents. Single respondents account for 13.0%, while divorced and widowed respondents represent 8.0%.

Household Size

Household size is an important indicator of living conditions and social welfare within a community. The survey findings show that households comprising six to ten persons constitute the largest category, accounting for 61.0% of respondents. Households with more than eleven persons account for 22.0%, while households with one to five persons account for 17.0%.

Overall, the demographic characteristics of the study area indicate a predominantly married, youthful, and economically active population living in moderately large households. These characteristics provide an important baseline for assessing the potential socioeconomic impacts of the proposed CNG Mother Station Project and for developing appropriate mitigation and community enhancement measures.

Main Occupations

Economic activities within Izom Community are largely influenced by the availability of agricultural land, water resources, and access to local markets. Findings from the socioeconomic survey indicate that farming is the dominant occupation among residents. The fertile agricultural land surrounding the community supports the cultivation of food crops, which serve as the primary source of livelihood for many households.

Apart from farming, residents engage in trading, fishing, civil service, artisanship, and other small-scale economic activities. Trading activities are particularly common among women, who are involved in the sale of agricultural produce, food items, and household goods within the community and neighbouring settlements.

Fishing is also practiced by a section of the population due to the presence of River Gurara, which traverses the area and provides livelihood opportunities for local fishermen.

Monthly Income Levels

Household income provides an indication of the economic wellbeing of residents and their ability to meet daily needs and social obligations. The survey results show that most households earn relatively modest incomes. The largest proportion of respondents (31.0%) reported earning between ₦61,000 and ₦90,000 monthly, while 29.0% reported monthly earnings between ₦31,000 and ₦60,000.

Only a small proportion of households reported monthly incomes above ₦120,000. This reflects the predominantly rural and agriculture-based nature of the community economy.

Education and Health

This section presents the educational and health characteristics of the study area. Education and health are important indicators of community wellbeing and human development. The assessment examined educational attainment, availability of educational and healthcare facilities, and the common health challenges affecting residents of Izom Community. The findings are based on responses obtained from the 130 household questionnaires administered during the socioeconomic survey, stakeholder consultations, and field observations.

Healthcare Facilities and Common Diseases

Access to healthcare services is an important determinant of community wellbeing. Information gathered during the survey indicates that residents obtain healthcare services from primary healthcare centres, private clinics, hospitals, and nearby health facilities located within and around the project area.

The survey revealed that 57.0% of respondents have access to a clinic or primary healthcare centre as their nearest health facility, while 27.0% reported hospitals as their nearest source of healthcare services. However, 16.0% of respondents indicated that the nearest healthcare facility is located more than five kilometres from their residence.

Waste Disposal Practices

The survey revealed that 61.0% of respondents dispose of their household waste through private waste collectors operating within the community, while 39.0% rely on open dumping and burning. During consultations, community members reported that private waste vendors regularly collect waste from households for a fee. However, most residents were unable to identify the final disposal locations used by these vendors.

Community Support Level

The findings indicate that the community generally welcomes the proposed project because of its anticipated economic and development benefits. However, respondents emphasized the need for continuous engagement and fulfilment of community expectations.

The high level of support demonstrates the willingness of the host community to accommodate the project, particularly where community benefits and employment opportunities are assured.

Perceived Benefits

The results show that community members expect the project to improve livelihoods through direct and indirect employment opportunities, increased commercial activities, and community development initiatives

Concerns and Fears

The major concern identified was environmental pollution and possible health effects. Respondents also expressed concerns regarding accidents, fire outbreaks, and increased cost of living that may arise from project-induced economic activities.

These concerns highlight the need for effective environmental management measures, occupational safety programmes, and continuous stakeholder engagement throughout project implementation.

Community Demands and Expectations

During consultations and questionnaire administration, respondents identified several key expectations and community development priorities.

The most important expectation is the employment of local indigenes, followed by the establishment of a tertiary institution and implementation of formal community development agreements.

The findings indicate that the community expects the project proponent to prioritize qualified local labour and contractors during project implementation. Stakeholders also requested the establishment of a formal Memorandum of Understanding (MoU) to guide community-company relations and ensure transparent implementation of Corporate Social Responsibility (CSR) programmes.

The stakeholder engagement exercise demonstrates strong community acceptance of the proposed CNG Mother Station Project in Izom Community. Support for the project is primarily linked to expectations of employment creation, business opportunities, and community development. Nevertheless, concerns relating to environmental pollution, safety risks, and rising living costs were identified and should be addressed through appropriate mitigation measures, regular stakeholder engagement, local content implementation, and an effective grievance redress mechanism. The establishment of a mutually agreed MoU between the project proponent and the host community is recommended to promote sustainable community relations throughout the project lifecycle.

ES 5 ASSOCIATED AND POTENTIAL IMPACTS

Preliminary Identification and Screening

In line with recommended impact assessment approaches (FMEnv, 1995; UNEP, 1996; Canter, 1996; DPR 2002, Lohani, *et al*., 1997), the first level of impact assessment involves the preliminary identification and screening of potential environmental impacts by anticipating activity-environment interactions. This requires a thorough understanding of the project activities (project description), the project setting (the environmental and social characteristics), and the interaction with environmental components. A modified Leopold matrix (Leopold, 1971) was used for the identification and screening. The matrix arrays project activities against environmental (biophysical, social and

health) components, and supports a methodical, comprehensive, and objective identification of the impacts that each distinct project activity may have on the biophysical, social, and health components.

Modified Leopold Matrix Screening

The modified Leopold impact matrix consists of a horizontal list of biophysical and social environment components that could be affected by the proposed project activities versus a vertical list of project activities, which represent environmental aspects, or "sources of impact," associated with each sub-project phase. Environmental aspects are elements of an activity that can or will interact with the biophysical, social and health conditions within the area of influence.

Impact Severity Evaluation

During detailed assessment, five criteria were used to assess the severity of the environmental (biophysical, social, and health) impacts that were not screened out in the earlier steps.

The severity criteria set forth in this section are applicable to all types of impacts identified, including impacts that can be expected from the project and impacts resulting from emergencies. Several types of potential consequences (or impacts) were considered for all project stages where applicable:

- Biological and physical environment
- Social environment
- Health and Safety of the public or workers

The detailed assessment of impacts involved evaluating the potential effects of project activities on the impact indicators but in greater detail. Impacts were assessed as to whether they are positive (beneficial) or negative (detrimental). Only negative impacts were given a detailed assessment.

Impact Identification

Impact prediction considers any mitigation, control and operational management measures that are part of the project design and project plan. Social, economic and biophysical impacts are inherently and inextricably interconnected. Change in any of these domains will lead to changes in the other domains.

Direct impacts of the project result from construction, maintenance and operation of the facility. The most significant project-related impacts are those related to site preparation activities, construction and operation/maintenance. The environmental aspects of the proposed project were teased out from the planned Project Activities

description. These aspects were then matched with the existing baseline description of the Project Environment and used to develop a checklist of potential and associated impacts of the proposed project. From the planned project implementation, four major phases could be identified:

- Site Preparation (Pre-Construction Phase)
- Construction Phase
- Post Construction phase
- Decommissioning Phase

Summary of Impact

Increase in Income from Transportation

During the Project implementation, there will be transportation of workers, equipment, and supplies to and from the project area by road. Nigerian companies involved in road transportation will benefit directly from the increase in demand for transportation services related to the project. Although specific estimates of income generation associated with this business opportunity are presently hard to determine, it is anticipated that 98% or more of the transport business will be handled by Nigerian Companies drawing workers from both within and outside the project area.

Increase in Income from Employment

A number of Nigerians (local area indigenes and others) will be employed during the implementation of the project activities. A number of people will be employed over the project implementation period. The project labour requirements include a mix of local, national, and expatriate workers, based on need and skills, and prioritised for the recruitment of nationals. The Project will be executed largely by local contractors, so a number of jobs will be filled by local and national workers with additional support from expatriates and other developing country Nationals. Detailed identified impacts of the project are presented in chapter five of this report.

ES6 MITIGATION MEASURES

Mitigation measures are options that can be used to either completely eliminate or minimize identified negative impacts of a development project. The traditional approach to design and operations is to ensure compliance with the applicable safety codes and standards during design. However, compliance with regulations, codes and standards may not be sufficient to achieve an appropriate level of Health Safety and Environmental (HSE) performance in design. Design codes are generic and applicable to facilities in a number of geographical areas that face a wide range of technical challenges unique to the project. The design of the proposed project is based on the best practices of international codes.

General Mitigation Measures

General mitigation measures encompass those measures built into the engineering design or operational design of the project. These measures are environmental, social, and health best practices, most already in use by the project sponsors in their operations or proposed as operational controls during the project execution. Some mitigations are however specific to impacts associated with particular activities of the various project activities. Many general mitigation measures have been developed and adopted by the project before the ESIA process commenced; therefore, the impact assessment has already applied them in assessing the project impacts. Furthermore these measures were incorporated into the GVLNG Limited Project-design considerations and project implementation planning as part of the overall operational controls and ESMP for the project.

These mitigations will be incorporated into plans and procedures that contractors will follow to ensure the protection of the environment. The measures will be implemented by GVLNG directly, and passed on through contractual commitments to its contractors, subcontractors, and suppliers. Further details about the content of each plan and operational control are provided in Chapter 7.

ES 7 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Environmental and Social Management Plan (ESMP) is the essential component of an Environmental and Social Impact Assessment (ESIA) that provides the assurance that the mitigation measures developed for reducing the effects of adverse associated and potential impacts to as low as reasonably practicable (ALARP) as well as those proposed for enhancing beneficial impacts are implemented and maintained throughout the project lifecycle.

EMP Objectives

The objectives of this EMP are:

- To demonstrate that a systematic procedure, which ensures all project activities are executed in compliance with applicable legislations and GVLNG policies on Health, Safety, Environment, Security and Community Relations have been established for the project;
- To show that mitigation measures for all impacts have been established and shall be maintained throughout the project life cycle, so that impact risk levels will remain ALARP;
- To demonstrate that emergency response measures will be in place. This will ensure that adequate responses in case of emergency have been established for the project; and

- To set out the structure that will ensure compliance to the EMP by GVLNG and its contractors.

Management Organization

In accordance with regulatory requirements, GVLNG has established a HSE organization structure that defines roles, responsibilities and authority to put into practice an effective HSE Management System, including undertaking any training necessary to do so.

During pre-operations activities, all instructions and official communications regarding environmental matters shall follow the generic organogram. The organizational structure identifies and defines the authority structure, and the communication structure for the various parties involved in the construction of the proposed development. The structure may require revision as the project unfolds.

Training

GVLNG shall identify, plan, monitor, and record HSE training needs for personnel whose work may have a significant adverse impact upon the environment or social conditions. GVLNG recognizes that it is important that employees and Contractors at each relevant function and level are aware of GVLNG's environmental, social, and health policy; potential impacts of their activities; roles and responsibilities in achieving conformance with the policy and procedures.

This will be achieved through a formal HSE training process. It is expected that employee training will include awareness of and competency with respect to:

- Environmental and social impacts that could potentially arise from their activities;
- Necessity of conforming to the requirements of the EIA and EMP, in order to avoid or reduce those impacts; and
- Roles and responsibilities to achieve that conformity, including with regard to change management and emergency response.

The HSE Manager is responsible for coordinating the training, maintaining employee-training records, and ensuring that these are monitored and reviewed on a regular basis. The HSE Manager will also periodically verify that staffs are performing competently through discussion and observation.

Employees responsible for performing site inspections shall receive training drawing on external resources as necessary. Training will be coordinated by the HSE Manager

and/or Human Resources Manager prior to the beginning of construction activities. Upon completion of training and once deemed competent in the requirements, staff will be allowed to train other people. Similarly, GVLNG shall require that each of the Contractors institute training for its personnel. Each Contractor is responsible for site HSE awareness training for personnel working on the job sites. The Contractor is also responsible for identification of any additional training requirements to maintain required competency levels.

The GVLNG training program will be subject to audit to ensure that:

- Training programs are adequate;
- All contractor requiring training have been trained; and
- The Contractor has periodically verified that its personnel perform competently after training.

Environmental Monitoring Plan

An Environmental Monitoring Plan is a systematic schedule for the collection of environmental data through a series of repetitive measurements. UNEP (1996) describes three known types of environmental monitoring within the conceptual EIA (or ESIA) framework as follows:

- ***Baseline Monitoring***: This refers to the measurements of environmental parameters during the pre-project period;
- ***Effects Monitoring***: This involves the measurements of environmental parameters during project construction and implementation so as to detect changes in these parameters which can be attributed to the project; and
- ***Compliance Monitoring***: It is the periodic or continuous measurement of environmental parameters or discharges to ensure that regulatory requirements and standards are met. Compliance monitoring can further be broken down into:
    - Mitigative measures monitoring, which relates to the prescribed mitigation measures put in place by the pre-project EIA to the existing operational structure of the project, and
    - Regulatory compliance monitoring, which compares the regulatory monitoring requirements to the existing operational, occupational and environmental parameters.

GVLNG shall adopt a systematic monitoring schedule that will comprise both effects and compliance monitoring plans for the implementation of the proposed LNG Project. Baseline requirements are already embodied in Chapter 4 of this report and

are, therefore, not considered in this chapter. The monitoring schedule prescribed by this ESIA shall be implemented as the Post-ESIA Monitoring Programme by GVLNG.

Scope of the Environmental Monitoring Plan

The Environmental Monitoring Plan shall cover two types of monitoring activities as follows,

- Monitoring of compliance with mitigation measures during site preparation, construction and operation activities;
- Effects-environmental monitoring, which includes sampling and analyses of discharges and the recipient environmental components during site preparation, construction and operational activities.

The monitoring programme under the plan shall establish the specifics of the environmental and socioeconomic monitoring parameters for each component of the environment that will be affected by the proposed project. The components shall include:

- Air quality
- Noise
- Water quality (surface and sub-surface water qualities)
- Hydrology
- Hydrobiology and fisheries
- Waste management
- Traffic and transport
- Personnel health and safety
- Public health and safety
- Socio-economic and community health impacts

Based on the project activities, predicted impacts and recommended mitigation measures, the monitoring programme is considered adequate for the project.

ES 8 DECOMMISSIONING AND ABANDONEMENT

This section presents the plans that have been put in place by GVLNG to recover and/or restore the project site to its original state after the project's life cycle. Remediation plans after decommissioning require a sound understanding of all the environmental components of the project on the ecosystem during its lifespan. It is therefore a best-practice requirement to take this component into cognisance even at the conceptualisation of the project. After decommissioning, there are various

restoration options as it relates to the environment where the project once existed. These options include:

- Remediation to pre-project state or condition.
- Partial remediation.
- Remediation to an acceptable alternative condition.
- No remediation.

For the proposed project, GVLNG proposes to adopt a combination of partial remediation and complete remediation to acceptable state.

Decommissioning Activities

The major activities that will be carried out during the decommissioning phase include:

- Dismantling and removal of LNG plant and other ancillary equipment.
- Excavation, dismantling and removal of all underground cables, water pipes and other facilities.
- Removal of all structures including administrative office buildings etc.

The recommended remediation measures are expected to mitigate the possible resultant negative impacts of this decommissioning phase on the environment.

Site Remediation

The remediation measures depend on the environmental/social characterization of the project area as well as the predicted potential and associated impacts. However, the following measures shall be planned for implementation after decommissioning/closure. All equipment and debris shall be removed from the environment and disposed of in an environmentally friendly manner. The mode of disposal of these shall include the following:

- Gas pipes shall be sold to steel making industries or for other commercial uses.
- Excess laterite from excavated portions shall be used to fill other failed portions around the project area or sold off as inputs in the building industry.
- Plant debris shall be cut into pieces and carted away by accredited waste management consultant or used as organic manure.
- Administrative buildings shall be leased out or used for other purposes.
- Reinstatement of all excavated routes to their original status to minimize negative impacts.

- Grading of site to its original topography to prevent erosion.
- Good waste management plan shall be put in place.

ES 9 CONCLUSIONS AND RECOMMENDATIONS

Based on the detailed description of baseline environmental characteristics, impact assessments, mitigation measures, and the Environmental Management Plan (EMP) presented in this Environmental and Social Impact Assessment (ESIA) report for the Proposed CNG Compression Station Project at Izom Community, Gwagwalada Area Council, Abuja-FCT. It is concluded that:

- The technology, equipment, and facilities proposed for the CNG facility are among the most cost-effective and environmentally friendly available. These technologies have been successfully utilized by other developers in across the world and have proven to be both efficient and sustainable.
- Safety distancing shall be maintained between the gas storage tanks and other buildings, while the generator house will be adequately soundproofed to minimize noise pollution in the surrounding office environment.
- The project is expected to yield several positive impacts, including the creation of employment opportunities, improved gas availability, and increased local income.
- Negative impacts have also been identified, such as potential air, water, and soil pollution, soil erosion, increased noise levels, pressure on limited infrastructure, and the possible proliferation of sexually transmitted diseases (STDs). However, with the recommended mitigation measures, these impacts can be effectively reduced to minor and negligible levels.

Recommendations

GVLNG Limited has demonstrated a strong commitment to implementing this project in an environmentally responsible manner. The use of best available technology and the existing good relationship with host communities provide a solid foundation for the successful implementation of the proposed CNG facility. In light of this, the following recommendations are made:

- All project activities from the planning and construction phases through to operations should be closely monitored by relevant environmental regulatory agencies to ensure compliance with environmental standards.

- GVLNG should strictly adhere to all design and construction specifications, including the mitigation measures and the Environmental Management Plan (EMP) as outlined in this report.
- Continuous consultation with relevant stakeholders, including host communities, should be maintained to foster transparency, cooperation, and the successful implementation of the project.
- The mitigation measures prescribed in this report must be fully implemented by GVLNG and its contractors, with strict adherence to regulatory guidelines and standards throughout the project lifecycle.
- GVLNG should enforce all safety programs outlined in this report, particularly those related to worker safety during all project phases.
- Emergency response procedures should be continuously improved and adhered to throughout the lifecycle of the CNG facility to ensure swift action in the event of any unforeseen incidents.

ACKNOWLEDGEMENT

Greenville LNG Limited (GVLNG) wishes to express her appreciation to the Federal Ministry of Environment, Abuja Environmental Protection Board, the Project host Community as well as Zipod Environmental and Engineering Services Limited (The Environmental Consultant) and other stakeholders for their support during the Environmental and Social Impact Assessment of this CNG Compression Mother Station Project. You all made the work possible, Thank you.

CHAPTER ONE: INTRODUCTION

1.0 Background

Natural gas is one of the most sought energy sources globally. This is because it is a cleaner source of energy compared to diesel, coal and wood, and also cheaper than most other fossil fuels. Nigeria has abundant gas reserves in a number of gas fields, mostly in remote locations within and around the Niger Delta area. The country has not fully harnessed the economic potential of its gas resources due to various factors, which include a lack of infrastructure. Thus, useful gas resources have been either flared or remain stranded in remote areas. Gas gathering, processing and transportation infrastructure in Nigeria is grossly inadequate, which has greatly hampered the industrial growth of the country. Therefore, the implementation of the Greenville LNG Project offers an opportunity to harness Nigeria's natural resources for use across the country, particularly in locations not served by pipeline infrastructure. The project, therefore, aligns with the Federal Government's policies:

- To reduce gas flaring.
- To monetize gas resources.
- To improve energy availability across the country through its gas-to-power initiative.

1.1 The Project Proponent

Greenville Liquefied Natural Gas Company Limited (GVLNG) was founded in 2015 and is a Nigerian private company based in Abuja, FCT, Nigeria**.** Greenville Liquefied Natural Gas Company Limited (GVLNG), formerly Greenville Oil and Gas Company Limited (GOGCL).

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 Federation of Nigeria, 2004), as well as international environmental best practices GVLNG Limited wishes to subject the proposed plant upgrade project to an EIA process. Despite the laudable benefits associated with the proposed project, it could be associated with some significant environmental, social and health hazards/impacts that need to be carefully identified and appropriately avoided or mitigated, hence the EIA study. This Environmental Impact Assessment (EIA) identified the likely impacts that could arise from the proposed project activities and then proffer mitigation measures to ameliorate adverse impacts and enhance the beneficial ones. For the conduct of this study GVLNG Limited Commissioned Messr *Zipod Environmental Consultancy and*

Energy Services Limited to carry out the Environmental Impact Assessment (EIA) of the proposed LNG plant upgrade.

1.2 Project Location and Accessibility

The proposed project would be sited on a 10ha of land at Izom Community, Gwagwalada Area Council, Abuja-FCT. The proposed project site falls within the following geographical coordinates: 8°48'11.4"N 6°56'57.4"E.

Figure 1.1: Nigeria Showing Abuja-FCT.

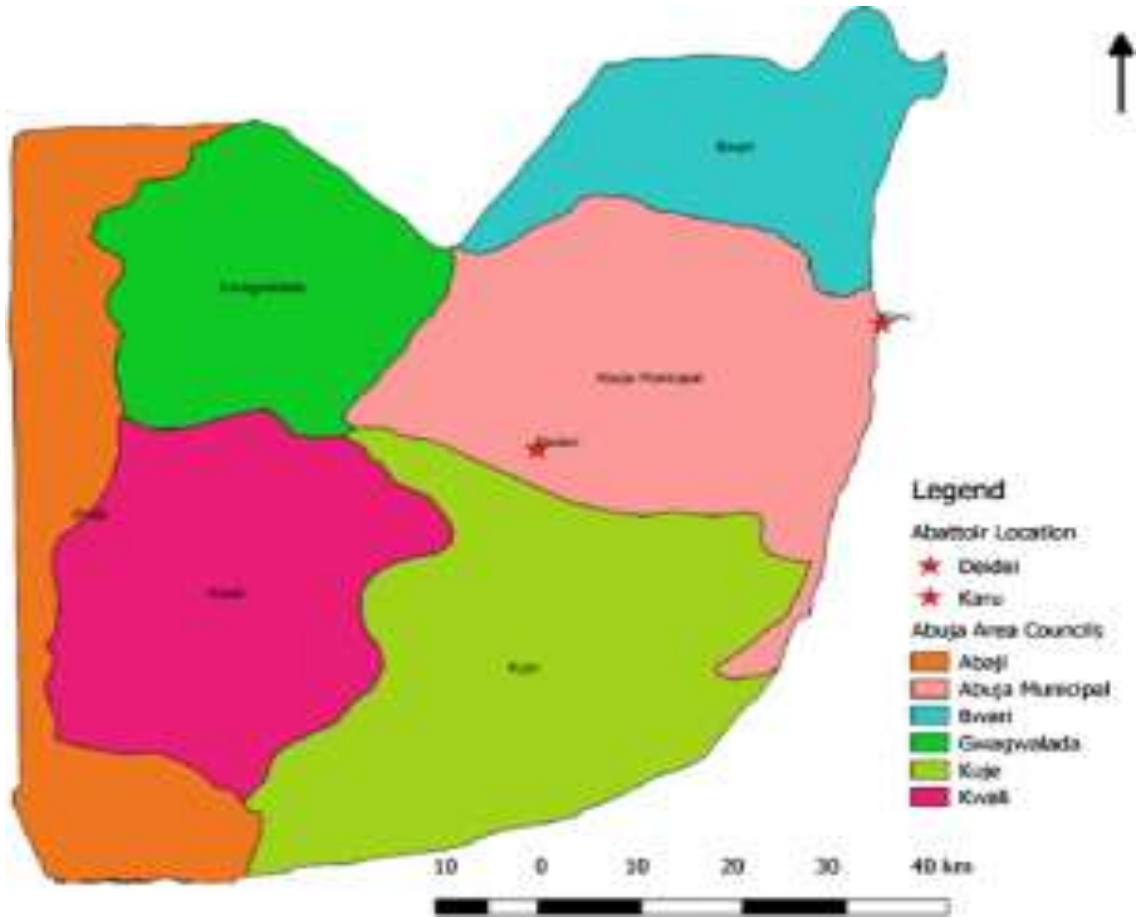

Figure 1.2: FCT showing Gwagwalada Area Council in Green Colour

1.3 Terms of Reference for the ESIA

In line with the ESIA Procedural Guidelines of the Federal Ministry of Environment (FMEnv, 1995), World Bank/International Finance Corporation (IFC) Performance Standards, the terms of reference (ToR) for ESIA of the GVLNG CNG Mother Station Project was submitted to the FMEnv by GVLNG. The ToR defined the scope of work, objectives, baseline data requirements and assessment tools and methods for the ESIA. The document also outlined the regulatory and administrative framework within which the ESIA would be conducted and highlighted the key issues / activities of environmental concern in the proposed project planning and implementation.

1.4 ESIA Objectives

The objectives of the ESIA of the GVLNG CNG Mother Station Project are:

- To provide information and evidence needed for developing an Environmental Impact Statement (EIS) for the proposed project in its entirety;

- To generate all the necessary data for establishing the environmental baseline conditions of the proposed project area;
- To demonstrate that a systematic approach has been adopted in identifying, evaluating and characterizing as well as proffering cost-effective mitigation.
- To develop a Social and Environmental Management Plan (SEMP) for all phases of the proposed project.

1.5 ESIA Methodology

The collection of environmental baseline data/information, environmental impact analysis and the preparation of the report were performed by a multi-disciplinary team. The team selection was based on characteristics of the project environment and experience/discipline of each specialist. A team leader coordinated the tasks and team members towards achieving set targets as well as liaison with client. The methods adopted in performing specific tasks of the ESIA for the proposed Plant Upgrade Project are as follows:

1.5.1 Desktop Research

The geography and the relevant environmental, socio-economic and health information on the proposed project location were gathered from maps, charts, articles, previous study reports on the area and similar environment, photographs, fisheries research publications, textbooks, etc. The information generated enabled definition of limits of the area to be assessed. Data gap analysis was carried out to identify areas where additional information was required and the result was used in planning the execution of field sampling/measurement aspects of the ESIA project.

1.5.2 Field Data Collection

The information gathered from desktop consultation and site identification was used in categorising the major habitats in the area, and their respective sampling requirements defined to effectively collect qualitative and quantitative data on the flora and fauna of the project area. The fieldwork covered all relevant elements of the ecological, socio-economic and health conditions to complement information obtained from desktop studies.

1.5.3 Consultation with Stakeholders and Experts

In order to more efficiently deliver improved project sustainability and protect the interest of the affected communities, especially the poor and vulnerable, an elaborate public consultation process was undertaken as part of this ESIA. It involved engaging them in a dialogue characterized by two-way information flow.

Consultation allowed obtaining from the affected population information that might influence the decision-making process in scoping, project design, mitigation, monitoring and management plans, as well as the analysis of alternatives to be implemented.

The decision-making and the representatives of the host communities were consulted (as appropriate) for their opinions on issues relating to the potential ecological, socio-economic and health impacts of the proposed project.

1.5.3.1 Stakeholder Engagement Activities

Stakeholder engagement is a two-way process of communication between the project proponent and its stakeholders. It is a key aspect of the ESIA process, allowing stakeholders to express their views about Project. It involves sharing information and knowledge, seeking to understand the concerns of others and building relationships based on collaboration, thereby allowing stakeholders to understand the risks, impacts and opportunities of a project in order to achieve positive outcomes.

This section focuses on stakeholder engagement activities that have been carried out to date in support of the ESIA process for the Project

1.5.3.2 Objectives of Stakeholders Engagement

The objective of the engagement process is to present the proposed project and ESIA process to stakeholders and to identify associated potential issues, concerns and opportunities. This phase involved: identification of preliminary list of stakeholders; meetings with a number of government departments and stakeholder groups; and focus group discussions with local community members.

Specifically, GVLNG Limited and her consultants consulted the following organizations:

- Federal Ministry of Environment;
- Abuja Environmental Protection Board
- Gwagwalada Area Council
- Izom Community

1.5.3.3 Stakeholder Engagement Planning

The stakeholder engagement process followed the requirements of the Nigerian Environmental Impact Assessment Act No 86 (1992) as amended by EIA Act Cap E12 LFN 2004, and was also guided by environmental and social policies, guidelines and performance standards of the World Bank Group. To fulfill these requirements, the Project developed a plan for engagement with stakeholders that was aligned to key stages of the ESIA process. The plan included the following key steps.

- Identification of stakeholders and mechanisms for their engagement (meetings, letters, press releases, etc);
- Development of project information for and a Background Information document (BID) to convey high level project information and provide an overview of the project and potential impacts; and
- Identification of where in the ESIA process certain stakeholders should be contacted and how'

1.5.3.4 Screening/Scoping Workshop

In line with international best practices on environmental management, a Screening/Scoping Workshop for the proposed project was held at Izom Community. In attendance were representatives of the Regulatory Agencies, the proposed project team, independent environmental consultants, Non-Governmental Organizations (NGOs) and representatives of the host communities,

Specifically, representatives from the following groups participated in the meeting:

- Federal Ministry of Environment (FMEnv)
- Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)
- Abuja Environmental Protection Board (AEPB)
- Gwagwalada Area Council
- Izom Community

The objectives of the Screening/Scoping Workshop were the following:

- To enhance the process of identifying potential project impacts by assembling all stakeholders to the project;
- To provide opportunity for regulators and stakeholders to have a better outstanding of the project thereby allowing the relevant stakeholders' view and concerns to be integrated into the scope of the ESIA Study; and
- To identify potential environmental and social concerns early in the project cycle.

1.5.3.5 Disclosure

During disclosure, this ESIA report will be submitted to the FMEnv. The relevant authorities will determine the level of engagement required during disclosure of the ESIA report and meetings with the local communities. The objective of this engagement would be to explain the results of the ESIA and to obtain feedback. The ESIA report will also be disclosed in the Africa Development Bank and World Bank's

InforShop, an online, resource center offering access to information on ADB and World Bank projects and programs to the public.

1.5.3.6 Grievance Mechanism

International standards require that a grievance mechanism be put in place. A grievance mechanism is a company process that enables any stakeholder to make a complaint or a suggestion about the way a project is being implemented and that provides a mechanism for follow-up and resolution, if appropriate.

1.5.3.7 Impact Identification and Evaluation

The environmental aspects of the proposed project that may interact positively or negatively with the environment at the construction, operation and decommissioning phases were identified at this stage of the assessment. The FMEnv's EIA Sectoral Guidelines for Infrastructure projects, the World Bank Environmental Source Book and Risk Assessment report, among other information, were used in the process.

The ISO 14001 – Environmental Management System approach was adopted in evaluating the potential and associated impacts of the project on the environment.

1.5.3.8 Impact Mitigation

Mitigation measures designed to prevent, reduce or control the adverse impacts of the proposed project activities were proffered using professional judgment based on scientific deductions and project experience. Other resource materials also consulted include the FMEnv's EIA Sectoral Guidelines for Infrastructures projects, the World Bank Environmental Sourcebook, Risk Assessment Study report, etc. Similarly, enhancement measures were proffered to ensure that beneficial impacts of the project are optimized. Furthermore, post-auditing or monitoring has been designed into the social and environmental management plan of the proposed project to allow for continual operations improvement.

The flowchart presented as **Figure 1.3** summarizes the general approach adopted in this ESIA.

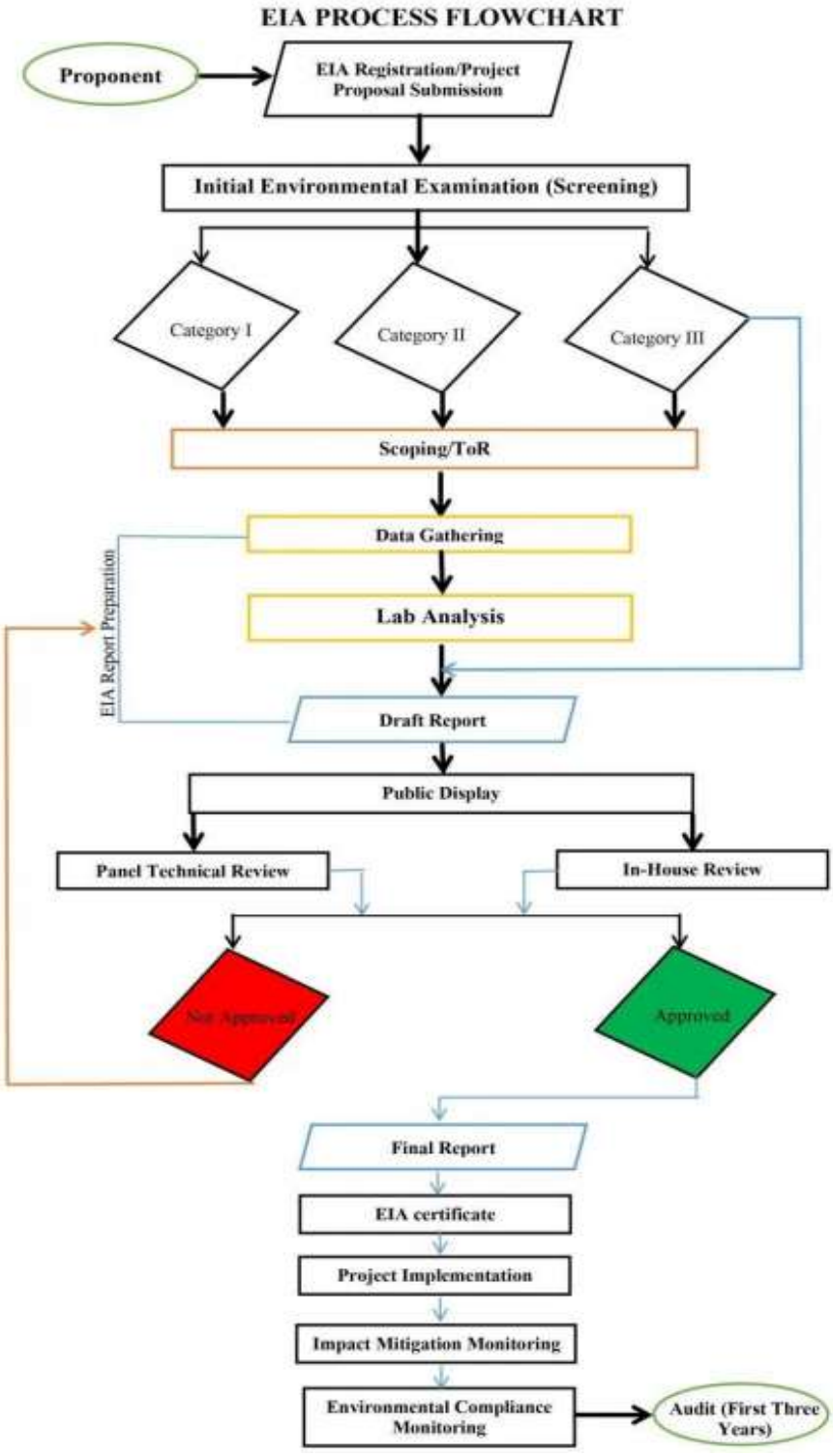

Figure 1.3: ESIA Flow Diagram

1.7 Legal and Administrative Framework for ESIA in Nigeria

The environment has emerged as one of the most critical issues of contemporary times, driven by the increasing negative impacts of rapid industrial development. As natural resources are exploited at unprecedented rates, environmental quality deteriorates, rendering many development projects unsustainable. This situation has necessitated the enforcement of environmental protection laws to safeguard and restore the Nigerian environment.

The requirement for an Environmental and Social Impact Assessment (ESIA) aligns with the Federal Republic of Nigeria's (FRN) laws and policies aimed at achieving sustainable development goals through environmental stewardship, public health protection, and social well-being. It also fulfills international requirements for projects of this scale, ensuring adherence to best practices in environmental and social safeguards. This section reviews relevant Nigerian legislation, guidelines, and international conventions applicable to infrastructure development. The legislative framework outlined here is drawn from federal and state laws, as well as international conventions and instruments to which Nigeria is a signatory. In accordance with the **Nigerian Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004**, the potential environmental impacts of this project must be evaluated through an EIA process and documented in an Environmental Impact Statement (EIS). Screening of the project under Nigerian law confirmed the need for an EIA. Additionally, compliance with the **World Bank/International Finance Corporation (IFC)** requirements and the **African Development Bank's (AfDB) Environmental and Social Safeguard Policies** is essential for financing a project of this magnitude.

In line with Nigerian law and AfDB policies, public participation is integral to the ESIA process. The **World Bank/IFC Environmental and Social Standards** also require transparent stakeholder engagement and disclosure of information. As part of these requirements, the final ESIA has been published for public review and comment, ensuring compliance with regulatory standards and facilitating final approval and financing of the project.

This revalidated ESIA underscores adherence to all relevant environmental and social safeguards to guarantee the project's alignment with local and international best practices, thereby supporting its sustainability throughout its lifecycle.

The legal and regulatory framework for carrying out ESIA of the proposed plant upgrade Project are contained in GVLNG Limited's policies, relevant national statutes and international environmental conventions to which Nigeria is signatory. These include:

- Various National regulations, standards, codes and recommended practices;
- The Environmental Impact Assessment Act;
- The regulations, standards, codes and recommended practices of Abuja Environmental Protection Board (AEPB);
- GVLNG Company Limited's policies on health, safety and environment (HSE); and
- Applicable international guidelines and conventions to which Nigeria is signatory.

1.7.1 National Regulations

1.7.1.1 The Federal Ministry of Environment

The defunct Federal Environmental Protection Agency (FEPA) was created by Decree No. 58 of 1988 as a parastatal of the Federal Ministry of Works and Housing. In 1992, the Agency's authority was strengthened through Decree 59 of 1992 by which the defunct FEPA was transferred to the Presidency. FEPA's goals were to improve and maintain the quality of the Nation's environment, manage its resources and physical characteristics, prepare ecological Master Plan to guide the use of coastal areas rift with diverse and often conflicting economic and social activities.

In same year, Nigeria took a giant step towards the sustainable management of its environment by formulating a decree of Environmental Impact Assessment (EIA). This has become globally accepted as an environmental management tool. June (1999), Nigeria formed a bigger body, "The Federal Ministry of Environment" which include the defunct FEPA and other departments from different Federal Ministries and Parastatal. The Federal Ministry of Environment is charged with the responsibility of all matters concerning the nation's environment and its biodiversity.

It has developed instruments of intervention to halt environmental degradation in form of policies, standards, guidelines and regulations and programmes. With the initiation of these instruments, enforcement by FMEnv has become the most effective tool to bring industries and regulated community into compliance through compliance promotions. The relevant policies, guidelines and regulations of the ministry are outlined below:

National Policy on the Environment

In 1989, the Federal Government of Nigeria through the Federal Environmental Protection Agency established a National Policy on Environment (NPE) revised 1999 and 2016 with the goal of achieving sustainable development. Environmental

management in Nigeria is based on the NPE, as revised in 1999 and 2016. The goal of this policy is to achieve sustainable development, to:

- securing a quality of environment adequate for good health and well-being;
- promoting sustainable use of natural resources and the restoration and maintenance of the biological diversity of ecosystems;
- promoting an understanding of the essential linkages between the environment and economic development and encouraging individual and community
- participation in environmental improvement initiatives;
- raising public awareness and engendering a national culture of environmental preservation; and
- partnership among all stakeholders including government at all levels, international institutions and governments, non-governmental agencies and communities on environmental matters.

The action plans to achieve the policy objective include the following:

- that environmental aspects are considered in major economic decision-making processes;
- that an integrated environmental management approach is built into major development projects;
- that economic instruments and environmental reporting are employed in the management of natural resources;
- that the best practicable environmental technology is applied in major economic activities;
- that environmental impact assessment (EIA) is mandatory before any major development project is embarked upon; and
- that environmental monitoring and auditing is routinely carried out in major economic activities.

All environmental regulation in Nigeria is intended to align with the NPE. Based on this policy, the National Guidelines and Standards for Environmental Pollution Control in Nigeria were published.

National Guidelines and Standards for Environmental Pollution Control

These guidelines and standards were initiated in March 1991 sequel to the promulgation of the National Environmental Policy in 1989 revised in 1999 and 2016. This document is a basic instrument for monitoring and controlling industrial and urban pollution. The guidelines and standards relate to six (6) areas of concern, thus:

- Effluent limitations;
- Water quality or industrial water uses at point of intake;
- Industrial emission limitations;

- Noise exposure limitations;
- Management of solid and hazardous wastes, and
- Pollution abatement in industries.

National Environmental Protection Regulations

S. I. 8 -National Environmental Protection (Effluent Limitation) Regulations 1991

The National Effluent Limitation Regulation, S.I.8 of 1991, makes it mandatory for industries as waste generating facilities to install anti-pollution and pollution abatement equipment on site. The regulation is specific for each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contravention are also prescribed.

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

National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, S.I.9 of 1991, imposes restrictions on the release of toxic substances and stipulates requirements for pollution monitoring units, machinery for combating pollution and contingency plan by industries; submission of lists and details of chemicals used by industries to Federal Ministry of Environment (FMEnv); requirement of permit by industries for the storage and transportation of harmful or toxic waste; the generator's liability; strategies for waste reduction; permissible limits of discharge into public drains; protection of workers and safety requirements; environmental audit (or environmental impact assessment for new industries) and penalty for contravention.

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

The Management of Hazardous and Solid Waste Regulation, S.I.15 of 1991, defines the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators etc. It also describes the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituent. It also states the requirements and procedure for inspection, enforcement and penalty.

The Environmental Impact Assessment Act

The EIA Act Cap E12 LFN 2004 requires that for all new major public and private projects in Nigeria, where the extent, nature or location of a proposed project or activity is such

that it is likely to significantly affect the environment, its EIA is undertaken in accordance with the provision of the Act. The EIA Act sets out to:

- consider the likely impacts, and the extent of these impacts on the environment before embarking on any project or activity;
- promote the implementation of appropriate policy in all Federal Lands consistent with all laws and decision-making processes through which the goal of this Act may be realized; and
- encourage the development of procedures for information exchange, notification and consultation between organizations and persons when the proposed activities are likely to have significant environmental effects on boundary or trans-state or on the environment of bordering towns and villages.

The Act gives specific powers to the FMEnv to facilitate environmental assessment of projects. In 1995, the then Federal Environmental Protection Agency (FEPA, now FMEnv) published *EIA Procedural Guidelines.* The guideline is intended to assist in the proper and detailed execution of EIA studies in Nigeria.

NESREA Requirements

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in November 2006 by the federal government. It is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards, and regulations in Nigeria. It also has the responsibility for enforcing compliance with the provisions of international agreements, protocols, conventions and treaties on environment to which Nigeria is signatory.

NESREA Act

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

Section 7: provides authority to ensure compliance with environmental laws, local and international, on environmental sanitation and pollution prevention and control through monitory and regulatory measures.

Section 8: empowers the agency to make and review regulations on air and water quality, effluent limitations, control of harmful substances and other forms of environmental pollution and sanitation.

Section 27: prohibits, without lawful authority, the discharge of hazardous substances into the environment. This offence is punishable under this section, with a fine not exceeding, N1,000,000 (One Million Naira) and an imprisonment term of 5 years. In the case of a there is an additional fine of N50,000, for every day the offence persists. Other sections include:

Section 1: requires industry facilities to have anti-pollution equipment for the treatment of effluent.

Section 3: requires a submission to the agency of a composition of the industry's treated effluents.

Section 4 and 5: requires industries to report a discharge if it occurs and to submit a comprehensive list of chemicals used for production to the Agency.

1.7.1.2 The Petroleum Industry Act (2021)

The Petroleum Industry Act (PIA) was passed into law in August 2021. It provides a comprehensive framework for the legal, governance, regulatory and fiscal matters of the Nigerian Petroleum Industry (upstream, midstream, and downstream) as well as the development of Host Communities. The Act repeals the following six (6) laws:

- the Associated Gas Reinjection Act 1979
- the Hydrocarbon Oil Refineries Act,
- Motors Spirit Returns Act,
- Nigerian National Petroleum Corporation (Projects) Act,
- Nigerian National Petroleum Corporation Act,
- the Petroleum Products Pricing Regulatory Agency (Establishment) Act

Two extant (2) laws are to be subsequently repealed upon the happening of some events – the Petroleum Profit Tax Act, 2004 and the Deep Offshore and Inland Basin Production Sharing Contract Act, 2019.

It is noted that the PIA (2021) does not repeal the Petroleum Act (1969). Holders of the previously issued licenses/leases such as the Oil Prospecting License, Oil Mining Lease, etc. are still governed by the provision of the Petroleum Act (1969) until the license/lease expires or are converted to leases or licenses issued under the Petroleum Industry Act. More importantly, provisions under the repealed laws shall remain in force provided that they are not inconsistent with the provisions of the PIA.

The PIA (2021) also establishes dual regulators for the petroleum industry,

- The Nigerian Upstream Petroleum Regulatory Commission (The Commission) - which is a body whose functions are limited to only the upstream petroleum activities as provided for in Section 4 of the Act.
- Nigerian Midstream and Downstream Petroleum Authority (The Authority) – which is responsible for the technical and commercial regulation of the midstream and downstream petroleum operations in the petroleum industry as provided under Section 29(3) of the Act.

Relevant Highlights on HSE issues:

- The Act empowers the Authority to:
  - Ensure strict compliance with environmental policies, laws, guidelines and regulations applicable to midstream and downstream petroleum operations.
  - Ensure compliance with all conditions of permits granted for midstream and downstream petroleum operations
  - Promote healthy, safe, and effective conduct of midstream and downstream operations in an environmentally acceptable and sustainable manner
- The operator of a midstream or downstream facility is required by the Authority to submit for approval an environmental management plan in respect of projects which require environmental impact assessment within one year of the effective date of the PIA or six months after the grant of the applicable license.

1.7.1.3 Nigerian Oil and Gas Industry Content Development Act, 2010

The Nigerian Local Content law was created to enhance utilization of the country's human and material resources for the provision of goods and services to the petroleum industry by ensuring that:

- Nigerians are given first consideration in the award of oil blocks, oil field licenses, oil lifting license and shipping service as well as projects for which contracts are to be awarded in the industry;
- there is exclusive consideration for Nigerian indigenous services to the oil and gas industry subject to the fulfilment of specified conditions;
- every multinational oil company operating in Nigeria is to domicile a minimum of 10% of its annual profit in Nigerian banks;
- Nigerian insurance companies are to do all aspect of insurance in the oil and gas sector except where local capacity has been exhausted;

- one percent of every contract awarded in Nigeria's oil and gas sector to be set aside for capacity building;
- at least 50% of the asset of any company seeking to execute oil and gas contract in Nigeria must be domicile in Nigeria, among others.

1.7.1.4 National Gas Policy, 2017

The Nigerian gas policy was developed to encourage sustainable development and use of the Nigerian gas. The policies developed are listed below:

- the nation's gas resources shall be harnessed and optimally integrated into the national economy, energy mix and industrial processes;
- the nation shall engage intensively in gas exploration and development with a view to increasing the reserve base to the highest level possible;
- the nation shall put in place necessary infrastructure and incentives to encourage indigenous and foreign companies to invest in the industry; and
- the nation shall put in place necessary infrastructure and incentives to ensure adequate geographical coverage of the gas transmission and distribution network.

The aims of the policies shall be achieved by:

- eliminating the flaring of associated gas in Nigeria;
- expanding the utilization of natural gas as industrial and domestic fuel, as well as for power generation;
- increasing the use of natural gas as industrial feedstock for petrochemical, pharmaceutical and fertilizer plants, etc.;
- using gas to diversify the foreign exchange earnings base of the nation;
- accelerating the process of technology acquisition and diffusion in the gas industry;
- encouraging indigenous entrepreneurial capability in the gas industry including the development of end-use devices; and
- determining the level of gas reserves available to the nation.

Strategies put in place by the Nigerian Government to ensure these aims are achieved are:

- encouraging the oil-producing companies to gather and utilize associated gas in order to eliminate flaring;
- imposing appropriate and effective penalties to discourage gas flaring;
- encouraging the establishment of the necessary infrastructure for the effective gathering, transmission and distribution of gas nationwide;

- formulating suitable urban and regional planning regulations needed for the effective distribution of natural gas to, and its utilization by, domestic and industrial consumers;
- providing necessary incentives to indigenous and foreign entrepreneurs to facilitate their participation in the gas industry;
- providing incentives to encourage industrial and domestic consumers to use gas or to convert to gas;
- establishing suitable infrastructure for the export of natural gas;
- expanding and promoting gas related R & D outfits in the country; and
- ensuring that the price of natural gas is cost-effective, while giving due attention to the effect on local consumption.

In line with the National Gas Policy, the Gas Master Plan was developed and approved by the Federal Executive Council to provide a framework for Nigeria to maximize value from its gas resources through leveraging the multiplier effect of gas in the domestic economy and optimizing Nigeria's share in the high value export market.

- The Nigerian Gas Master Plan is hinged on 3 critical elements, which are:
- Gas pricing policy;
- Domestic gas supply obligation; and
- Gas infrastructure blueprint

1.7.1.5 The Nigerian Urban and Regional Planning

The Nigerian Urban and Regional Planning Act **CAP N138, LFN 2004** was established to:

- promote co-operation and co-ordination among states and local governments in the preparation and implementation of urban and regional plans;
- formulate urban and regional planning standards in Nigeria;
- ensure effective supervision and monitoring of the execution of projects in urban and regional areas; and
- ensure development control over Nigeria.

The specific requirements of the Act pertinent to the proposed development as contained in Part II of the Act are as follows:

Planning Authority Approval

- it is mandatory for a developer to submit a development plan which would be approved by the Development Control Department (department under the commission);
- it is mandatory for a developer (whether private or government) to apply for development permit by using specified forms and providing information such as

plans; design drawings and other information as may be prescribed by regulation made pursuant to this section.

- no development shall commence by any Government or its agencies without obtaining an approval from the relevant Development Control Department.
- plan required to be made under this Act shall be prepared by registered Architect of Town Planner or Engineer and shall be in accordance with the provisions of this Act.

Submission of Detailed Environmental Impact Statement

A developer shall at the time of submitting his development application submit to an appropriate Control Department a detailed environmental impact statement for an application for:

- residential land in excess of 2 hectares; or
- permission to build or expand a factory or for the construction of an office.
- permission for a major recreational development.

Validity of Development Permit:

A development permit granted to a developer shall:

- remain valid for two years from date of communication of the plan to the approval of a developments permit to a developer; and
- where a developer fails to commence development within two years the development permit shall be subject to re-validation by the Control Department which issued the original permit.

Acquisition of Land and Compensation

Part IV of the Act requires that where it is necessary to obtain any land in connection with planned urban or development in accordance with the policies and proposals of any approved plan, any right of occupancy subsisting on that land shall be revoked on the recommendation of the appropriate authority. All matters connected with the payment of compensation for the revocation of the right of occupancy under the Act shall be governed in accordance with the relevant provision of the Land Use Act. Any compensation payable because of the revocation of the right of occupancy shall be paid within a reasonable period.

1.7.1.6 Water Resources

The Water Resources Act Cap W2 LFN 2004 is targeted at developing and improving the quantity and quality of water resources. The following sections are pertinent:

Section 5 and 6 provides authority to make pollution prevention plans and regulations for the protection of fisheries, flora and fauna; and

Section 18 makes offenders liable, under this Act, to be punished with a fine not exceeding N2000 or an imprisonment term of six months. He would also pay an additional fine of N100 for every day the offence continues.

1.7.1.8 The Labour Act Cap L1 LFN, 2004

The Labour Act Cap L1 LFN, 2004 is the primary law protecting the employment rights of individual workers. The Labour Act covers protection of: wages; contracts; employment terms and conditions; and recruitment. It also classifies workers and special worker types. Union membership is governed by the Trade Union Amendment Act (1995). A 1999 constitution includes stipulation of "equal pay for equal work without discrimination on account of sex, or any other ground whatsoever".

Labour will be sourced from a national, regional and local scale depending on project requirements during the construction and full operation of the plant upgrade. The Labour Act will guide all labour engagement in line with this.

1.7.1.9 Land Use Act Cap L5 LFN 2004

The Land Use Act Cap L5 LFN 2004 states that "it is public interest that the rights of all Nigerians to use and enjoy land in Nigeria and the natural fruits thereof in sufficient quality to enable them to provide for the sustenance of themselves and their families be assured, protected and preserved".

1.7.1.10 Endangered Species Act

Section 1 (*prohibition of hunting of or trading in wild animals*) of the Endangered Species Act 11 of 1985 (amended in 1990 as Act, Cap 108 and Act Cap E9, Laws of the Federation of Nigeria, 2004) prohibits the hunting, capture and trade on endangered species such as otter shrew, giant / tree / long-tailed pangolin, colobus monkeys, chimpanzee, gorilla, African palm squirrel, lion, leopard, cheetah, hyenas, immature elephant, giraffe, tortoises, crocodiles, etc. being animal species threatened with extinction or otherwise deal with animals species which though not necessarily now threatened with extinction may become so threatened except one is in possession of a license issued under the Act.

The Act also stipulates pertinent permits, certificates and the processes for trading of the identified endangered species as well as prescribes penalties for contraventions.

1.7.1.11 Harmful Waste Act

The Harmful Waste (Special Criminal Provisions) Act Cap H1, LFN 2004 prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

Section 6: provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.

Section 7: makes provision for the punishment accordingly, of any conniving, consenting or negligent officer where the offence is committed by a company.

Section 12: defines the civil liability of any offender. He would be liable to persons who have suffered injury as a result of his offending act.

1.7.1.12 Penal Code Act of Nigeria 2004

The Act makes it an offence punishable with up to 6 month's imprisonment for any person who:

- Violates the atmosphere in any place to make it noxious to the health of persons in general dwelling or carry on business in the neighborhood, or passing along a public way; or
- Does any act which is, and which he knows or has reason to believe to be, likely to spread the infection of any disease dangerous to life, whether human or animal.

1.7.1.13 Employees Compensation Act 2011

An Act to repeal the Workmen Compensation Act CAP. W6 LFN, 2004, and to make Provisions for Compensations for any death, injury, disease or disability arising out of or in the course of employment; and for related matters. The objectives of the Act are to:

- provide for an open and fair system of guaranteed and adequate compensation for all employees or their dependents for any death, injury, disease or disability arising out of or in the course of employment;
- provide rehabilitation to employees with work-related disabilities as provided in this Act;
- establish and maintain a solvent compensation fund managed in the interest of employees and employers;
- provide for fair and adequate assessments for employers;
- provide an appeal procedure that is simple, fair and accessible, with minimal delays; and
- combine efforts and resources of relevant stakeholders for the prevention of workplace disabilities, including the enforcement of occupational safety and health standards.

1.7.1.14 Climate Change Act 2021

Nigeria's 2021 Climate Change Act provides for an ambitious framework for mainstreaming climate actions in line with national development priorities and sets a net-zero target for 2050-2070. The Act codifies national climate actions by mandating

the Ministry of Environment to set, among others, a carbon budget, keeping average increase in global temperature within 2oC and pursuing efforts to limit the temperature increase to 1.5oC above pre-industrial levels. It further approves of formulation of a National Climate Change Action Plan in every five-year cycle to ensure that the national emission profile is consistent with the carbon budget goals and prescribes measures for identifying actions for climate adaptation and mitigation.

The Act applies to both public and private entities within Nigeria's territorial jurisdiction and directs both to implement mechanisms geared towards fostering a low-carbon emission, environmentally sustainable, and climate resilient society. The Act obligates any private entity with employees numbering 50 and above to put in place measures to achieve the annual carbon emission reduction targets in line with the Action Plan; and designate a climate change officer responsible for submitting annual reports to the National Climate Change Secretariats, at meeting its carbon emission reduction and climate adaptation plan.

The Act also establishes the National Council on Climate Change, chaired by the President of Nigeria, with members from both the public and private sectors, including members of the civil society, women, youth, and persons with disabilities. It empowers the Council with significant powers to coordinate national climate actions, administer the newly established Climate Change Fund, mobilize resources to support climate actions, and collaborate with the Nigerian Sovereign Green Bond in meeting Nigeria's NDC.

1.7.1.15 Natural Resources Conservation Act CAP 286 LFN 2004

This Act established the Natural Resources Conservation council to be responsible for the conservation of natural resources in Nigeria and formulate national policy for natural conservation. Section 3 of the Act provides that the functions of the council shall be to:

- Coordinating matters concerning the conservation of natural resources in Nigeria
- Formulate a national policy for national resources conservation.
- It also carries out such other activities calculated to facilitate the effectiveness of the performance of the functions of the council under this Act in Section 3(e).

Moreover, the Act measures in collaboration with other agencies, control coastal zone development to minimize erosion on the national coastline.

1.7.1.16 National Health Act, 2014

This Act provides a framework for the regulation, development and management of a national health system and set standards for rendering health services in the

federation, and other matters connected therewith, 2014. It also provides justification for the execution of developmental projects under guidelines that promote health by protecting the environment and safeguarding the humans' health. The Public Health Laws empower Medical Officers of Health (operating at the local government council, under the supervision of the State and Federal Ministries) to ensure the promotion of good health.

1.7.1.17 National Policy on Occupational Safety and Health, 2016

This policy is designed to make for safety and health of workers at workplaces. "It derives from the main ground norm law of the 1999 constitution as amended, which in section 17 (3c) prescribes that the Nigerian State shall make laws and bye-laws for preservation of the health and well-being of workers in the workplaces; men and women at work. "It also derives from the ILO convention 155, which Nigeria has also domesticated. Again, that talks about making the workplace conducive and ensuring the health and well-being of workers,

The policy is aimed at facilitating the enhancement of occupational safety and health performance in all sectors of the economy and ensuring that employees rights protection is consistent with regional and international standards.

1.7.1.18 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.

1.7.1.19 National Guidelines on Environmental Audit 2010

FEPA National Guidelines for Environmental Audit in Nigeria defines environmental audit as a management tool consisting of a systematic, documented, periodic and objective evaluation of environmental performance, management systems and equipment with the aim of firstly, facilitating management control of environmental.

1.7.1.20 National Guidelines on Environmental Management Systems of 1999

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Environmental Management Systems (EMS), the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.

1.7.2 FCT Policy, Guidelines and Regulations

1.7.2.1 Federal Capital Territory Administration (FCTA)

The Federal Capital Territory Administration (FCTA) is the administrative authority responsible for the governance, development and management of the Federal Capital Territory pursuant to the provisions of the Constitution of the Federal Republic of Nigeria and the Federal Capital Territory Act. The FCTA is responsible for ensuring that all public and private developments within the Territory are undertaken in accordance with approved planning standards, environmental requirements and sustainable urban development principles.

1.7.2.2 Federal Capital Development Authority (FCDA)

The Federal Capital Development Authority (FCDA) is the principal agency responsible for the planning, development and physical implementation of infrastructure within the Federal Capital Territory. The FCDA is mandated to implement the Abuja Master Plan, coordinate physical development, provide engineering infrastructure and ensure orderly urban growth within the Territory as well as supervise development projects to ensure consistency with approved layouts, infrastructure corridors, zoning regulations and engineering standards.

1.7.2.3 Abuja Environmental Protection Board (AEPB)

The Abuja Environmental Protection Board (AEPB) is the principal environmental regulatory agency of the Federal Capital Territory Administration (FCTA), established to protect and improve the quality of the environment within the Federal Capital Territory. The Board is responsible for implementing environmental policies, enforcing environmental regulations, monitoring environmental quality, promoting sustainable waste management, controlling environmental pollution, regulating sanitation services, and ensuring compliance with environmental standards throughout the FCT. The AEPB collaborates with the Federal Ministry of Environment (FMEnv), the Federal Capital Territory Administration (FCTA), Area Councils within the FCT and other relevant institutions to ensure that development projects are implemented in an environmentally responsible manner.

The proposed project is subject to the environmental oversight responsibilities of the Abuja Environmental Protection Board to ensure continued compliance with applicable environmental standards within the FCT.

1.7.2.4 Gwagwalada Area Council

The Gwagwalada Area Council is one of the six Area Councils established within the Federal Capital Territory to administer local government functions within its jurisdiction. Gwagwalada is responsible for the provision and coordination of certain municipal services including environmental sanitation, waste management, public health administration, local roads, markets, community liaison, and other statutory local government functions.

1.7.4.5 Izom Community

Izom Community is situated within the jurisdiction of the Gwagwalada Area Council. Accordingly, implementation of the proposed project will require appropriate coordination with the Area Council regarding environmental sanitation, construction waste management, public health, traffic management and other municipal services that may be affected during project implementation.

1.7.3 International Legal Framework

In addition to national and state laws/ regulations, Nigeria is signatory or party to several International Conventions and treaties that support the use of ESIA as key tool for achieving sustainable development in executing projects. International institutions such as the World Bank, African Development Bank, etc. provide guidance on requirements for the ESIA process and place emphasis on achieving sustainable environmental, social and health outcomes. They provide environmental standards and limits for emissions and discharges. This ESIA has been subjected to relevant guidelines and therefore is expected to meet the environmental requirements of other applicable institutions.

1.7.3.1 International Finance Corporation Performance Standards

The IFC Performance Standards, which define clients' responsibilities for managing their environmental and social risks have been adopted by the World Bank as the Performance Standards (WB Performance Standards) for Private Sector Activities. These Performance Standards are applicable to projects designed, owned, constructed and/or operated by a Private Entity1 for which the Bank's support is needed.

The Performance Standards are directed towards a private entity, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and

manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the private entity in relation to project-level activities.

There are eight Performance Standards (PS) which the private entity is expected to meet throughout the life of an investment by IFC:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous People
- Performance Standard 8: Cultural Heritage

For the CNG Mother Station Project, it's important to identify which standards are applicable and which are not. Below is a detailed explanation of the relevant Performance Standards that may likely be triggered by the project:

Performance Standard (PS) 1: Assessment and Management of Environmental and Social Risks and Impacts

PS 1 describes the importance of an integrated assessment to identifying the environmental and social impacts, risks, and opportunities of the project, an effective community engagement through appropriate and timely disclosure of information and consultation; and the private entity's management of environmental and social performance throughout the project lifecycle. This Performance Standard applies to business activities with environmental and/or social risks and/or impacts, which fits the classification of plant upgrade project. As part of the requirements of this performance standard, GVLNG Limited has in conjunction with all project stakeholders conducted an environmental and social assessment presented in this report, and shall establish and maintain an Environmental and Social Management System (ESMS) appropriate to the nature and level of environmental and social risks and impacts assessed.

This ESMS shall incorporate the following elements: (i) policy; (ii) identification of risks and impacts; (iii) management programs; (iv) organizational capacity and competency; (v) emergency preparedness and response; (vi) stakeholder engagement; and (iv) monitoring and review.

Performance Standard 2: Labor and Working Conditions

PS 2 recognizes that pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. This standard maintains that failure to establish and foster a sound worker management relationship can undermine worker commitment and retention, can jeopardize a project and hamper its overall sustainability. Guided by conventions and instruments of the International Labour Organization (ILO) and the United Nations (UN),

The objectives of this performance standard are to: (i) promote the fair treatment, nondiscrimination and equal opportunity of workers, (ii) establish, maintain and improve the worker-management relationship, (iii) promote compliance with national employment and labour laws, (iv) protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain, (v) promote safe and healthy working conditions, and the health of workers, and (vi) avoid the use of forced labor.

The environmental and social risks of this factor are established during the impact's identification process, and managed through the private entity's ESMS. GVLNG Limited shall ensure that all identified risks and impacts are managed following international and national standard policies and procedures. These are either documented in this report or included in supporting documents, plans and/or policies to this report.

Performance Standard 3: Resource Efficiency and Pollution Prevention This standard recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water and land, and consume finite resources in a manner that may threaten people and environment at the local, regional and global levels. In the light of more efficient and effective resource use and pollution prevention technologies, this performance standard takes a project-level approach to resource efficiency and pollution prevention and control in line with international best practices.

The levels of emissions for Greenhouse Gases (GHGs) and other recorded pollutants have been measured in this study and the expected levels during plant operation documented in this report as part of an environmental and social risks and impacts identification process. GVLNG Limited will consider all ambient conditions and apply technically and financially feasible resources efficiency and pollution prevention techniques best suited to avoid, or minimize adverse impacts on human health and the environment. The abatement measures to be implemented as highlighted in the Environmental and Social Management Plan (ESMP) and other supporting plans are consistent with national environmental laws and internationally recognized sources,

including the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines).

Performance Standard 4: Community Health, Safety, and Security

The objective of this performance standard is to scope and avoid adverse impacts on the health and safety of the project area during the lifecycle of the project from both direct and indirect project activities. It is also to ensure that property and personnel are safeguarded in a manner that avoids or minimizes risks to the local community especially to vulnerable groups.

Following an expansive scoping process and stakeholder engagement, GVLNG Limited has documented environmental and social risks and impacts affecting the community. Mitigation measures where these impacts cannot be avoided have been proffered in the report. Further to this, actions required to meet the requirements of this Performance Standard are managed by GVLNG Limited's ESMP and ESMS.

Performance Standard 5: Land Acquisition and Involuntary Resettlement

This performance standard recognizes that project-related land acquisition and land use change can have adverse impacts on persons and communities that use this land. Among the objectives of this standard are: (i) to avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs, (ii) to avoid forced eviction, (iii) to improve, or restore, the livelihoods and standards of living of displaced persons, where applicable (iv) To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use.

Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

This Performance Standard addresses how the private entity can sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle. The objectives of this performance standard are: (i) to protect and conserve biodiversity, (ii) maintain the benefits from ecosystem services, (iii) promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

Scoping during assessment of environmental and social conditions for the project identified modified habitats which will experience direct and indirect impacts because of the development. Threats to biodiversity and ecosystem services have been mapped in this report and mitigation measures proffered. Implementing

measures that ensure resource efficiency and proper utilization of land area to ensure minimal distortion to biodiversity are methods proffered to minimize impacts.

1.7.3.2 Equator Principles

The Equator Principles is a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. The Equator Principles are presented in Table 2.1.

Table 1.1: Equator Principles

Principle	Requirements
Principle 1	Review and Categorization of project
Principle 2	Conduct environmental and social impact assessment
Principle 3	Applicable social and environmental standards
Principle 4	Action plan and management systems
Principle 5	Stakeholder engagement
Principle 6	Grievance mechanism
Principle 7	Independent review
Principle 8	Covenants
Principle 9	Independent monitoring and reporting
Principle 10	Reporting and transparency

The Equator Principles set out the process for assessing a project in four key phases: Impacts are assessed on their degree of potential impact and are categorized as either A (High), B (Medium) or C (Low).

Category A- Projects with potentially significant adverse social or environmental impacts that are diverse, irreversible or unprecedented;

Category B- Projects with potentially limited adverse social and environmental impacts that are few, generally site-specific, largely reversible and readily addressed through mitigation measures; and

Category C- Projects with minimal or no social or environmental impacts.

1.7.3.3 World Bank Guidelines on Environmental Assessment

The World Bank requires an Environmental Impact Assessment (EIA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable to improve decision making. Additionally, the policy specifies that the Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of EIA. The Bank classifies projects into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. Details of World Bank EIA procedures and guidelines are published in the bank's EA Source Books Vols. i – iii of 1991.

World Bank Operational and Safeguard Policies

The World Bank is committed to several operational and safeguards policies that aim to prevent and mitigate undue harm to people and their environment in any development initiative involving the bank. These policies provide guidelines for bank and borrower staff in the identification, preparation, and implementation of programs and projects. There are ten World Bank Environmental/Safeguard Policies. Not all these policies are triggered by the CNG Mother Station Project. The World Bank policies that have been triggered by the proposed CNG Mother Station Project are:

Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment (last updated February 2011). This is the umbrella policy for the Bank's environmental 'safeguard policies' which among others include:

Operational Policy/Bank Procedure 4.04 (Natural Habitat) - seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society.

Operational Policy/Bank Procedure 4.36 –(Forests.) This policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development.

Operational Policy 4.09 (Pest Management) policy recognizes that pesticides can be persistent and harmful to the environment for a long time. If pesticides must be used, the policy requires that Pest Management Plan (PMP) be prepared by the borrower, either as a stand-alone document or as part of an Environmental Assessment.

Operational Policy /Bank Procedure 4.11 - Physical Cultural Resources seeks to avoid, or mitigate, adverse impacts on cultural resources from development projects that the World Bank finances.

The Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus improve decision making. Such EA is carried out by the borrower to evaluate a project's potential environmental risks and impacts in its area of influence. The EA process analyzes project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The Bank favours preventive measures over mitigatory or compensatory measures, whenever feasible. EA looks at the interaction of the project with the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and where applicable, transboundary and global environmental aspects.

World Bank Group EHS Guidelines

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards.

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, based on environmental assessments and/or environmental audits as appropriate, with an appropriate timetable for achieving them.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

The General EHS Guideline (*May, 2017*) is organized to provide environmental, occupational health and safety, community health and safety, construction and decommissioning guidelines for new and existing facilities. The General EHS Guidelines are designed to be used together with relevant Industry Sector EHS Guidelines to provide guidance on EHS issues in specific industry sectors.

1.7.3.4 United Nations Guiding Principles on the Human Environment

The United Nations (UN), concerned about negative environmental trends since its formation, published two major concept documents: Guiding Principles on the Human Environment, 1972 and the Rio Declaration on Environment and Development.

Ten of these Guiding Principles were defined as formal declarations that express the basis on which an environmental policy can be built and which provide a foundation for action. The principles relevant to the proposed project are summarised as follows.

Principle Two

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

Principle Four

Man has a special responsibility to safeguard and wisely manage the heritage of wildlife and its habitat, which are now gravely imperilled by a combination of adverse factors. Nature conservation, including wildlife, must therefore receive importance in planning for economic development.

Principle Six

The discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted to ensure that serious or irreversible damage is not inflicted upon the ecosystems.

1.7.3.5 The Rio Declaration on Environment and Development

The UN Conference on Environment and Development met at Rio de Janeiro in June 1992, at which time it reaffirmed the 1972 declaration on the Human Environment, and sought to build upon it. This is with the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people. It is also to aid work towards international agreements, which respect the interests of all, protect the integrity of the global environmental

developmental system, and recognized the integral and interdependent nature of the earth. The UN thus added additional principles to the originals, the more relevant being:

Principle Ten

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, everyone shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes.

States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle Thirteen

States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle Seventeen

Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

1.7.3.6 United Nations Conference on Environment and Development (1992) (Popularly referred to as Agenda 21)

The United Nations Conference on the Environment and Development (UNCED) in 1992 led to the adoption of agenda 21, which recommended a set of 21measures for waste management. Some of the recommendations include the following:

- Prevent and minimize waste production
- Reuse or recycle the waste to the extent possible.
- Treat waste by safe and environmentally sound methods.
- Dispose of the final residues by landfills in confined and carefully designated sites.
- Integrate environment into development planning at all levels of Government and the private sector;
- Commence a transition to sustainable development.

- Address sectorial priorities, plan policies and strategies for the major sectors of the economy; and
- Simultaneously foster regional and global partnership.

1.7.3.7 Convention on Biological Diversity (1992)

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.

1.7.3.8 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1987)

The convention focuses attention on the hazards of the generation and disposal of Hazardous wastes. The convention defines the wastes to be regulated and control their trans-boundary movement to protect human and environmental health against their adverse effects.

1.7.3.9 Convention on the Conservation of Nature and Natural Resources, 1986

This convention came into force in Nigeria on May 7th,1974. The objectives of the convention to encourage individual and joint action for the conservation, utilization and development of soil, water flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural and aesthetic point of view.

1.7.3.10 Montreal Protocol on Substances that Deplete the Ozone Layer, 1987 (as Amended)

The objective of the convention is to protect the ozone layer by-taking precautionary measure to control global emissions of substances that deplete it. This convention is aimed at protecting workers against occupational Hazards in the working environment.

1.7.3.11 Convention on Occupational Safety and Health and the Working Environment

The convention EIAs the objective of enhancement of the existing legal framework for occupational safety regulating the management of chemicals in the work place with the broad purpose of protecting the environment and the public, and with the specific objective of protecting workers from harmful effects of chemicals.

1.7.3.12 United Nations Convention on Climate Change

The Convention on the Climate Change was signed in 1992 during the Rio Earth Summit but was put into force in 1994. The Convention called on developed countries and economies in transition to limit their emissions of the greenhouse gases which cause

global warming, although it does not impose mandatory emissions on developing countries.

UNFCCC, Paris agreement of 2016 [The agreement was signed on 22 September 2016 and ratified by Nigeria on 16th May 2017]

The world is in a race to limit climate change and find workable, practical, and cost-efficient solutions (Renewable Energy, Circular Economy, and Natural Capital) to this emergency that is redefining global partnerships in a way not seen before. This is a race we, as humanity, can win. But for this to happen, unprecedented leadership, sacrifices, concessions from all nations big and small are needed. Nigeria has ratified the 2915 Paris Agreement. This is commendable considering it is one of the top six greenhouse gas emitters in Africa. The Paris Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework, and an enhanced capacity-building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

1.7.3.13 Polluter Pays Principle (Adopted by Nigeria in 1999)

In environmental law, the polluter pays principle is enacted to make the party responsible for producing pollution responsible for paying for the damage done to the natural environment. It is regarded as a regional custom because of the strong support it has received in most Organization for Economic Co-operation and Development (OECD) and European Community (EC) countries. The polluter pays principle underpins environmental policy such as an ecotax, which, if enacted by the government, deters and essentially reduces greenhouse gas emissions. Some eco-taxes underpinned by the polluter pays principle include: the Gas Guzzler Tax, in the US, Corporate Average Fuel Economy (CAFE) - a "polluter pays" fine. The U.S. Superfund law requires polluters to pay for clean-up of hazardous waste sites when the polluters can be identified. Polluter pays is also known as extended producer responsibility (EPR). This is a concept that was probably first described by Thomas Lindhqvist for the Swedish government in

1990. EPR seeks to shift the responsibility for dealing with waste from governments (and thus, taxpayers and society at large) to the entities producing it. In effect, it internalised the cost of waste disposal into the cost of the product, theoretically meaning that the producers will improve the waste profile of their products, thus decreasing waste and increasing possibilities for reuse and recycling

1.7.3.14 Stockholm Convention Against Persistent Organic Pollutants of 2004

Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs). In 1995, the Governing Council of the United Nations Environment Programme (UNEP) called for global action to be taken on POPs, which is defined as "chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment‖. Following this, the Intergovernmental Forum on Chemical Safety (IFCS) and the International Programme on Chemical Safety (IPCS) prepared an assessment of the 12 worst offenders, known as the dirty dozen. The INC met five times between June 1998 and December 2000 to elaborate the convention, and delegates adopted the Stockholm Convention on POPs at the Conference of the Plenipotentiaries convened from 22–23 May 2001 in Stockholm, Sweden. The negotiations for the Convention were completed on 23 May 2001 in Stockholm. The convention entered into force on 17 May 2004 with ratification by an initial 128 parties and 151 signatories. Co-signatories agree to outlaw nine of the dirty dozen chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans. Parties to the convention have agreed to a process by which persistent toxic compounds can be reviewed and added to the convention if they meet certain criteria for persistence and transboundary threat. The first set of new chemicals to be added to the Convention was agreed upon at a conference in Geneva on 8 May 2009. As of June 2018, there are 182 parties to the Convention, (181 states and the European Union). Notable non-ratifying states include the United States, Israel, Malaysia, and Italy. The Stockholm Convention was adopted to EU legislation in REGULATION (EC) No 850/2004.

1.7.3.15 Cartagena Protocol on Bio-safety of 2003

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international agreement on biosafety as a supplement to the Convention on Biological Diversity effective since 2003. The Biosafety Protocol seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology The Biosafety Protocol makes clear that products from new technologies must be based on the precautionary principle and allow developing

nations to balance public health against economic benefits. It will for example let countries ban imports of genetically modified organisms if they feel there is not enough scientific evidence that the product is safe and requires exporters to label shipments containing genetically altered commodities such as corn or cotton

1.7.3.16 Vienna Convention for the Protection of the Ozone Layer

This Convention was instituted in 1985 and places general obligation on the countries to make appropriate measures to protect human health and the environment against adverse effects resulting from human activities which tend to deplete the ozone layer.

1.7.3.17 International Best Practices

Other considerations of the ESIA include other international best practices. International institutions provide guidance on best practices for the ESIA process and place emphasis on achieving sustainable environmental, social, and health outcomes. They also provide environmental standards and limits for emissions and discharges. Some key project impact mitigation measures such as resettlement are also specified. The overall project design and this ESIA will align with international best practices such as guidelines published by the International Finance Corporation (IFC) and the World Bank. The following is a summary of the specific international requirements and standards that will be applied to this ESIA. It should be noted that, given the private-sector nature of the development, the IFC Performance Standards described below will be most directly applicable to the project in this case.

Other Relevant International Conventions

Other conventions, (classified according to their applicability to waste management, marine and biodiversity protections), relevant to the proposed project and to which Nigeria is signatory, but for which enabling legislation may not be in place in all cases, include:

- Environment of the West and Central African Regions, 1981;
- Convention on the Protection of the World Cultural and Natural Heritage, 1972;
- Convention on International Trade in Endangered Species (CITES), 1973;
- Bonn Convention on the Conservation of Migratory Species of Wild Animals, 1979;
- United Nations Convention on Biological Diversity (CBD) adopted at the Earth Summit in Rio de Janeiro, 1992;
- The Copenhagen Accord reached by Heads of State, Heads of Government, Ministers and other heads of delegation at the United Nations Climate Change Conference 2009 in Copenhagen, Denmark.

1.7.4 Greenville LNG Health, Safety and Environment (HSE) Policy

Greenville LNG Company Limited is committed to the protection of People, Assets, Environment, and its Reputation (PAERs), in all her operations including Construction, Production, Transportation, Service Stations, Customer Centers, etc. It aims to be in full compliance with all applicable legislation and industry best practices.

The philosophy of its operations is based on verifiable and reportable systems that engender the right and demonstrate positive HSE culture amongst employees, our host communities and other stakeholders. Our focus is for HSE continual performance improvement by implementing value-adding recommendations.

At Greenville LNG, we see safety as everyone's responsibility, and we work towards ensuring that every person at all our locations becomes safety-conscious and prioritises it. Thus, we task every person in our team with their safety and the safety of others.

1.8 Structure of the Report

This ESIA report has been prepared to highlight the biophysical, socio-economic and health issues related to the implementation of the Greenville LNG CNG Compression Station Project. It highlights the positive and negative impacts that may affect the installation and operation of the planned additional facilities on the project site and prescribes cost-effective mitigation measures to minimize or eliminate the negative impacts. In addition, it suggests a practical environmental and social management program (ESMP) for the expansion project. This report is presented in eight chapters.

- ***Chapter One*** is an introduction containing relevant background information about the proposed project and the Legal and Administrative Framework for ESIA in Nigeria among other relevant laws and guidelines relevant to the project.
- ***Chapter Two*** discusses the project justification, the need/value and the envisaged sustainability of the project as well as the project development and site/route options considered.
- ***Chapter Three*** contains the detailed descriptions of the proposed project including its location, overall layout, basis for design, type and specifications of equipment/facilities to be installed, source of power supply to the plant, operation/maintenance of facility, and specific project activities as contained in the conceptual design report. The emergency safety and security measures and overall project schedule are also contained in this chapter.
- ***Chapter Four*** describes the baseline ecological and socio-economic status of the study area. Information on consultation with stakeholders is also presented in this chapter.

- ***Chapter Five*** discusses the identified potential and associated environmental impacts of the proposed project.
- ***Chapter Six*** discusses the mitigation of identified potential and associated environmental impacts of the proposed project and highlights the various mitigation measures proffered against the identified significant impacts.
- ***Chapter Seven*** outlines a cost-effective environmental management plan that would be adopted throughout the project cycle. It also enumerates the environmental monitoring plan, the waste management plan and the project's decommissioning/abandonment plan.
- ***Chapter Eight*** discusses the decommissioning and restoration plans
- ***Chapter Nine*** gives the conclusion and requests approval for project implementation.

Other sections of this report include (not in any chronological order) are the table of contents, the list of references as highlighted in the report, the list of ESIA preparers, list of abbreviations and acronyms, the acknowledgement page, the Executive Summary and various appendices (attachments).

CHAPTER TWO: PROJECT JUSTIFICATION

2.0 Preamble

The establishment of a Compressed Natural Gas (CNG) mother/daughter station in Izom, Gwagwalada Area Council, Abuja FCT is justified by the growing national transition toward cleaner fuels, and the need to expand affordable energy access. The site's proximity to existing Ajaokuta-Abuja-Kaduna-Kano (AAKK) gas infrastructure enables efficient gas sourcing and distribution, while the mother/daughter configuration supports flexible supply to areas without pipeline connectivity.

2.1 Proposed Project Justification

The establishment of a Compressed Natural Gas (CNG) Mother/Daughter station network is a highly viable strategic project. The business and economic justification relies on four primary pillars:

- **Proximity to Feedstock and Existing Infrastructure**: The site is just a few meters away from the existing Ajaokuta-Abuja-Kaduna-Kano (AAKK) Gas Pipeline, the Mother Station shall directly taps into the existing domestic gas pipeline network. This allows for highly cost-efficient, high-volume gas compression at the source.
- **Virtual Pipeline Efficiency via Daughter Stations**: Due to the lack of vast secondary pipeline grids across the area, a Daughter Station model acts as a "virtual pipeline". The Mother Station compresses gas into mobile storage trucks, which then supply skid-mounted Daughter Stations in surrounding commercial areas and commuter corridors. This approach eliminates the exorbitant cost of building new physical pipelines and shorter construction timelines to meet pressing energy demands.
- **Immediate Commercial Demand**: The Gwagwalada-Kwali axis has a dense concentration of commercial transport fleets, tricycles, industrial logistics trucks, and marine vessels. High premium motor spirit (PMS) and diesel prices make local fleet operators eager to transition to cheaper fuel.
- **Direct Policy Alignment**: The project perfectly aligns with the Federal Government's Presidential CNG Initiative (Pi-CNG). This ensures strong regulatory backing, smoother environmental approvals through the Federal Ministry of Environment and potential fiscal incentives from the Midstream and Downstream Gas Infrastructure Fund (MDGIF).

2.2 Need for Project

The oil and gas industry plays an important role in the Nigerian economy, and this CNG

Compression is one such.

- The project will reduce dependence on PMS and diesel, lower greenhouse-gas and particulate emissions. This shift supports improved air quality and public health outcomes.
- Stimulate local economic activity and boost living conditions
- Enhance energy security in line with Nigeria's Decade of Gas policy.
- Improve the health of society and the environment
- Conservation of energy
- Provide resources for industrial production at lower cost and increase productivity
- Create employment opportunities for Nigerians

Environmental impacts identified are manageable and can be mitigated through established engineering and operational controls, making the project both environmentally viable and socio-economically beneficial

2.3 Benefits of the Proposed Project

The proposed CNG mother/daughter station will deliver significant environmental, economic, and energy-security benefits.

- It will reduce greenhouse-gas and air-pollutant emissions by providing a cleaner alternative to petrol and diesel, thereby improving local air quality and supporting Nigeria's energy-transition goals.
- The project enhances regional energy security by supplying a stable, locally sourced fuel and extending gas access to areas without pipeline infrastructure.
- It will stimulate economic growth through job creation, lower fuel costs for transport and industrial users, and increased business activity.
- The station also aligns with national policies such as the Decade of Gas and the National Gas Expansion Programme, while promoting safer fuel handling and reduced spill risks compared to liquid fuels.:

2.4 Value for the Proposed Project

The value of the proposed project is highlighted by the desire to enhance local environment cleanliness and health in the oil and gas operational areas. The project estimated cost is N1 billion, to be independently funded. The project lifespan shall be 25 - 30years.

2.5 Envisaged Sustainability

The sustainability of the proposed project is categorised as follows:

2.5.1 Economic Sustainability

The project is economically sustainable as it leverages Nigeria's abundant natural gas resources to provide a cheaper and more stable alternative to petrol and diesel. The station will reduce fuel costs for transport operators, SMEs, and industrial users, thereby improving business competitiveness. It will generate direct and indirect employment during construction and operation, stimulate local supply chains, and support long-term economic diversification in FCT. The mother/daughter model also ensures cost-effective distribution to areas without pipeline infrastructure, enhancing market reach and financial viability.

2.5.2 Technical Sustainability

The project is technically sustainable due to the use of proven CNG compression, storage, and transportation technologies widely adopted globally. The modular mother/daughter configuration allows phased expansion based on demand, reducing technical risk. The proximity to existing gas infrastructure ensures reliable feedstock supply, while modern safety systems—pressure relief devices, gas detection, automated shutdowns—enhance operational reliability. The design complies with relevant engineering standards, ensuring long-term functionality and maintainability.

2.5.3 Environmental Sustainability

CNG is a cleaner-burning fuel that significantly reduces CO_2, NOx, SOx, and particulate emissions compared to conventional liquid fuels. The project will contribute to improved air quality and reduced greenhouse-gas emissions in line with Nigeria's climate commitments. CNG poses minimal risk of soil or water contamination because it dissipates rapidly when released. Identified environmental impacts—noise, construction disturbance, waste generation—are limited in scale and can be effectively mitigated through standard environmental management practices, making the project environmentally viable.

2.5.4 Social Sustainability

The project supports social sustainability by creating employment opportunities, enhancing local skills, and improving access to affordable energy. Lower fuel costs will benefit transport operators and commuters, contributing to improved mobility and reduced cost of living. The project promotes safer fuel handling and reduces community exposure to pollutants associated with diesel and petrol. Engagement with host communities ensures inclusion, transparency, and alignment with local development priorities.

2.5.5 Legal/Legislative Sustainability

The project aligns with Nigeria's regulatory framework governing natural gas utilization, environmental protection, and industrial development. It complies with FMEnv EIA requirements, NESREA environmental standards, and NUPRC guidelines for gas handling and distribution. The project will operate under valid permits and licenses, adhere to national safety codes, and implement an Environmental Management Plan (EMP) consistent with statutory obligations. This ensures long-term legal compliance and regulatory sustainability.

2.5.6 Political Sustainability

The project is politically sustainable as it directly supports national policy priorities, including the Decade of Gas Initiative, the National Gas Expansion Programme (NGEP), and Nigeria's broader energy transition agenda. It aligns with government efforts to reduce dependence on imported refined fuels, promote cleaner energy, and stimulate gas-based industrialization. The project strengthens government credibility in delivering energy reforms and is likely to receive continued political support at federal and state levels.

2.6 Project Options

As required by law in Nigeria, some reasonable options and alternatives to the various elements of the proposed project shall be considered and examined. Accordingly, a number of alternatives have been weighed up for the construction and operation of the proposed CNG Mother/Daughter Station using economic, technical and environmental considerations.

2.6.1 No- Project Option

The no-project option means the development of the planned CNG Station shall not take place. As a direct consequence, this would result in no effect on the environment in the area as this option would result in no change of environmental features. A key implication of this option is that the project area which is suitable for the CNG operations, will be under-utilized. Additionally, the waste generated at the oil operation terminals may likely be spilled into the host environment, thus creating pollution and health challenges in that local environment. The adoption of this option will mean, negative impact on the environment, society and nation's economy as well as loss of employment opportunities with the opportunity to improve the host local community.

This option also goes against the gas policy of Federal Government of Nigeria that has declared the decade on gas and has depened investment in tbe sector and has

continued to woo private investment in the sector. Importantly, this mandate is geared toward addressing inadequate product (CNG – Autogas) availability across the country. In addition, the site is currently under-utilised, and the economic stimulus the proposed development will have on the host community would not occur. Since no viable economic or technical reason supports this option despite not negatively impacting the environment, the option was deemed not feasible and is rejected.

2.6.2 Delayed Project

Delaying the project involves moving the project to a later date. This situation is unlikely, and can only be considered if existing circumstances are highly un-favourable or risky for the execution of the project. Conflicts, war, hostilities, communities deeply resentful of the project or unacceptable/unattractive economics are some of the reasons this option can be adopted. In contrast, the economics and the political environment favour the execution of the project. Moreover, delaying the project will have no net effect on significant environmental impacts that would arise from the project. Additionally, the project will create job opportunities for the host communities. thus, delaying the project will have dire consequences as all processes that have been set up for the project design and implementation will be stopped. Furthermore, contractors will have to be demobilized, and when inflationary trends are taken into account, project costs could increase if the project is delayed and this leads to a decrease in the final profit and benefits accruable from the project. For these stated reasons, the delayed option is not considered.

2.6.3 "Go Ahead Project Option"

The justification of this project outweighs other negative variables; therefore the "go ahead" option is proposed for the project at the present location. It is therefore recommended that the project be carried out as planned, since adequate mitigation measures shall be incorporated into the project plan to minimise or eliminate potential negative environmental and social impacts of the proposed project. Importantly, it will add to achieving the FGN drive towards gas sector investment in the northern parts of Nigeria, which has been starved for years.

2.6.4 Alternate Site/ Locations

Alternative site locations were considered early on by the board of GVLNG Limited. Other location alternatives were considered before deciding on the present location but the current site is best suited for the project. This location is only about 100 from the gas node along the Ajaokuta – Kaduna – Kano (AKK) pipeline. Thus, access to gas is assured with limited need for a lengthy gas pipeline into the compression station. In addition, this location was considered as it's not within a dense community and

promises lower environmental impacts during the project lifecycle. The key advantage of this alternative from an environmental perspective is minimal impact on the host community. As a result, this is the preferred and selected site.

CHAPTER THREE: PROJECT AND OPERATIONS DESCRIPTION

3.0 Project Introduction

This chapter provides a comprehensive description of the Greenville Compressed Natural Gas (CNG) plant and associated facilities, which are strategically located at Izom Community, Gwagwalada Area Council, Abuja-FCT. Project details contained in this Chapter have all been provided by the project proponent. The project proponent is Greenville Liquefied Natural Gas Company Limited (GVLNG), formerly Greenville Oil and Gas Company Limited (GOGCL).

3.1 Geographical Location

The proposed project would be sited on 10ha of land at Izom Community, Gwagwalada Area Council, Abuja-FCT. The proposed project site falls within the following geographical coordinates: 9°13'54.4"N 6°59'33.8"E.

Figure 3.1: Nigeria Showing Abuja-FCT.

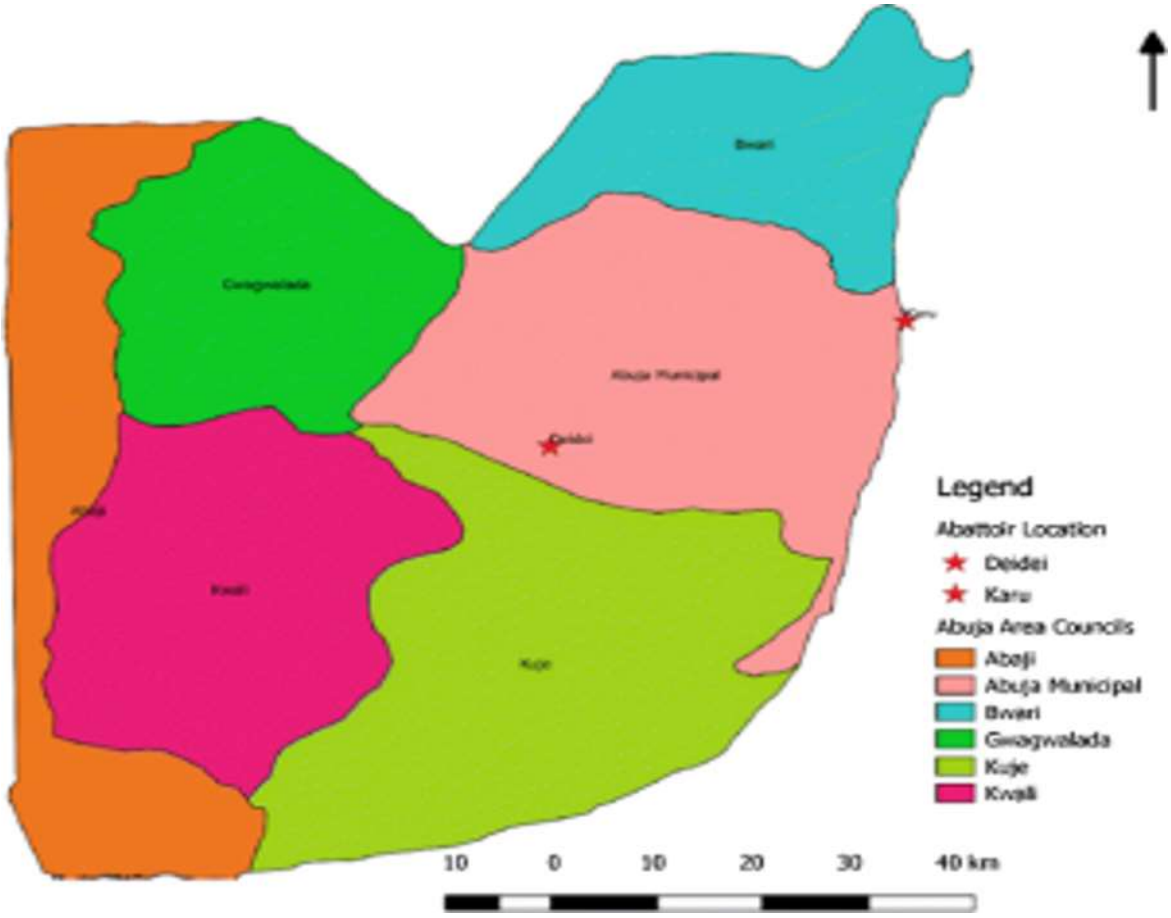

Figure 3.2: FCT showing Gwagwalada Area Council in Green Colour

3.2 Project/Process Description

The gas source for the CNG Compression Station comes from the AAKK Pipeline. The designed flow rate is 5000 Nm3/h, with an inlet gas pressure ranging from 5 to 6 MPa. The hydrogen sulfide content is no more than 15 mg/m3, and the total sulfur content is no more than 100 mg/m3. A control ball valve is installed on the pressure regulating and metering skid, which serves as the emergency shut-off valve for the inlet gas.

Inside the station, the gas pressure is regulated to about 4 to 4.5 MPa through the pressure regulating and metering skid, and then dried by a dehydration device. It is then reserved in a natural gas buffer tank with a volume of 5 m3 and subsequently compressed to 25 MPa by a compressor. (Three compressors are configured, each with a processing capacity of 2000 Nm3/h). The compressed natural gas is filled into CNG long tubes (CNG cascade storage group - sets), which are connected to a set of truck dispensers. A buffer recovery system is set up in this station.

The compressed gas is fed into a recovery tank with a volume of 2 m3, and the

recovered natural gas is returned to the inlet of the buffer tank and then enters the compression and pressurization process through the buffer tank. The exhaust gas and wastewater from the compressor recovery tank (V102) and the dryer buffer tank (V101) are collected in a sewage tank (V103) with a capacity of 1 m3. After gas-liquid separation, the liquid phase is regularly discharged through a water seal pool. The vent pipes at all levels of this station's system are centrally released in a graded manner.

The vent pipe outlets are at least 5 meters above the ground. The vent pipe outlets are set vertically upward along the columns of the process area canopy.

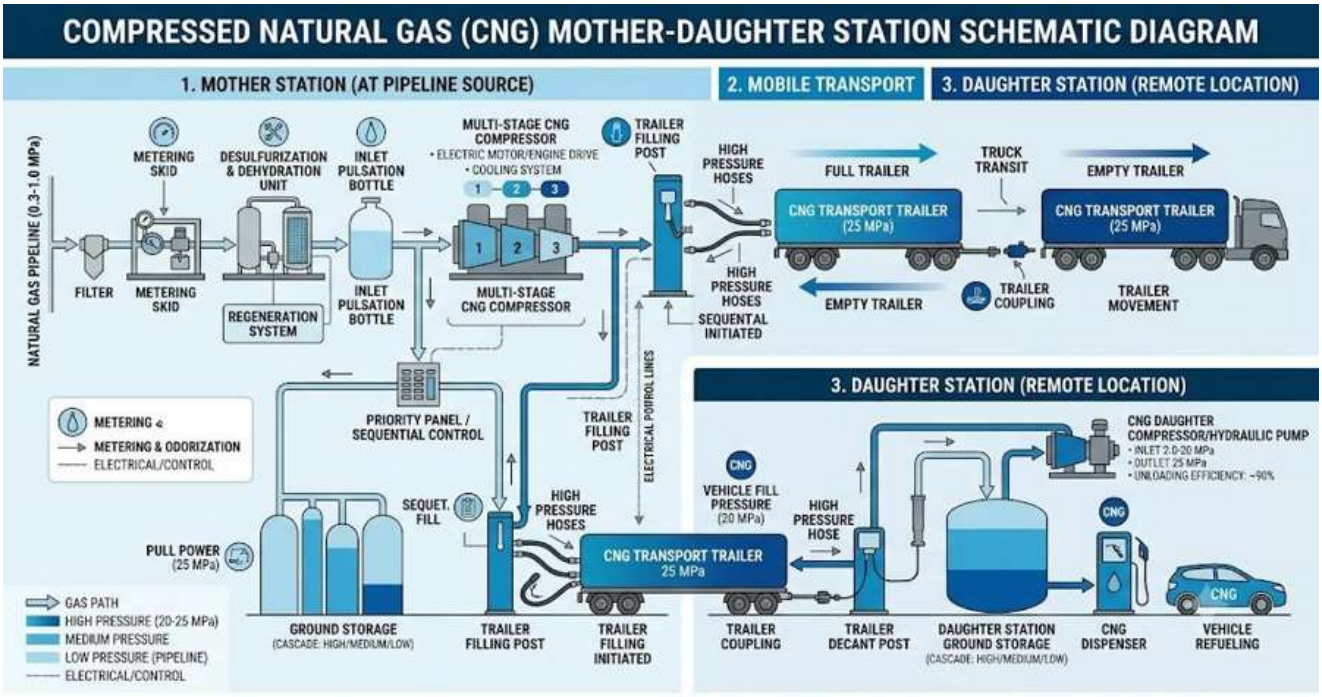

Fig 3.3: Process Flow Diagram for the CNG Mother Station Station Operations

Table 3.1: Key Equipment

Mother Station	Daughter Station
Gas filter/separator	Trailer unloading manifold
Fiscal metering skid	Priority panel
Gas dryer	Storage cascade
High-pressure compressor	Pressure regulating system
Cascade storage banks	CNG dispensers
Tube trailer filling skid	Emergency shutdown system
CNG dispensers	CNG dispensers

Plate 3.1: AAKK Gas Pipeline

3.3 Facilities Description

The proposed CNG Compression Station is an industrial energy facility comprising two integrated zones: a compression section and a retail section.

- **Gas Receiving Unit (GRU):** Receives natural gas from an upstream pipeline or gas supplier.
- **Compression System:** High-pressure compressors that raise gas pressure to CNG standards (typically 200–250 bar).
- **Cascade Storage System:** High-pressure storage cylinders arranged in banks for efficient loading and unloading.
- **Dispenser Units:** For direct vehicle fueling (if applicable) and for loading CNG into daughter-station transport modules.
- **Control Room & SCADA System:** For monitoring pressure, flow, safety systems, and operational parameters.
- **Fire & Safety Infrastructure:** Fire-suppression systems, gas detectors, emergency shutdown systems, and safety signage.
- **Ancillary Facilities:** Administrative building, workshop, security post, internal roads, drainage, and utilities.

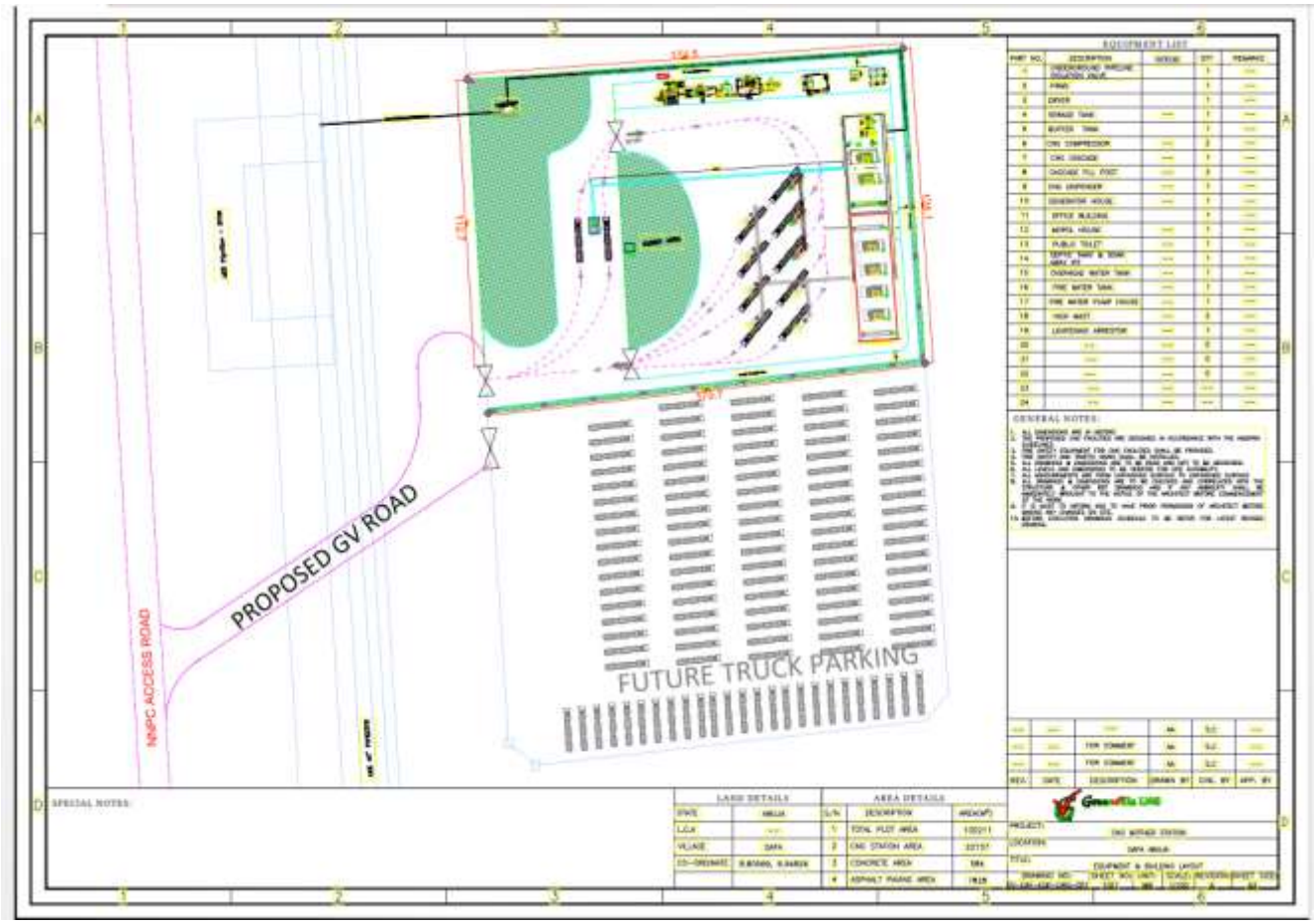

Figure 3.4: CNG Compression Station Facility Layout

3.4 Project Phases

3.4.1 Pre-Construction Activities

The activities in the pre-construction stage shall primarily be made up of:

- Concept development,
- Feasibility studies
- Site acquisition
- Site survey and geotechnical investigations
- Front-End Engineering Design,
- Environmental baseline studies
- Community engagement and stakeholder consultations
- Procurement of permits and approvals

All activities in this phase of project shall take into account environmental, technical

and economic considerations.

3.4.2 Construction Phase

The construction of the facility would involve:

- Topographic Surveys
- Soil Investigation Surveys
- Mobilization of equipment and labour
- Site clearing and grading
- Installation of facilities that shall be fitted within the storage terminal e.g., piping, valves, loading hoses/nozzles, and safety alarms.
- Construction and installation of an administrative block, etc.
- Installation of Installation of foundations, equipment, and storage systems
- Construction of buildings and utilities
- Provision of Parking spaces.
- Painting of facilities
- Erection of safety signs around the facility
- Designation of Muster Stations
- Testing and commissioning of mechanical and electrical systems

3.4.3 Operations Phase

The operational activities shall include the following:

- Continuous gas compression, storage, and distribution
- Routine maintenance of compressors, storage banks, and safety systems
- Monitoring of environmental and safety parameters
- Good housekeeping
- Engagement with host communities and regulatory agencies

3.4.4 Decommissioning Activities

- Removal of equipment and structures
- Site remediation and restoration
- Waste disposal in accordance with regulatory standards

Applying a contemporary view, it is expected that all operation streams shall be stopped and all facilities shall be put out of use and/ or dismantled. Furthermore, the facility shall most likely have to be utilized for a different purpose and the environment shall be restored to as close to its original state as possible, with the specific decommissioning plan to be drawn up following the prescribed decommissioning guidelines of by FMEnv.

3.4.5 Maintenance Activities

Periodic checks of the pipeline, valves, compressors and dispensers shall be carried out. All leaks and spills shall be reported to the safety personnel who shall recommend and take appropriate actions. In addition, security personnel shall man the facility round the clock. Informal inspections shall be done on a daily basis noting the overall facility condition however formal inspections shall be conducted on a monthly basis. Piping must be maintained in sound condition and hydrostatically tested yearly. Sagging and cracking pipes as well as rusting or rotten pipe supports shall be checked for routinely. Maintenance activities shall also include repainting pipes; and repairing and replacement of defective pipes and valves. The hydrant tanks shall be checked for peeling, blistering or chipping periodically. The storage tanks shall be emptied, cleaned and the inside examined for holes and corrosion. The nozzles shall be checked for any signs of leaks from the valves and they shall be checked to see if they can be completely turned on and turned off to stop product flow.

Record keeping is a key aspect of maintenance and this would be kept for inspections, maintenance activities, training and product inventory.

3.4.6 Health, Safety, Security and Environmental Issues - Construction Stage

- All personnel involved in the construction activities shall wear appropriate PPE's during work;
- Hearing protection devices shall be provided in areas of excessive noise pressures;
- Only authorized personnel shall be allowed into the construction site;
- Wastes shall be appropriately handled during the construction phase to protect the water resource and environment;
- The entire construction area shall be cordoned off using a tape that serves a dual purpose for security and safety;
- Strict access control shall be implemented at the facility;
- There shall be sufficient security to protect all workers as well as the site, with security agencies being deployed if necessary.

- A secondary security team made up of members of the community shall be used, if necessary, to foster a good relationship with the community and negate any form of local security threats.
- A competent security officer shall manage security affairs during construction and shall report directly to the Managing Director.

3.4.7 Health, Safety, Security and Environmental Issues - Operations Phase

- An HSE Officer shall be in charge of all HSE related matters.
- PPE's and safety signs shall be in place all over the facility.
- The facility shall be run with an integrated safety management system that shall cover health, safety, environment and quality. All the safety items and features required by the management system after Hazard identification and risk assessment shall be made available.
- Relevant industrial training for staff shall be carried out, including operational health, environmental awareness and basic safety training;
- Adequate attention shall be given to environmental pollution;
- The plan for security during facility operations shall include the use of a reputable security firm to provide a team of trained private security personnel;
- Security matters shall be implemented following an approved security plan. The plan shall include round the clock security, access control, surveillance, training, communication, community relationship, emergency response, drills, exercises etc. This plan shall be reviewed periodically for update.
- The Chief Security Officer shall be at the senior management level with direct line of reporting to the CEO.
- The facility shall be inspected regularly for general cleanliness
- The safety superintendent shall visually inspect generators feed tank, water reservoir valves, pipelines, flanges and loading arms for leaks, cracks, dents, corrosion, open/close position of valves and will record all observations appropriately.
- The fire hydrant system shall be inspected daily to ensure that it is ready for use. In addition, firefighting equipment shall be manned at all times by at least one well-trained fire staff.
- The Health and Safety department shall have a firefighting unit. The unit shall be made up of highly trained personnel. However, all work units within the facility shall have at least one staff trained in firefighting and designated "Unit Fire man" in addition to their primary duties. These men shall be effective in fire prevention efforts within their units, assisting the safety officers and act as first responders in

the case of a fire within their work areas;

- Fire drills shall be carried out half yearly for the entire staff of the factory. Situations may, however arise such as employment of new staff or introduction of new processes or equipment which may necessitate a fire drill before the set time;
- There shall be muster points for fire drills and safety signs also displayed at various locations of the facility to put all workers, contractors and visitors on alert.
- There shall be "no smoking" signs at smoking prohibited areas, in addition to danger and warning signs all around the facility

3.4.8 Health, Safety, Security and Environmental Issues - Decommissioning Stage

- All personnel involved in decommissioning activities shall wear appropriate PPE's during work
- Hearing protection devices shall be provided in areas of excessive noise pressures
- Only authorized personnel shall be allowed into the project area
- Wastes shall be appropriately handled by DSEPA during the decommissioning phase to protect the groundwater and the environment.

3.5 Emergency Response Procedures

Emergency Response Procedures during the project shall be in the areas of:

- Medical emergencies
- Fire Outbreaks
- Security
- Extended power losses
- Chemical/ Oil spills
- Water contamination

The response for medical emergencies shall be:

- Immediately contact emergency phone numbers of paramedics and health care facilities and notify them of the nature and location of the emergency;
- Not to move the victim unless absolutely necessary;
- Any trained personnel available will give CPR/ first aid to the victim/ injured personnel involved prior to the arrival of professional help. However, if no trained personnel are available, minor actions like stopping bleedings through the application of pressure on wounds as well as clearing victims' air passages can be initiated;

- In case of rendering assistance to personnel exposed to hazardous materials, the Material Safety Data Sheet (MSDS) will be consulted and appropriate personal protective equipment will be worn. In such cases, first aid will be attempted by ONLY trained and qualified personnel.

The response for fire outbreaks shall be:

- Activation of the nearest fire alarms;
- Notifying the Nigerian Fire Service/ FCT Fire Service;
- Getting all personnel within the facility to the muster points through the designated escape routes, but in the case of very large fires evacuating all personnel from the facility;
- Ensuring all personnel have evacuated the affected area;
- Getting trained firefighting personnel to combat the fire while awaiting the Nigerian Fire Service;
- Using the appropriate fire extinguishers for the various fire classes (viz Multipurpose Dry Chemical for Classes A, B, C and Dry powder for Class D;
- Regularly servicing the extinguishers for optimal performance
- Shutting down any processes and isolation of any materials that will escalate the fire, if it is safe to do so; and
- Ensuring all personnel remain at their designated muster stations until the competent authority decides it is safe to re-enter the affected area when the fire is out.

The response for security incidents shall be:

- Notifying the relevant security agencies particularly the Nigerian Police on the nature of the threat;
- Getting all personnel to take shelter to any threat that may pose danger to personnel, with all exterior doors locked;
- Encourage personnel to flee the facility if the threat is within and they are close to an exit;
- Encourage personnel to hide, turn off phones and lights, if personnel are facing a clear and present danger within the facility;
- Keep all doors locked in the building until law enforcement or security officers issue an official "all clear";
- Only the security personnel at the site will be allowed to combat the security threats.

The response for extended power losses shall be:

- Cease activities or operations that involve potentially hazardous conditions;
- Plug equipment needed during a prolonged power outage into emergency power outlets;
- Turn off equipment sensitive to power failure while unnecessary electrical equipment and appliances should be turned off in the event that power restoration would surge, causing damage to electronics and affecting sensitive equipment in the process;
- Use of alternative sources of lights like emergency lights or flashlights; but use of open flames will be avoided;
- Increasing natural lighting by opening windows to aid visibility;
- After power is restored, all equipment will be checked to make sure they have restarted properly; and
- Personal belongings must be secured.
- The response to chemical/ oil spills shall be:
- Immediate notification of the designated personnel and safety coordinator;
- Containing the spill with available equipment (e.g. pads, booms, absorbent powder etc.);
- Securing the area and alerting other site personnel;
- Preventing personnel from attempting to clean-up the spill unless trained to do so;
- Attending to injured personnel and calling in the medical team;
- Calling the registered spill clean-up company; and
- Notifying the necessary Government regulatory body/ agency.
- The response for water contamination shall be:
- Immediate notification of the designated personnel and safety coordinator;
- Notification of Local Authorities and the appropriate regulatory agencies;
- Notification of neighbouring communities and other water resource users;
- Providing alternative sources of water for use by personnel;
- Immediate removal of the source of contamination; and
- Conducting immediate water quality monitoring.

3.6 Waste Generation

According to the Basel Convention, wastes are substances or objects that are

disposed or are intended to be disposed of, or are required to be disposed of by the provisions of national laws. Wastes include any items that people no longer have any use for, which they either intend to get rid of, or have already discarded. In addition, wastes also include such items which are required by law to be discarded, because of their hazardous properties.

In the light of this, Greenville LNG Limited recognize the implications of the ineffective handling and final disposal of generated wastes. GVLNG intends to be practical, systematic and efficient in the handling of waste materials during the construction and operation phases at the petroleum products terminal.

As a result, a stand-alone Waste Management Plan will be developed to conform to the universal principles of minimize/reduce at source (waste generation); reuse (components); recycle (before disposal) and responsible disposal – the 4 Rs Principle.

The Waste Management Plan shall entail detailed strategies for conducting waste identification, waste collection/characterization, waste segregation, storage, tracking, treatment and disposal and the various strategies are highlighted in this section.

3.6.1 Waste Identification and Characterisation

Various forms of waste expected to be generated during the construction and operations phases have been identified. These wastes have been classified as solid, liquid and gaseous; they have also been categorized as hazardous and non-hazardous as well as biodegradable and non-biodegradable. The characterization of expected wastes from the project is shown in **Table 3.2**.

Table 3.2: Expected Wastes, Sources and Characterization of Wastes in the Various Project Phases

S/N	Wastes	Source(s)	Solid/ Liquid/ Gaseous	Hazardous/ Non-Hazardous	Biodegradable / Non-Biodegradable	Project Phases Associated with Wastes	
						Construction Stage	Operations Stage
1	Earth Fill	Excavation	Solid	Non-Hazardous	Non-Biodegradable	X	
2	Vegetation (Trees, tree stumps and thick branches)	Excavation and Site Clearing	Solid	Non-Hazardous	Biodegradable	X	
3	Construction Wastes/ Rubble	Unused and Broken aggregates, cement powder, concrete, grout, bricks and tiles	Solid	Non-Hazardous	Non-Biodegradable	X	
4	Steel Rods	Off-cuts of steel rods, steel plates	Solid	Non- Hazardous	Non-Biodegradable	X	
5	Scrap metal	Metal off-cuts, metal drums, rusted scaffolds and fabrication	Solid	Non-Hazardous	Non-Biodegradable	X	
6	Untreated Wood	Support boards, wood chippings and cuts, boxes and crates	Gaseous	Non-Hazardous	Biodegradable	X	
7	Gaseous Emissions	Generator diesel engines, heavy duty engines, storage tank vents, flash emissions, vehicular emissions	Solid	Hazardous	Non-Biodegradable	X	X
8	Dust	Excavation, site clearing, Dust present in the ambient air	Liquid	Non-Hazardous	Non-Biodegradable	X	
9	Spent/ Spilled hydraulic and lubricating Oil	Generators, BRV's, pumps	Liquid	Hazardous	Non-Biodegradable	X	X
10	Used/ Spent Oil	Generators, machinery and Big Road Vehicles (BRV's)	Liquid	Hazardous	Non-Biodegradable	X	X
11	Oil Spills	Pipeline leakages;	Solid	Hazardous	Biodegradable		X
12	Oil Filters	Maintenance of Engines and pumps	Solid	Hazardous	Non-Biodegradable		X
13	Oily Rags/ Absorbents	Clean up of oily surfaces and equipment	Solid	Hazardous / Non-Hazardous	Non-Biodegradable	X	X
14	Lead –Acid Batteries	Used Lead-acid batteries	Liquid	Hazardous	Non-Biodegradable		X
15	Run-off Water	Precipitation into drainage channels and indiscriminate surface run-off during construction	Liquid	Hazardous / Non-Hazardous	Non-Biodegradable	X	X
16	Paints	Spilled or residual paints in	Solid	Hazardous/	Non-Biodegradable	X	X

		containers		Non-Hazardous			
17	Nails	Unwanted or damaged nails	Solid	Non-Hazardous	Non-Biodegradable	X	
18	Bulbs/ tubes	Damaged or destroyed bulbs from illuminated areas	Solid	Hazardous	Non-Biodegradable	X	X
19	Treated Wood	Unused, Damaged or destroyed finished wood products such as office furniture etc.	Solid	Hazardous / Non-Hazardous	Biodegradable		X
20	Plastic	Packaging materials, damaged plastic materials and containers, PVC pipes and plumbing fittings	Solid	Non-Hazardous	Non-Biodegradable	X	X
21	Glass	Bottles and jars, ceramics, broken windows	Solid	Non-Hazardous	Non-Biodegradable	X	X
22	Paper and cardboard	Packaging, newspapers, computer prints, domestic sources, office documents,	Solid	Non-Hazardous	Non-Biodegradable	X	X
23	Metal drums and tins	Packaging for chemicals, paints, varnishes etc	Solid/ Liquid	Hazardous / Non-Hazardous	Non-Biodegradable	X	X
24	Food and Beverage	Personnel food consumption	Solid/ Liquid	Non-Hazardous	Biodegradable	X	X
25	Sanitary Wastes/ Sewage	Urinals, Water Closet, sinks, showers and laundry	Solid	Non-Hazardous	Biodegradable		X
26	Agricultural/ Plant Waste	Pruning of plants, Excavated plant / agricultural material or dead or decayed plant material	Solid	Non-Hazardous	Biodegradable	X	
27	Electrical Waste and E-Waste	Unused or damaged electric wires; off cuts of electric wires, Old computer systems, flash drives, CD's, Digital scanning equipment		Hazardous	Non-Biodegradable	X	X

3.6.2 Construction Wastes

During construction, the main type of wastes are rubble, concrete-based masonry, blocks and tiles. Others envisaged wastes include earth fill, tree and tree stumps, wooden planks, packaging material, waste oils, spent diesel, oily rags, steel rods, plastic, glass, plumbing off-cuts and electric wiring. Dust and gaseous emissions shall be released into the ambient air. Exposure to dust in construction sites shall come from material stockpiles and unpaved surfaces or excavation operations, while sources of gaseous emissions shall be from earth moving equipment and diesel generators.

Reusable wastes shall be recycled on-site, so as to reduce the collection, transportation and disposal and any associated charges from handling.

3.6.3 Operations Waste

Operational wastes shall include: packaging materials, paper and plastic materials accumulated from consumables and deliveries. The primary sources of such materials shall be mainly from maintenance works during operations.

Wastes shall be accumulated in suitable receptacles which shall be placed in appropriate areas throughout the facilities where these wastes are generated.

Metals and plastic containers shall be used for a wide range of lubricants and chemicals, while drums and containers shall inevitably contain variable quantities of residues. These wastes and other solid wastes shall be cleared, properly packaged and disposed of at designated disposal locations. GVLNG shall also seek opportunity for waste minimization through the use of the "reduce, reuse and recycle / recover" philosophy.

Treated wood waste shall be generated from office furniture that are no longer used or needed and they shall be sold for reuse at other locations or sent to an offsite facility for treatment (if hazardous) prior to final disposal.

Oily rags are envisaged to be generated from cleaning oily surfaces (lubricating oils), fuels, paints or other solvents. Oily rags used in cleaning hazardous substances (if any) shall be stored in air-tight, non-combustible containers and sent to AEPB or any FMEnv/NMDPRA approved disposal facility.

Lead-acid batteries from generators and automobiles shall be replaced regularly during the operational phase of the project. Lead-acid batteries contain large quantities of lead and sulphuric acid. Once the lead plates begin to wear and the acid weakens, they will need to be changed and disposed-of, and these wastes shall then be sent for recycling for its valuable components or to a lead-acid battery vendor.

3.6.4 Decommissioning Waste

A broad range of wastes shall be generated during decommissioning. These could range from demolition waste/ rubble from any structures that shall be brought down, earth fill and plant wastes that would be generated from any excavations being carried out, in addition to scrap metals, wood, plastic, glass, metal drums, paper and bulbs. Steel plates from the storage tanks and other structures shall be removed and re-used/ recycled if practical. Spent oil/fuel could be generated from the earth moving equipment used during decommissioning operations. Dust and gaseous emissions is envisaged to be generated from the earth moving equipment used.

3.6.5 Waste Segregation

An integral part of the Waste Management Programme is waste segregation which prevents the disposal of hazardous waste with non-hazardous wastes, and also ensures re-use of recyclable wastes. During construction, wastes shall be segregated as inert construction waste, non-inert construction waste, chemical waste and general refuse; while during operations, the wastes shall be further segregated into general wastes, food waste, effluents, oil/ chemical spills, glass, paper, plastic waste, tins and drums, e-waste and electrical wastes etc. and stored in separate colour-coded bins.

3.6.6 Waste Storage

All wastes shall be handled and stored in a manner which ensures they are held securely without loss or leakage to minimize the potential pollution. Portable containers shall be used to accumulate and hold solid wastes prior to disposal by appropriate vendors. While, sanitary wastes shall be routed to a septic tank, and be removed by accredited waste managers.

3.6.7 Waste Tracking

To ensure that all wastes collected from the proposed CNG Mother/Daughter Station are disposed of appropriately, a Waste Consignment Note (WCN) shall accompany all waste transfers.

The WCN shall contain the description and the quantity of waste, as well as the disposal facility. The materials handler shall prepare a WCN for each transport, and shall include the Materials Safety Data Sheet (MSDS) for any hazardous wastes.

3.6.8 Waste Disposal

The individual waste streams collected from the proposed project across all project phases shall be managed or disposed of in varying manners, with the frequency of disposal individually tailored to the characteristics of each individual waste stream. For example, general refuse generated on-site during construction shall be

disposed-off by a waste vendor on a daily or every other day, to minimize potential odour impacts; minimize the presence of pests and other scavengers, and prevent unsightly accumulation of waste.

Due to the nature and scale of activities associated with the proposed project, GVLNG shall engage a waste vendor for handling the facilities waste streams to ensure a more effective and sustainable management of generated wastes. **Tables 3.3** and **3.4** shows the waste disposal, treatment and management options for the project.

Table 3.3: Construction Waste Streams

Wastes	Disposal/ Treatment
Earth Fill	• Reuse a portion on-site as backfill material for foundations as well as for landscaping • Any good quality fill can be transported for reuse at other locations • Surplus material to be collected and transported to an off-site disposal facility
Vegetation (Trees, tree stumps and thick branches)	• Trees and tree stumps to be cut into logs and sold for timber for various uses including fuel/ charcoal • Leaves and small branches to be transported for composting at an off-site facility
Construction Wastes/ Rubble	• Wastes to be reduced by purchase control of construction materials and prevention of excessive concrete mixing • Proper storage will minimize the damage or contamination of construction materials • Construction rubble will be reused as much as possible within the project • Waste that cannot be reused will be collected and transported to landfill
Steel Rods/ Steep Plates	• Waste volumes will be reduced by purchase control of steel materials • As much steel as possible will be reused on-site • Unused steel materials will be collected and reused offsite • Damaged/ broken steel rods/ plates will be gathered and sent to a metal scrap yard for recycling
Scrap metal	• Waste volumes to be reduced by purchase control of metals/ metal containing materials • Scrap metal will be collected and sent for recycling
Wood	• Wood will be reused if practical • Unused wood waste will be collected and transported to recycling or disposal facility
Gaseous Emissions	• Emissions will be minimized through strict equipment maintenance programs • Total hours of operation of equipment will be optimized • Low sulphur, clean burning diesel will be used

Spent/ Spilled hydraulic and lubricating Oil	• Planning and good housekeeping practices to be employed to minimize surplus and contamination Surplus chemicals may be usable in other locations or returned to vendors, if possible
Used/ Spilt Diesel or Fuel	• Fuel wastes generated will be reduced through purchase control of fuels • Spills and leakage to be avoided by improved housekeeping, maintenance and transport procedures (like use of secondary containment and proper decanting system for petrol/diesel from damaged drums or vessels.)
Oily Rags	• The potency for fires will be reduced by storing in air-tight containers • Used oil rags employed to clean hazardous substances will be collected and transported to waste disposal facility
Run-off Water	• Contamination of the runoff water to be avoided as much as possible as the groundwater is prone to contamination in the construction phase. • Thought will be given to the segregation of drainage from oil, fuel and chemical storage areas from the rest of the site.
Paints	• Residual Paints will be reused where it is feasible • Old and poor-quality paints will be hardened and disposed to landfill (with the exception of oil paints) • Residual oil paints will be collected and transport to disposal facility • Unused paints to be returned to vendors
Nails, screws, bolts and nuts	• Waste quantities to be reduced through purchase control • Nails, screws bolts and nuts to be reused if practical • Damaged nails will be collected for recycling at a metal scrap yard
Bulbs/ tubes	• Damaged bulbs to be collected and transported to disposal facility
Plastic	• Plastic containers or bottles to be reused for various purposes if safe to do so • Plastic containers/ plastic materials no longer needed, will be collected and sent for recycling
Glass	• Waste glass will be collected and transported to a disposal facility
Paper and Cardboard	• Will be collected and sent for recycling
Metal drums and tins	• Bulk transport and storage for high volume consumption items to reduce the number of waste drums and tins generated. • These containers will be refilled and reused where possible • Non-refillable containers will be returned to vendors for reuse or to a company specializing in container refurbishment.
Food and Beverage	• Food wastes to be used as animal feed • Food and beverage wastes to be collected by a waste disposal vendor
Sanitary Wastes/ Sewage	• Sanitary waste to be collected and treated in a septic tank

Agricultural/ Plant Waste	• To be collected for composting
Electrical Waste	• Electrical wastes will be collected and transported for recycling to recover valuable materials including copper/ other conducting metal as well as rubber.

Table 3.4: Operations Waste Streams

Wastes	Disposal/ Treatment
Scrap metal	• Scrap metal to be gathered and sent for recycling at a metal scrap yard
Wood	• Wood waste will be collected and transported to recycling or disposal facility
Gaseous Emissions	• Emissions will be minimized through strict equipment maintenance programs • Total hours of operation of equipment will be optimized Low sulphur clean burning diesel will be used
Spent/ Spilled hydraulic and lubricating Oil	Planning and good housekeeping practices to be employed to minimize surplus and contamination
Used/ Spent Oil	• Fuel wastes generated will be reduced through purchase control of fuels • Spills and leakage to be avoided by improved housekeeping, maintenance and transport procedures (like use of secondary containment and proper decanting system for petrol/diesel from damaged drums or vessels.) Spent oil to be discharged into sump pit and recycled
Oil Spills	• Planning and good housekeeping practices to be employed to minimize oil spills • Absorbed where possible, booms will also be used (if on water), absorbent, and then collected before injecting into a waiting vessel for reprocessing
Oil Filters	• Old oil filters to be collected and transported to disposal facility to recover used oil and steel components for recycling
Oily Rags	• The potency for fires will be reduced by storing in air-tight containers • Rags containing oil and grease will be laundered, dried and reused • Used oil rags employed to clean hazardous substances will be collected and transported to disposal facility
Lead-Acid Batteries	• Batteries to be collected and transported and sent to a recycling facility or lead acid battery vendors
Run-off Water	• Contamination of the surface drainage water to be avoided as this is considerably easier than any subsequent treatment. • Thought will be given to the segregation of drainage from oil, fuel and chemical storage areas; loading/unloading areas; • and production operations areas from the rest of the facility.
Paints	• Any leftover paints will be reused when required • Old and poor-quality paints will be hardened and disposed to

	landfill (with the exception of oil paints) • Residual oil paints will be collected and transported to disposal facility
Nails, screws, bolts and nuts	• Waste quantities to be reduced through purchase control • Nails, screws bolts and nuts to be stored for reuse during maintenance • Damaged nails will be collected for recycling at a metal scrap yard
Bulbs/ tubes	• Wastes can be reduced by purchasing LED/ energy saving bulbs as substitutes • Old bulbs to be collected and transported to disposal facility
Treated Wood	• Will be collected to be reused at another facility or recycled • Wasted treated wood will be collected and transported for treatment and disposal
Plastic	• Plastic containers or bottles for various purposes will be reused if safe to do so • Plastic containers/ plastic materials no longer needed will be collected and sent for recycling
Glass	• Waste glass will be collected and transported to a disposal facility
Paper and Cardboard	• Will be collected and sent for recycling
Metal drums and tins	• Bulk transport and storage will be used for high volume consumption items. • Containers will be refilled and reused where possible, • Non-refillable containers will be returned to the vendor for reuse or to a company specializing in container refurbishment.
Food and Beverage	• Food wastes to be used as animal feed • Food and beverage wastes to be collected by a waste disposal vendor
Sanitary Wastes/ Sewage	Sanitary waste to be collected and treated in a septic tank
Agricultural/ Plant Waste	To be collected for composting
Electrical Waste and E-waste	• Electrical and E-wastes will be collected and transported for recycling to recover valuable materials including copper/ other conducting metal as well as rubber/ plastics
Process Wastewater/ Effluent	• Treated in skimmer pit before disposal

3.7 Traffic Management

GVLNG's Traffic Management Plan is essential for maintaining optimal traffic flow and taking into account worst-case scenarios, especially during operations. The plan contains the mandatory minimum requirements for traffic management during the various project phases and separate Traffic Management Plans shall be designed for the construction and operations phases. Accidents carry a risk of loss of life, property, money; products, or damage to equipment. The traffic

management plan shall aim to:

- Identify, assess and control the risks associated with traffic hazards
- Eliminate traffic hazards where reasonably practical;
- Adopt adequate traffic management planning where operations/ work force causes changes to the flow of either pedestrian, vehicular or mobile plant traffic

The key features of the Traffic Management Plan include:

- Vehicle Routes
- Signage
- Facility Protection
- Safe Crossings and Pedestrian Zones
- Training and Review

3.7.1 Vehicle Routes

Vehicle routes shall be designated within the premises during the different project phases and there shall be specified vehicle lanes for road tankers and smaller vehicles during project operations. Parking areas will be provided separately for trailers and cars, and these will be clearly marked. Stopping and non-stopping areas shall also be specified in addition to haul and loading/ unloading routes for supplies and materials. In a bid to keep optimal traffic flow, there shall be separate entry and exit points especially in the operational phase where the route surface will be made of well-drained material such as bitumen or concrete in order increase grip and prevent slippage.

The route surfaces shall always be kept free of hazards such as oil, slippery substances, potholes or other surface damage as these hazards affect stopping distances, maximum speeds and cause vehicle wear. Excessively steep gradients shall be avoided as much as possible, as they will create instability in vehicular movements within the facility.

The lane widths are crucial and shall have buffer zones slightly larger than the widest load of the largest vehicles thus reducing the risk of accidents and collisions. The roads widths shall be designed to permit easy maneuvering of vehicles, with corner radii to suit the turning circle of the largest vehicle expected (i.e., fire trucks, road tankers or any specialist vehicles carrying special loads).

3.7.2 Signage

Signage is an integral part of the Traffic Management Plan as it guides drivers and pedestrians on appropriate movement around the facility. Reflective markers and lines and easy to read signs will alert all vehicles and pedestrian users to things of

importance. It will be ensured that all signs will need to be legible at maximum speeds and they will be placed far above eye level. Clear signage will be used to alert drivers to:

- Exclusion zones
- Parking/no parking zones
- Speed limits
- Pedestrian crossings
- Vehicle crossings
- Blind corners
- Steep gradients
- Overhead hazards (e.g., powerlines) specifying maximum vehicle clearance heights
- Poor or changed traffic conditions
- Sharp or blind corners
- Other known hazards

3.7.3 Facility Protection

Areas within the proposed facility having vulnerability and susceptible to wear will be subject to protection. Protective items like bollards will be useful in protecting important parts of the facility and to also alert pedestrians to dangerous zones and prevent them from walking into oncoming traffic. In addition to bollards, guardrails will be used in certain areas to protect pedestrians from traffic.

To reduce wear on the structural features of the facility, bump rails or rub rails, may be used to extend the life of key facility structures. These protective measures will extend the life of the facility and they will be put in place to minimize the possibility of accidents.

3.7.4 Safe Crossings and Pedestrian Zones

Pedestrian zones shall be clearly demarcated and physically separated so that vehicles cannot encroach. Where it is not possible to physically separate pedestrian and vehicle zones, alternative options such as vision panels in doors, mirrors for pedestrian and vehicle use will be applied. Natural pedestrian routes and clearly marked footpaths will be made obvious to both the people walking them and the vehicles.

Barriers will be used not just to stop traffic but also to remind pedestrians of entrances and exits when moving around the facility. Should pedestrians need to cross vehicle routes, protection through the use of physical barriers with inward opening gates,

gates with warning devices and the use of traffic light systems will all be contemplated. These control measures will also be combined with clearly visible ground markings, lights and signs.

3.7.5 Training and Review

Every person who enters the facility shall be made to understand the Traffic Management Plan during induction tarining. They will be made aware of designated safe routes, no-go zones and speed limits which will be done through an induction process. A supervisor will be provided for visitors to ensure their safety and protection when navigating around the facility. Training is a critical element and many types of vehicles require operators to have high risk work licences.

A review of the Traffic management Plan will be done periodically to assess whether all strategies have been effective and how they could be improved. This will ensure that the Traffic Management Plan keeps up with the advancements offered by new technology, new procedures and staff experience.

3.7.6 Responsibilities and Duties

The CEO of GVLNG is ultimately responsible for all safety, health and environmental issues in the company, including the provision of adequate human and material resources for effective implementation of the company's Spill Prevention and Countermeasures plan. The general manager (operations) has the overall authority and responsibility in the management of all activities related to control, and effective combating of any oil spill in the company's operations. The commercial manager's primary responsibility is to ensure that the Facility/ Plant Manager and the Marine Manager are fully equipped to handle emergency situations in their respective business units; while the HSE Manager ensures that oil spill response operations are carried out in accordance with company HSE Policy and Procedures, relevant laws and regulations.

The Facility Manager shall be the on-scene commander in the event of an oil spill occurring at the proposed CNG Compression Station.

The transportation or logistics manager shall be responsible for providing facilities, services and materials in sufficient quantities to support oil spill incident response; with the clean-up coordinator being responsible for co-ordinating oil spill clean-up on land by determining resource needs; mobilizing clean-up personnel for oil spill response in addition to delegating various assignments as deemed fit to the response team/personnel assigned to deal with any oil spill incident.

3.7.7 Spill Risk Analysis

The proposed project will be evaluated to determine where there is reasonable potential for equipment failure, which would result in a potential release of oil to the environment. This will involve the predetermination of potential sources of oil

spillages, analysis of oil spill scenarios, resources at risk and potential damage to the resources. Spill risk analysis based on knowledge of the facility operations shows that the major risks are associated with:

i. Pipeline corrosion/rupture
ii. Malfunctioning of valves/nozzles
iii. Loading Failure
iv. Road Tankers accident/overfill
v. Fire/Explosion.

3.7.8 Spill Prevention Mechanisms

The proposed CNG Mother/Daughter Station shall contain the following at vulnerable areas:

- Curbing; culverts, gutters or other drainage systems;
- Storage sheds with built-in containment
- Weirs, booms or other barriers;

3.7.9 Equipment and Materials for Spill Response and Clean-up

The equipment and materials that will be stockpiled at the facility for Tier-1 Spill response include:

Response Equipment

- Response vehicle fitted with spark arresters.
- Waste oil storage tanks and drums of various capacities
- Caution signals and Reflecting Tapes
- Pick-up trucks with spark arresters.

Clean-up Equipment

- Hot water cleaner
- Sorbent Pillows
- Sorbent sheets
- Non-spark Shovels/Rakes
- Sorbent booms
- Vacuum truck and hoses
- Containment boom
- Storage containers of various sizes.
- Buckets

- Fire mains water portable air pumps
- Sand

Personnel Protective Equipment

- Rubber boots
- Rubber Gloves
- Face Visors/goggles
- Waterproof suits/coveralls
- Respirators
- Hazardous Vapour defector
- Stock of soap detergent for degreasing/deoiling of concreted areas, vessel/decks and general cleaning purposes.
- Hard hats

Contact Persons and Agencies

Spills at the proposed facility shall be under the jurisdiction of the Abuja Environment Protection Board (AEPB) and the National Oil Spill Detection and Response Agency (NOSDRA). In addition, some key personnel of GVLNG Limited will be designated as being responsible for oil spill prevention at the facility. Their names, roles and responsibility and contacts will be contained in the Spill Prevention, Control and Countermeasures plan at the start of operations.

CHAPTER FOUR: DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 The Study Approach

Environmental baseline study of the Compressed Natural Gas (CNG) Mother/Daughter Station in Izom Community, Gwagwalada Area Council, Abuja-FCT is undertaken in order to establish the situation of the physical, biological, social and health environment of the study area prior to the commencement of the project development. This serves as baseline or benchmark to assess and monitor the impacts of the proposed CNG Station at Abuja-FCT.

Consequently, upon completion of the environmental baseline study, the results generated would serve as a benchmark against which any potential beneficial or non- beneficial impact of the proposed project on the environment and socio-economics of the project area would be identified and assessed.

The main environmental components considered in the environmental baseline study include:

- **Physical components**: soil, surface/ground water resources, water/air quality and climatology;
- **Biological environment**, which includes: flora, (i.e trees, grasses, forest, fauna i.e, fish, Mega fauna, birds, mammal), threatened, and/or endangered species (plant/animals), species diversity, overall ecosystem stability etc.
- **Cultural** and **socio-economic components**: pollution trends, distribution of socio-economic resources indicative of human welfare, i.e. educational system, transportation/land use networks, and other infrastructures like water supply, waste water/domestic disposal, solid waste management, public services, fire protection, medical facilities and health impacts.

An integrated approach was adopted in presenting the multidisciplinary results of the baseline studies. The environmental baseline studies conducted were grouped under five main categories viz:

Physico-Chemical Environment Studies

- Climate and Meteorology
- Land Use
- Air Quality and Noise Level
- Water quality – surface and underground water
- Soil Studies
- Aquatic Studies

Biological Environment studies

- Flora and Fauna
- Soil and Water Microbiology
- Hydrobiology and Fishery including benthos

Socio-Economic studies

- Corporate Social Responsibility of Greenville LNG to the host community
- Educational, Socio and cultural setting in the study area

Health Status

- Health infrastructure and human health disease patterns.

Waste Management Analysis

4.2 Environmental Baseline Data Acquisition Methods

The acquisition of data basically involved field data gathering, measurements and the collection of representative samples used to establish the environmental conditions of the study area. This exercise involved a multi-disciplinary approach and was executed within the framework of a QHSE Management System approach. This approach assured that the required data and samples were collected in accordance with agreed requirements (scientific and regulatory) using the best available equipment, materials and personnel. Elements of this approach include:

- Review of existing reports that contain environmental information on the study area;
- Designing and development of field sampling strategies to meet work scope and regulatory requirements;
- Pre-mobilization activities (assembling of field team, sampling equipment/materials calibrations/checks, review of work plan and schedule with team, and job hazard analysis);
- Mobilization to field;
- Fieldwork implementation - sample collection (including positioning and field observations), handling, documentation and storage protocols and procedures;
- Demobilization from field; and
- Transfer of sample custody to the laboratory for analyses.

The following sections present the field data gathering methodology/procedures and the descriptions of the environmental baseline conditions of the study area. The detailed documentation of the fieldwork execution including descriptions of the laboratory analytical methods and procedures, the detection limits for the various parameters analyzed as well as an overview of the general QHSE plan adopted for field data gathering and laboratory analysis is presented.

4.2.1 Desktop Studies

Desktop studies involved the acquisition of relevant background information on the environment of the study area. Materials that were consulted included approved reports on previous environmental surveys in the area, publications, textbooks, articles, maps, etc. on the area and similar environments. The list of materials consulted is specified in relevant sections. Specific documents consulted are given in their respective sections.

4.2.2 Field Sampling

The data gathering exercise was undertaken between 16th to 17th June, 2026 for the proposed, Projects at Izom Community, Gwagwalada Area Council, Abuja-FCT. The specific objectives of the field sampling were to:

- Determine the ambient air quality and noise level of the study area;
- Determine the physico-chemical and biological characterization of groundwater and surface water of the study area;
- Establish the socio-economic and health status of the host and impacted communities.

The exercise involved in-situ measurement of salinity, temperature and pH. Samples were taken at defined sample points using bottle sampler for water quality determinants. These were stored and preserved as appropriate for each analysis. Water samples were collected for laboratory analyses using

- 2-litre plastic bottle for groundwater samples for physicochemical analysis;
- 1-litre plastic bottle for groundwater samples for microbiological analysis;
- 1-litre glass bottle with Teflon seal cap for groundwater samples to be analysed for hydrocarbon content (oil and grease, etc.).

4.2.3 Field Studies and Sampling Design

Sampling was designed to comprehensively capture all the ecological and socio-economic components peculiar to the study area. Design of field activities was made prior to mobilization. This was aided by information obtained during reconnaissance survey of the project area.

Sampling locations were decided as waypoints in Geographic Position System (GPS) and later plotted in a sampling map used during the field studies. Locations for biophysical sampling considered ecological types around the project areas, vulnerable environmental attributes with regards to the potential and associated impacts of the environment and control or buffer zones. Socio economic and health impact studies on the other hand, considered human habitations, infrastructure, cultural heritage sites and prevailing health conditions of people within the sphere of influence to the project area. The spatial location maps of the sampled points are presented in the respective component sections.

The Quality Assurance/Quality Control (QA/QC) procedures were implemented during sample collection, labeling, analyses and data verification. Chain of custody procedures including sample handling, transportation, logging and crosschecking in the laboratory were also implemented.

4.2.4 Desktop Studies

Desktop studies were undertaken to acquire information on climate and atmospheric conditions, geology, soil, vegetation, socio-economics, and other environmental components of the proposed project expansion catchment area. In addition, materials reviewed include Internet sources, textbooks, reports, survey maps, aerial photographs, and articles in local and other international journals. These serve as secondary data for the environmental database for the EIA studies. Observations and results of laboratory analysis of samples collected on the field serve as primary sources of data.

4.2.5 Fieldwork Activities/Laboratory Analysis

Fieldwork activities/Laboratory analyses were carried out to complement secondary data gathered from literature and to collect new and additional primary data to fill information gaps. The activities were carried out in accordance with FMEnv and recommended international methods. The laboratory analyses of the samples collected were carried out at **Kano State Ministry of Environment Laboratory at Tarauni, Kano State.**

Plate 4.1: FMEnv Representative with the Lab Staff.

4.2.6 Field Data

Environmental Field data is gathered or collected during field exercises, gives a real time description of the state of that specific environment, at a particular time. Field data helps in **quantitatively** & **qualitatively** describing the state of the project site which has been selected for the study. The analysis of environmental field data is a particularly complicated task, owing to the fact that the potential sources of impacts recorded at a site, might be diverse, and of which they might not all be traceable to a single project. Therefore, due diligence must be done to ensure the integrity of environmental data analysis.

In subsequent sections, the field data gathered/collected/generated during the EIA baseline study are in line with the FMEnv EIA guidelines.

Table 4.1: Sample Matrix

S/N	Environmental component	Sampling points or Stations
1	Ground Water	2 + 1 Control
3	Surface Water	2 + 2 Control (where applicable)
4	Sediment	2 + 2 Control (where applicable)
5	Vegetation	
6	Soil	28 + 2 Controls
7	Ambient Air Quality	28 + 2 Controls
8	Socio-economic and Health	

4.2.6.1 Field Surveys

The field sampling was carried out for this study in line with the FMEnv/NUPRC - approved ToR. Sampling and observations for air quality and noise, soil, surface water/sediments, groundwater, vegetation, and wildlife were carried out during fieldwork. The socio-economic survey was obtained through consultation with the project community, which is within 2.5km radius of the proposed project site, and administration of questionnaire through stratified random sampling was done. Sample collection and handling procedures to maintain the integrity of samples and enhance quality of the results, were in accordance with international standards and with particular reference to FMEnv/NUPRC guidelines and standards. This was followed by detailed ecological sampling and laboratory analysis of samples.

All biophysical sampling and observation points were geo-referenced using Garmin eTrex 22x, Rugged Handled GPS Navigator, Garmin eTrex 10, and Worldwide

Handheld GPS Navigator. The sample positions are also shown on the map of the project site. Quality assurance was applied to all aspects of the study including sample collection, handling, laboratory analysis, data coding, statistical analysis, presentation and communication of results.

4.2.6.2 Quality Assurance

All equipment and materials and their calibration certificates were inspected and certified by the regulator before the commencement of the field sampling. The methodology and procedures for sample collection, storage/handling and analysis were such that integrity was assured. To ensure the accuracy and reliability of in-situ field measurements, field instruments were calibrated prior to use and cross-checked from time to time. Sampling points were properly geo-referenced. Field portable pH meter was calibrated using pH4, pH7 and pH9 buffer solutions. The conductivity and dissolved solids meter were checked against solutions of known conductivity and dissolved solids provided by the manufacturers.

All sample containers for water sample collection were rinsed with the water being sampled before putting the sample into the containers. Amber bottles were used for BOD_5 samples while sterile vials were used for all microbiology samples. Plain glass bottles were used to collect water samples for THC. Soil samples for physio-chemical analysis were collected in appropriately labelled and sealed polythene bags in accordance with the quality assurance criteria as contained in the Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN, 2018 Revised) (Part (VIII) D (2) (Sampling & Handling of Samples)). Aluminium foils were used for soil samples for THC. Ice-chests were used to preserve samples in the field before transportation to the laboratory for analysis.

All parameters were analysed within their shelf life. Chain of custody procedures including sample handling, transportation, logging and cross-checking in the laboratory were also implemented. The samples were preserved in an ice chest during transportation to the laboratory.

4.2.6.3 Data Analysis

Standard data spreadsheets were used for recording and transmitting analytical results. Processing/calculation of results was done following written standard operating procedures. Final results were issued only after a general QA/QC check and validation had been done.

Table 4.2: Summary of Laboratory Methods

Sample Matrix	Parameter	Test Method	Test Equipment
Water	pH	APHA 4500H+B	HANNA HI 93414 in situ meter

Sample Matrix	Parameter	Test Method	Test Equipment
Water	Temperature (°C)	APHA 2550B	HANNA HI 93414 in situ meter
Water	Chloride	APHA 4500 Cl^-	Titration
Water	Nitrate	EPA 352.1	UV/Visible light spectrophotometer
Water	Sulphate	APHA 4500-SO_4^{2-}-E	UV/Visible light spectrophotometer
Water	Magnesium	APHA 3111B/ASTM D 3561	FAAS
Water	Potassium	APHA 3111B/ASTM D 3561	FAAS
Water	Sodium	APHA 3111B/ASTM D 3561	FAAS
Water	Calcium	APHA 3111D	FAAS
Water	Cadmium	APHA 3111B	FAAS
Water	Total Chromium	APHA 3111C	FAAS
Water	Copper	APHA 3111B	FAAS
Water	Phosphate	APHA 4500 PD	UV/Visible light spectrophotometer
Water	Total Iron	APHA 3111B	FAAS
Water	Lead	APHA 3111B	FAAS
Water	Nickel	APHA 3111B	FAAS
Water	Zinc	APHA 3111B	FAAS
Water	Manganese	APHA 3111B	FAAS
Water	Salinity	APHA 2520	HANNA HI 93414 in situ meter
Water	DO	APHA 4500-OG	HANNA HI 93414 in situ meter
Water	Turbidity	APHA 2130B	HANNA HI 93414 in situ meter
Water	TOC	BS 1377	Titration
Water	TDS	APHA 2510A	HANNA HI 93414 in situ meter
Water	TSS	APHA 2540D	Gravimetry
Water	BOD_5	APHA 5220D	WTW Oxitop
Water	COD	APHA 5220D	Titration
Water	Total Hardness	APHA 2340C	Titration
Water	Oil & Grease	ASTM D 3921	FTIR
Water	Microbiology	ASTM D5465-93	Microscope
Soil	pH	ASTM D 4972	WTW Multi 340i Meter
Soil	All heavy metals	USEPA 6200	X-ray fluorescence spectrometer
Soil	Extractable Sulphate	CAEM/APHA 4500 SO_4^{2-}E	UV/Visible Spectrophotometer

Sample Matrix	Parameter	Test Method	Test Equipment
Soil	Extractable Phosphate	CAEM/APHA 4500 PD	UV/Visible Spectrophotometer
Soil	Microbiology	ASTM D5465-93	Microscope
Soil	TOC	BS 1377	Titration
Soil	Microbiology	ASTM D5465-93	Microscope

4.3 Environmental Conditions of the Proposed Project Area

4.3.1 Climate and Meteorological Features

The overview of climatic/meteorological features (rainfall, temperature, humidity, and wind) of the area presented here was based primarily on information from literature review and field measurements.

Plate 4.2: Measurements of air quality and meteorological parameters

The Federal Capital Territory (FCT), Abuja, experiences two distinct seasons annually, the wet and dry seasons. The wet season typically spans from late March to October, while the dry season extends from October to early March. During the dry season, conditions are generally characterized by low humidity, dusty Harmattan winds (especially from December to February), and higher daytime temperatures.

The project area lies within Nigeria's Guinea Savannah ecological zone, and its climatic conditions are governed by the interaction between the Tropical Maritime (mT) air mass originating from the Atlantic Ocean and the Tropical

Continental (cT) air mass originating from the Sahara Desert. (Sub Equitoria south) figure 4.1

Baseline climatic and meteorological conditions for the project area were established using a combination of secondary data obtained from long-term records of the Nigerian Meteorological Agency (NiMet) 1994-2024). In line with the approved ESIA Terms of Reference, the primary wet-season data were complemented with secondary wet-season data sourced from a reviewed ESIA conducted within the same urban and ecological setting in Abuja.

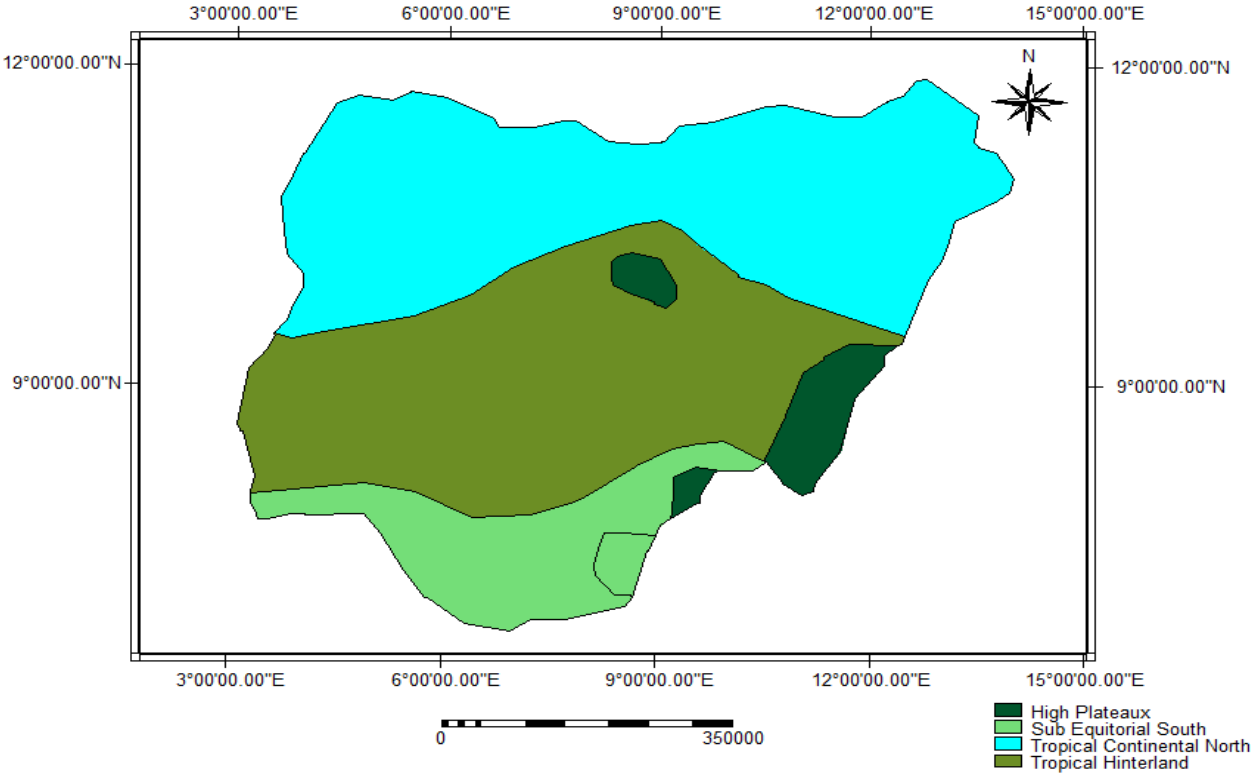

Figure 4.2 Climate Map of Nigeria (Nimet 2020)

Relative Humidity: Baseline relative humidity conditions for the project area were established using a secondary long-term climatological data.

Long-term relative humidity data for Abuja were sourced from World Weather Online, based on approximately 30 years of historical climate records, which are considered representative of prevailing climatic conditions in the Federal Capital Territory. According to these data, relative humidity in Abuja exhibits clear seasonal variation:

- During the wet season (April–October), average relative humidity typically ranges between 60% and 85%, with peak values occurring between July and September.

- During the dry season (November–March), relative humidity values are considerably lower, generally ranging from 20% to 40%, particularly during the Harmattan period (World Weather Online, n.d.).

From a project perspective, the observed and long-term relative humidity conditions are within acceptable operational limits for the project. While higher humidity during the wet season may contribute to increased dust adhesion and moisture-related degradation over time, such effects are manageable through appropriate system design, material selection, and routine maintenance. Overall, relative humidity conditions in the project area do not present any significant constraint to the construction or operation of the proposed project.

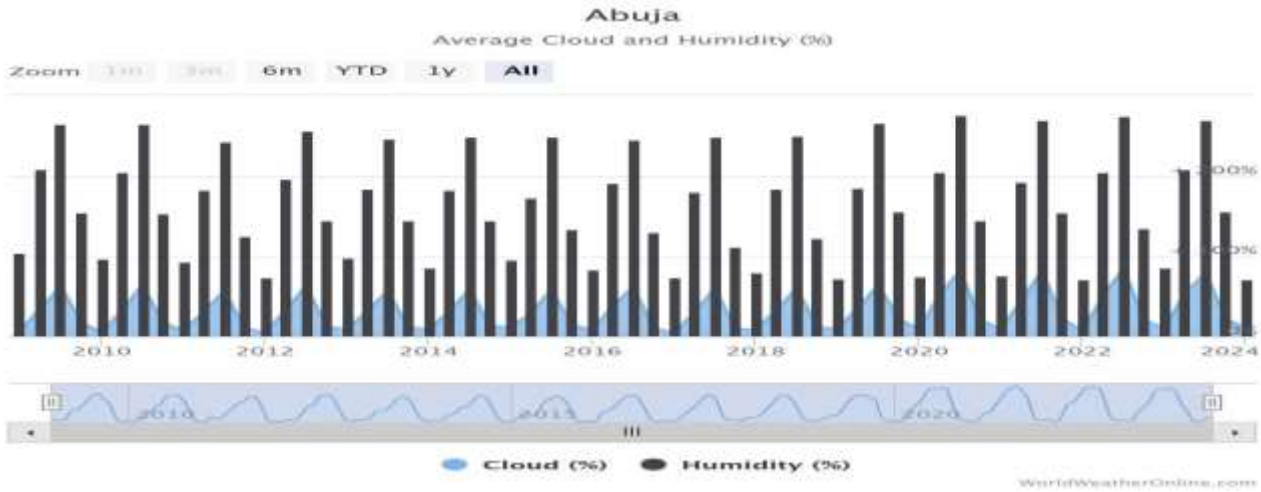

Figure 4.3 Annual Graph of Relative Humidity of Abuja (WCO 2024)

***Temperature*:** Temperature is a dominant climatic factor and air temperature varies from place to place over a period of time at a given location. The spatial distribution of temperature over the earth is influenced by: amount of insulation received, nature of surface, distance from water bodies, relief, nature of the prevailing winds and ocean current **(Ayoade, 1988).**

Historical temperature data for Abuja were obtained from NIMET and World Weather Online, covering a 30-year period, which provides a robust representation of prevailing thermal conditions in the Federal Capital Territory (World Weather Online, n.d.). Key observations include:

- Mean annual temperature: 26°C to 34°C
- Hottest months: February to April, with peak daily maximums occasionally exceeding 36°C
- Coolest period: December to January, influenced by the Harmattan wind, with minimum temperatures occasionally dropping below 20°C.

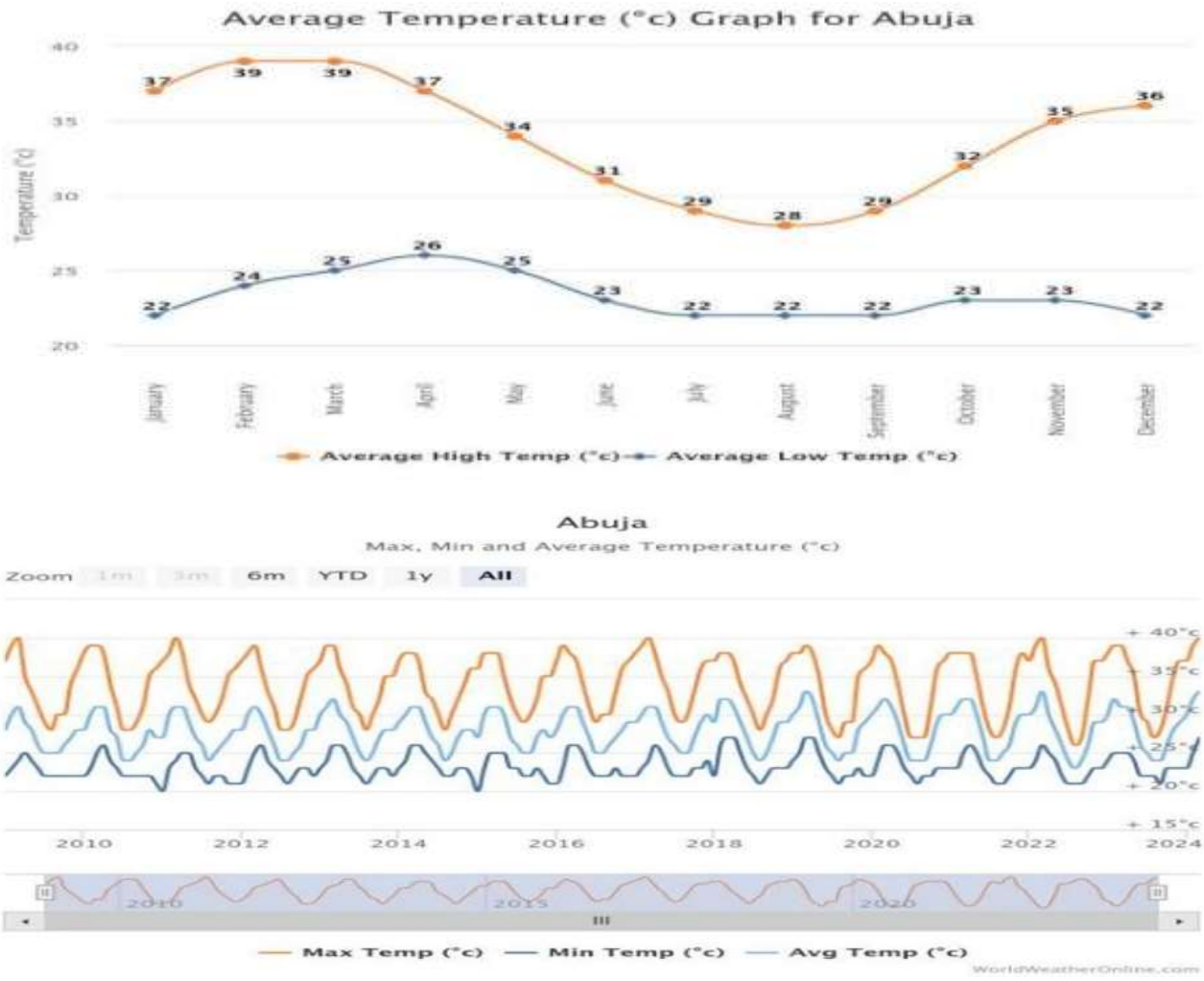

Figure 4.4 Annual and Monthly Temperature Graph of FCT (WCO 2024)

***Rainfall*:** Rainfall generally occurs from March to November with peak period (highest rainfall values from August to September). Towards the end of the wet season or beginning of the dry season (late October to November), heavy thunderstorms commonly accompany the rains.

The rainfall regime is characterized by a maximum in the month of July with a short 'August Break'. The dry season lasts between mid - December to late March. Rainstorms in the wet season are characterized by thunder and lightning. The Average annual number of days with thunderstorms is between 45 and 70 days. The highest number is about 5-9 days usually occurs between April and May and towards the end of the rainy season around October when rainfall is accompanied by greater frequency of thunderstorms, line squalls and disturbance lines.

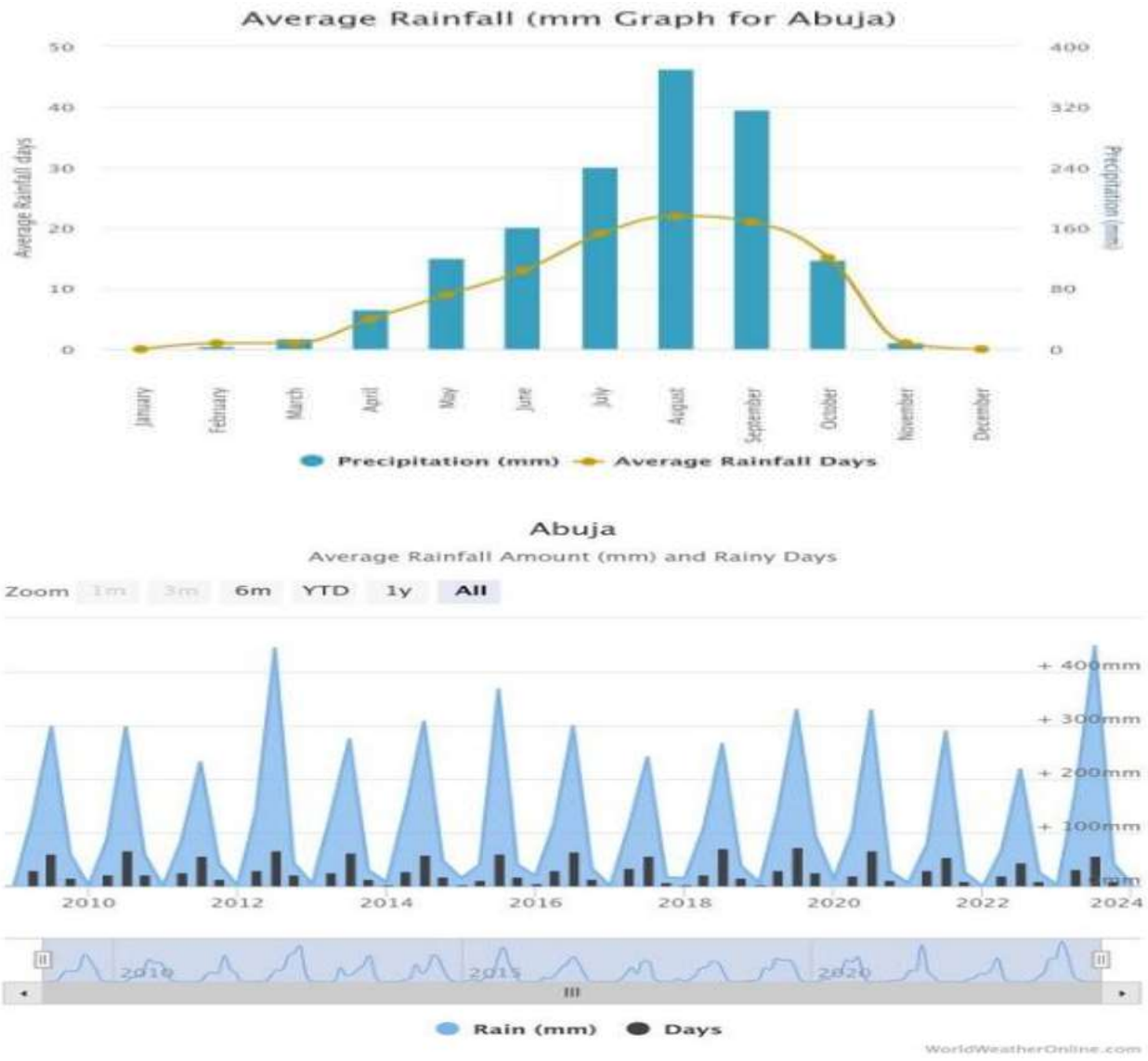

Figure 4.5 Annual and Monthly Rainfall graph of Abuja (WCO)

***Winds*:** Wind direction in the project area shows a clear seasonal pattern, with prevailing south-westerly winds during the wet season and north-easterly winds during the dry season. Field measurements conducted during the dry season recorded wind speeds between 0 and 1.2 m/s, consistent with historical climatological records. These relatively low wind speeds, combined with predictable seasonal directions, present no significant operational or structural constraint for the proposed project. Nonetheless, consideration of wind forces will be incorporated into the structural design of mounting systems and any elevated infrastructure to ensure long-term durability and safety.

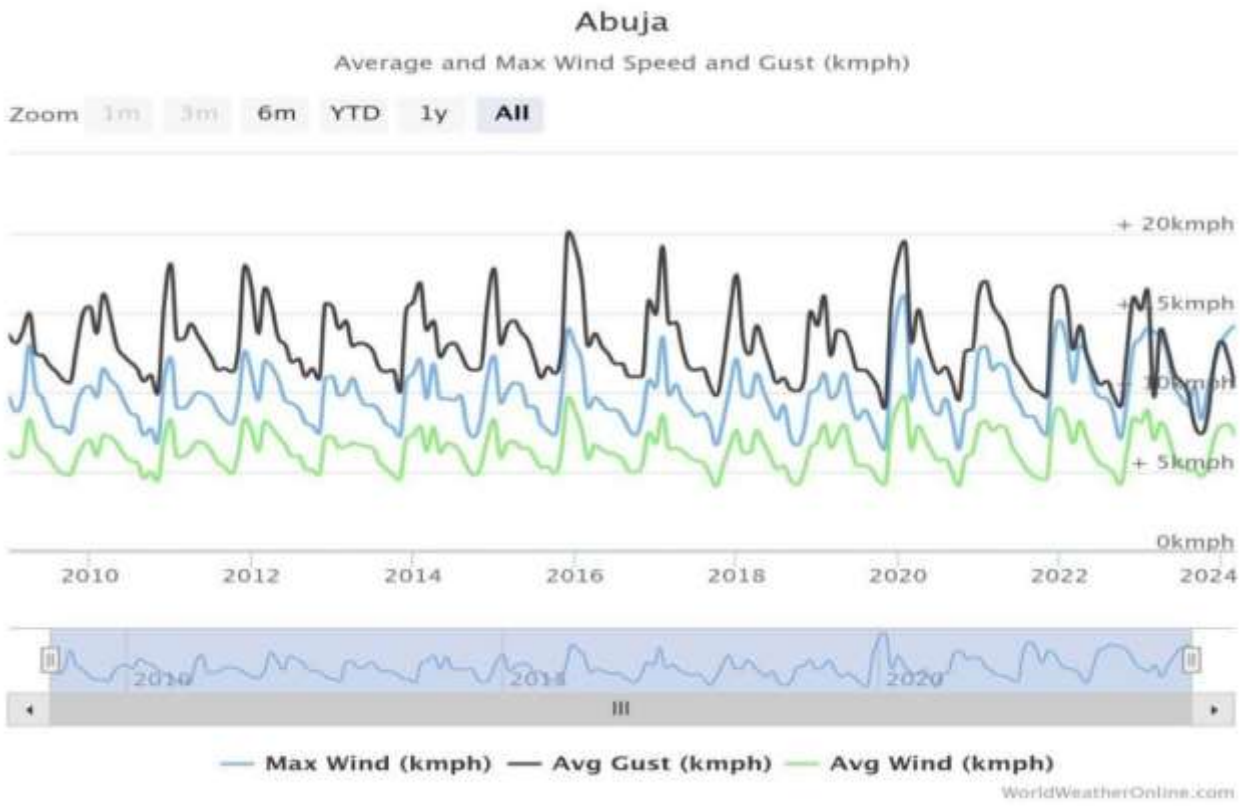

Figure 4.6: Average wind speed graph of Abuja (WCO)

***Visibility*:** Fogs are formed in the morning hours impairing visibility to less than 1000m. In November through February, being the harmattan period, morning mist is usually prominent with visibility as low as 200m and remaining below 2000m for a number of days thus constituting a serious hazard to land and air transport. Generally, visibility, especially in the dry season is foggy in the early hours of the day and improves as the day progresses.

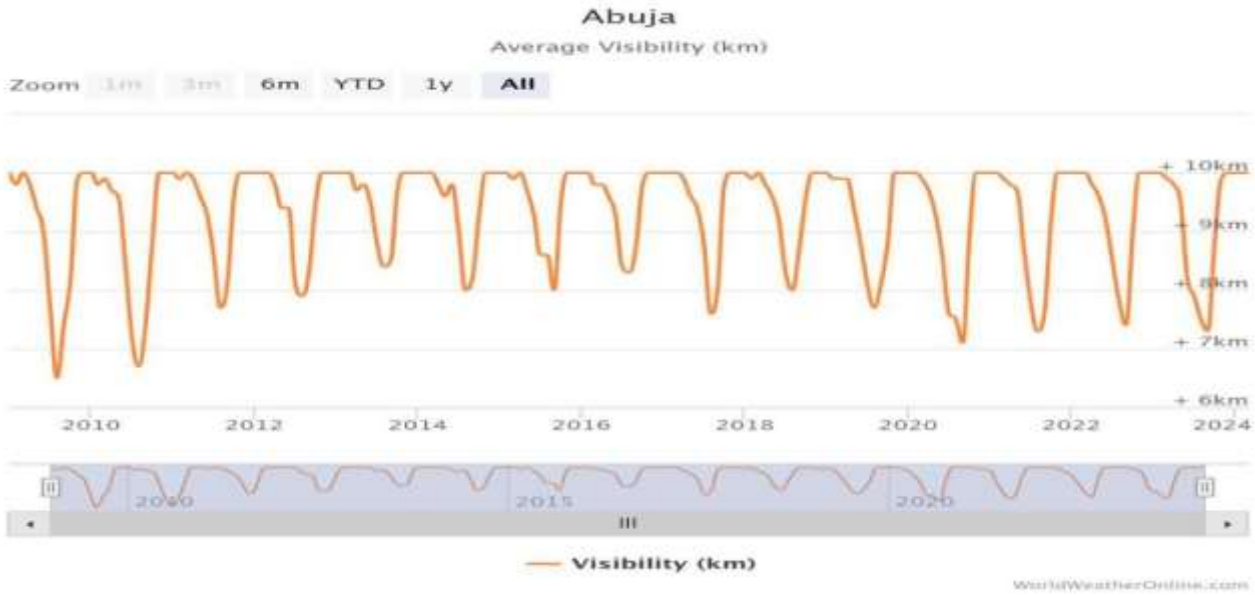

Figure 4.7: Average visibility Graph of the project area

Atmospheric Pressure: Atmospheric pressure is an important climatic parameter that can influence the stability of air masses and weather patterns. in Abuja, long-term climatological data from World Weather Online (World Weather Online, n.d.) indicate that average atmospheric pressure ranges between 1010 and 1015 hPa. These values are typical of stable tropical conditions in the Guinea Savannah ecological zone and do not impose any operational or structural constraints on the installation or performance of PV modules. The relatively consistent pressure regime also supports predictable local weather patterns, which aids in planning construction and maintenance schedules.

4.3.2 Air Quality and Noise Characteristics

One of the main components of Earth's interdependent physical systems is the atmosphere. An atmosphere is made of the layers of gases surrounding a planet or other celestial body. Earth's atmosphere is composed of about 78% nitrogen, 21% oxygen, and one percent other gases. These gases are found in atmospheric layers (troposphere, stratosphere, mesosphere, thermosphere, and exosphere) defined by unique features such as temperature and pressure. The atmosphere protects life on Earth by shielding it from incoming ultraviolet (UV) radiation, keeping the planet warm through insulation, and preventing extremes between day and night temperatures.

The introduction into the air any chemical, physical or biological agent in quantities large enough to produce harmful effects on man and its surrounding is a call for concern. Effects of air pollutants on human health, vegetation, property or the global environment as well as create aesthetic insults in the form of brown or hazy air or unpleasant smells have been reported in the literature (Smith, 1991, Rim-Rukeh and Okokoyo, 2003., Pope, 1992., McComick *et al*., 1995).

The pollutants commonly monitored in relation to air quality are; nitrogen dioxide (NO_2), sulphur dioxide (SO_2), suspended particulate matter (SPM), ammonia (NH_3), hydrogen sulphide (H_2S), carbon dioxide (CO_2), carbon monoxide (CO), and volatile organic compounds (VOCs). The air quality in the study as expressed in their values is presented in Table 4.3. Samples were collected from Thirty (30) sampling stations and two (2) control points for air quality.

Table 4.3: Air Quality Assessment Result.

SN	Location ID	Temp (°C)	R/Humi (%)	Wind Spee	HCHO (mg/m³)	TVOC (mg/m³)	PM_1 (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	CO (ppm	CO_2 (ppm)	NO_2 (ppm)	SO_2 (ppm)	H_2S (ppm)	NH_3 (ppm)	CH_4 (ppm)	O_2 (ppm)	Sound Level	H_2S (ppm)	HCN (ppm)	O3 (ppm
1	GIP AQ 1	30.4	61	2.1	0.003	0.020	14	20	33	0.7	412	0.01	0.003	0.000	0.01	1.8	20.9	46	0.000	0.000	0.00
2	GIP AQ 2	30.8	59	2.0	0.003	0.021	15	21	34	0.8	416	0.02	0.004	0.000	0.02	2.0	20.9	47	0.000	0.000	0.00
3	GIP AQ 3	31.2	58	1.9	0.003	0.022	16	22	35	0.8	420	0.02	0.004	0.000	0.02	2.1	20.9	48	0.000	0.000	0.00
4	GIP AQ 4	31.6	60	2.2	0.003	0.021	15	22	34	0.8	415	0.02	0.004	0.000	0.02	2.0	20.9	47	0.000	0.000	0.00
5	GIP AQ 5	31.0	57	2.0	0.003	0.023	17	24	38	0.9	425	0.03	0.005	0.000	0.03	2.3	20.9	51	0.000	0.000	0.00
6	GIP AQ 6	30.2	63	2.4	0.003	0.019	14	20	32	0.7	410	0.01	0.003	0.000	0.01	1.8	20.9	45	0.000	0.000	0.00
7	GIP AQ 7	30.9	59	2.1	0.003	0.021	16	22	36	0.8	418	0.02	0.004	0.000	0.02	2.1	20.9	48	0.000	0.000	0.00
8	GIP AQ 8	31.3	56	1.8	0.003	0.023	17	24	39	0.9	427	0.03	0.005	0.000	0.03	2.3	20.9	52	0.000	0.000	0.00
9	GIP AQ 9	31.5	55	1.7	0.003	0.024	18	25	40	1.0	430	0.03	0.006	0.000	0.03	2.4	20.9	54	0.000	0.000	0.00
10	GIP AQ 10	30.5	60	2.2	0.003	0.020	15	22	35	0.8	417	0.02	0.004	0.000	0.02	2.0	20.9	47	0.000	0.000	0.00
11	GIP AQ 11	30.1	62	2.3	0.003	0.021	14	20	33	0.7	412	0.01	0.003	0.000	0.01	1.8	20.9	46	0.000	0.000	0.00
12	GIP AQ 12	30.7	60	2.1	0.002	0.021	15	21	34	0.8	416	0.02	0.004	0.000	0.02	2.0	20.9	47	0.000	0.000	0.00
13	GIP AQ 13	31.0	58	2.0	0.003	0.022	16	22	36	0.8	421	0.02	0.004	0.000	0.02	2.1	20.9	49	0.000	0.000	0.00
14	GIP AQ 14	31.2	57	1.9	0.003	0.023	17	23	38	0.9	425	0.03	0.005	0.000	0.03	2.2	20.9	50	0.000	0.000	0.00
15	GIP AQ 15	30.4	55	1.8	0.003	0.024	18	25	40	1.0	430	0.03	0.006	0.000	0.03	2.4	20.9	55	0.000	0.000	0.00
16	GIP AQ 16	30.4	61	2.2	0.003	0.020	15	21	34	0.8	415	0.02	0.004	0.000	0.02	2.0	20.9	47	0.000	0.000	0.00
17	GIP AQ 17	30.8	59	2.0	0.003	0.021	16	22	35	0.8	420	0.02	0.004	0.000	0.02	2.1	20.9	48	0.000	0.000	0.00
18	GIP AQ 18	31.1	57	2.0	0.003	0.022	17	23	37	0.9	423	0.03	0.005	0.000	0.03	2.2	20.9	50	0.000	0.000	0.00
19	GIP AQ 19	31.3	56	1.8	0.003	0.023	17	24	39	0.8	428	0.03	0.006	0.000	0.03	2.3	20.9	52	0.000	0.000	0.00
20	GIP AQ 20	30.6	60	2.1	0.003	0.021	15	22	35	0.7	418	0.02	0.004	0.000	0.02	2.1	20.9	52	0.000	0.000	0.00
21	GIP AQ 21	30.2	62	2.3	0.002	0.019	14	20	33	0.8	411	0.01	0.003	0.000	0.01	1.8	20.9	48	0.000	0.000	0.00
22	GIP AQ 22	30.9	58	2.0	0.003	0.0224	16	22	36	0.9	420	0.02	0.004	0.000	0.03	2.1	20.9	45	0.000	0.000	0.00
23	GIP AQ 23	31.2	56	1.8	0.003	0.023	17	24	39	1.0	427	0.03	0.005	0.000	0.03	2.3	20.9	48	0.000	0.000	0.00
24	GIP AQ 24	30.4	55	1.8	0.003	0.024	18	25	40	0.8	430	0.03	0.006	0.000	0.02	2.3	20.9	52	0.000	0.000	0.00
25	GIP AQ 25	30.5	60	2.2	0.003	0.020	15	21	34	0.8	416	0.02	0.004	0.000	0.02	2.4	20.9	54	0.000	0.000	0.00
26	GIP AQ 26	30.8	59	2.1	0.003	0.021	16	22	35	0.8	419	0.02	0.004	0.000	0.03	2.0	20.9	47	0.000	0.000	0.00
27	GIP AQ 27	31.0	57	1.9	0.003	0.022	17	23	37	0.9	423	0.03	0.005	0.000	0.03	2.1	20.9	48	0.000	0.000	0.00
28	GIP AQ 28	30.3	56	1.8	0.003	0.023	17	24	39	0.9	428	0.03	0.006	0.000	0.02	2.2	20.9	50	0.000	0.000	0.00
29	GIP AQ 29	30.6	60	2.1	0.003	0.021	15	22	35	0.8	417	0.02	0.004	0.000	0.03	2.3	20.9	52	0.000	0.000	0.00
30	GIP AQ 30	31.1	57	1.7	0.003	0.022	16	23	37	0.9	422	0.03	0.005	0.000	0.01	2.0	20.9	48	0.000	0.000	0.00
31	GIP AQ 31	30.0	63	2.5	0.002	0.018	12	18	28	0.7	410	0.01	0.003	ND	0.01	1.8	20.9	50	0.000	0.000	0.00
32	GIP AQ 32	30.2	62	2.4	0.002	0.019	13	19	29	0.7	412	0.01	0.003	ND	0.01	1.9	20.9	46	0.000	0.000	0.00
33	GIP AQ 33	30.1	64	2.6	0.002	0.018	12	18	27	0.7	409	0.01	0.003	ND	0.01	1.8	20.9	45	0.000	0.000	0.00

Source: Field Data ESIA of Greenville CNG Mother (Compression) Station Project, 2026

4.3.2.1 Air Quality and Noise Result Discussion

The ambient air quality assessment was conducted at thirty (30) sampling locations across the proposed Greenville LNG CNG Mother Station at Izom, Gwagwalada Area Council, with three (3) control stations located outside the proposed project area. The assessment covered meteorological parameters, particulate matter, gaseous pollutants, volatile organic compounds, atmospheric gases and environmental noise to establish the baseline environmental conditions prior to project development. The results indicate that the project area currently experiences generally good ambient air quality, with most measured parameters complying with the applicable Federal Ministry of Environment (FMEnv) standards and, for several parameters, the World Health Organization (WHO) Air Quality Guidelines.

The ambient temperature across the study area ranged from 30.2 to 31.6°C, while the control locations recorded temperatures between 30.0 and 30.2°C. These values are typical of the Guinea Savannah ecological zone of the Federal Capital Territory during the dry season and indicate that no unusual heat sources currently influence the project environment. Relative humidity ranged from 55 to 63%, reflecting normal atmospheric moisture conditions, while wind speed varied between 1.7 and 2.6 m/s, providing favourable conditions for atmospheric dispersion of pollutants. The moderate wind velocities reduce the likelihood of pollutant accumulation within the project area and contribute to maintaining good ambient air quality.

The particulate matter concentrations demonstrate that the study area is only moderately affected by suspended dust. $PM_{2.5}$ concentrations ranged from 20 to 25 µg/m³, while PM_{10} concentrations varied from 32 to 40 µg/m³. The PM_{10} values are well below the FMEnv limit of 150 µg/m³ and the WHO 24-hour guideline value of 45 µg/m³, indicating that coarse particulate pollution is minimal and unlikely to pose significant environmental or public health concerns. The $PM_{2.5}$ concentrations also comply with the FMEnv guideline value of 35 µg/m³, confirming that the project area satisfies the Nigerian regulatory requirement. However, the measured $PM_{2.5}$ concentrations exceed the updated WHO Air Quality Guideline of 15 µg/m³. This suggests that while the ambient air quality is acceptable from a national regulatory perspective, fine particulate concentrations remain sufficiently elevated to warrant attention because prolonged exposure to $PM_{2.5}$ has been associated with increased risks of cardiovascular and respiratory diseases. Since the proposed CNG Mother Station has not yet been developed, these particulate concentrations most likely originate from existing unpaved roads, vehicular movement, agricultural activities and natural wind-blown dust rather than industrial emissions.

Carbon monoxide concentrations ranged between 0.7 and 1.0 ppm, which are substantially lower than the FMEnv ambient air quality limit of 10 ppm and the WHO guideline value. These very low concentrations indicate that combustion-related emissions within the study area are minimal and that there are currently no significant sources of incomplete fuel combustion. The observed concentrations are characteristic of rural and peri-urban environments with relatively low traffic density.

Carbon dioxide concentrations ranged from 410 to 430 ppm, which closely correspond to present-day global atmospheric background concentrations. These values indicate that there are presently no significant anthropogenic carbon dioxide emission sources affecting the project area. The uniformity of the measured concentrations across both project and control locations further confirms that atmospheric conditions remain largely unaffected by industrial activities.

Nitrogen dioxide (NO_2), an important indicator of combustion-related pollution, ranged from 0.01 to 0.03 ppm. These concentrations are below the FMEnv ambient air quality limit of approximately 0.04–0.06 ppm, indicating compliance with national regulatory standards. Although the highest values approach or marginally exceed the more stringent WHO guideline, the concentrations remain relatively low and are typical of locations influenced primarily by light vehicular movement rather than intensive industrial operations. The results indicate that nitrogen oxide pollution is currently insignificant within the proposed project area.

Sulphur dioxide concentrations ranged between 0.003 and 0.006 ppm, remaining well below the FMEnv limit of 0.01 ppm and the WHO guideline value. These low concentrations indicate the absence of significant sulphur-containing fuel combustion or industrial emissions within the study area. Similarly, hydrogen sulphide was not detected at any sampling location, demonstrating that there are currently no emissions from sewage decomposition, petroleum contamination or other sulphide-generating sources.

Ammonia concentrations varied from 0.01 to 0.03 ppm, while methane concentrations ranged between 1.8 and 2.4 ppm. Both parameters occurred at very low concentrations consistent with natural atmospheric background conditions. The methane values indicate that there is currently no leakage of natural gas or accumulation of combustible gases within the project area prior to project implementation. This observation is particularly important because methane monitoring will become a key environmental performance indicator during operation of the proposed CNG facility.

Formaldehyde concentrations ranged from 0.002 to 0.003 mg/m³, while total volatile organic compounds (TVOCs) varied between 0.018 and 0.024 mg/m³. Both parameters are substantially lower than internationally accepted health-based guideline values, indicating negligible emissions from hydrocarbon evaporation, solvent use or industrial activities. These low concentrations further demonstrate that the proposed project site has not experienced pre-existing contamination from petroleum products or volatile chemical compounds.

Ozone (O_3) and hydrogen cyanide (HCN) were not detected at any monitoring location. The absence of ozone accumulation indicates that photochemical smog formation is not occurring within the study area, while the non-detection of hydrogen cyanide confirms that there are no industrial or combustion processes capable of generating cyanide-containing emissions. These findings further support the conclusion that the project environment currently experiences minimal atmospheric pollution.

Atmospheric oxygen concentration remained constant at 20.9% throughout the study area, corresponding to the normal composition of ambient air. This indicates that no oxygen depletion has occurred due to combustion, gas leakage or biological activity, further confirming the absence of abnormal atmospheric conditions.

Ambient noise levels ranged from 45 to 55 dB(A) across the project area, while the control stations recorded values between 45 and 50 dB(A). These values comply with the FMEnv permissible daytime noise limit of 55 dB(A) for residential environments and are also consistent with the WHO environmental noise guideline. The measured noise levels reflect a relatively quiet rural environment with only minor contributions from local vehicular traffic and community activities. The results indicate that the proposed project site is currently free from significant noise pollution.

Overall, the baseline ambient air quality at the proposed Greenville LNG CNG Mother Station in Izom is good and indicates a relatively clean atmospheric environment prior to project development. All monitored gaseous pollutants, including carbon monoxide, sulphur dioxide, ammonia, hydrogen sulphide, methane, formaldehyde and volatile organic compounds, comply with FMEnv standards and generally remain within internationally accepted guideline values. PM_{10} concentrations also comply with both FMEnv and WHO standards, while $PM_{2.5}$ concentrations comply with FMEnv requirements but exceed the more stringent WHO guideline, suggesting moderate exposure to fine particulates primarily associated with existing road dust and local traffic activities. Consequently, the current results establish a robust environmental baseline against which future impacts associated with the construction and operation of the proposed CNG Mother Station can be assessed and monitored

4.3.3 Groundwater and Surface Water Quality Assessment

The baseline water quality assessment was undertaken to determine the existing condition of groundwater and surface water resources within and around the proposed Greenville LNG CNG Mother Station at Izom, Gwagwalada Area Council, FCT Abuja. Six (6) groundwater samples, three (3) surface water samples and one (1) control groundwater sample were analysed for physicochemical characteristics, major ions, heavy metals, organic contaminants and microbiological parameters. The analytical results were compared with the applicable Federal Ministry of Environment (FMEnv) permissible limits to determine the suitability of the water resources and establish baseline environmental conditions prior to project implementation. The result of the laboratory analysis of the water samples collected is presented on tables 4.4 below:

Table 4.4: Ground and Surface Water Quality Assessment Result

S/N	Parameters	Unit	GIPGW 01	GIPGW 02	GIPGW 03	GIPGW 04	GIPGW 05	GIPGW 06	GIPSW 01	GIPSW 02	GIPSW 03	GIPGW Control	FMENT Limit
A)	**Coordinates**												
1	Latitude		9.244260	9.245180	9.243050	9.242380	9.246010	9.243620	9.234890	9.232670	9.230310	9.232360	-
2	Longitude		7.003160	7.004320	7.001940	7.004870	7.002480	7.00560	6.989120	6.987670	6.985940	6.985888	-
B)	**Physicochemical Test**												
3	Colour	TCU	Clear	Clear	Clear	Clear	Clear	Clear	Pale brown	Cloudy	Cloudy	Clear	Unobjectionable
4	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Bad odour	Odourless	Odourless	Unobjectionabl
5	Taste	-	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	ND	ND	ND	Tasteless	Unobjectionabl
6	pH	-	6.8	6.6	6.9	6.5	6.8	6.6	7.1	6.9	6.7	7.3	6.5 - 8.5
7	Turbidity	NTU	0	0	0	2	0	0	15	15	19	0	50
8	TDS	ppm	205	235	190	255	220	245	105	128	155	119	500
9	TSS	mg/l	0	0	0	1	0	0	9	11	11	2	20
10	Dissolve Oxygen	mg/l	5.8	5.2	6.0	4.9	5.7	5.1	7.8	7.1	6.5	5.3	2-8
11	Salinity	%	0.02	0.02	0.02	0.01	0.00	0.00	0.03	0.03	0.03	0.01	< 1000
12	ORP	mV	259	211	268	255	208	249	98	123	109	201	200-600
13	BOD	mg/l	1.7	0.9	1.8	2.1	2.0	1.9	2.7	2.5	2.7	1.4	NS
14	Temperature	°C	26.1	26.7	25.9	27.0	26.3	26.8	27.4	27.9	28.3	27.6	Ambient
15	Electrical Conductivity	µs/cm	365	410	345	445	385	425	185	220	265	341	1000
C)	**Chemical Test**												
16	Calcium (Ca^{2+})	mg/l	0.96	1.23	1.04	1.22	1.00	1.43	2.89	3.16	3.08	1.97	200
17	Magnesium(Mg^{2+})	mg/l	1.22	1.48	1.58	1.96	2.16	3.92	3.55	3.96	4.43	2.36	20
18	Sodium (Na^{+})	mg/l	13	8	9	9	9	6	28	13	20	12	20
19	Potassium (K^{+})	mg/l	0.0	0.1	0.1	0.0	0.0	0.0	1.9	0.7	1.7	0.3	NS
20	Ammonium(NH_4^{+})	mg/l	0.000	0.000	0.000	0.000	0.000	0.000	0.634	0.035	0.119	0.000	100
21	Sulphate (SO_4^{2-})	mg/l	16	24	19	35	14	23	67	59	67	21	50
22	Nitrate (NO_3^{-})	mg/l	2.04	2.11	2.05	0.99	1.33	1.06	9.90	13.62	10.47	2.00	NS
23	Phosphate (PO_4^{3-})	mg/l	0.11	0.03	0.18	0.04	0.62	0.21	1.12	1.43	1.86	0.2	0.2
24	Nitrite (NO_2^{-})	mg/l	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.9	0.0	150
25	Chloride (Cl^{-})	mg/l	0.06	0.18	0.11	0.01	0.30	0.17	2.96	19.8	12.4	1.00	-
D)	**Heavy Metals**												

S/N	Parameters	Unit	GIPGW 01	GIPGW 02	GIPGW 03	GIPGW 04	GIPGW 05	GIPGW 06	GIPSW 01	GIPSW 02	GIPSW 03	GIPGW Control	FMENT Limit
26	Zinc (Zn^{2+})	mg/l	2.604	1.774	1.052	1.431	1.056	1.118	2.621	2.511	2.860	1.053	3.0
27	Copper (Cu^{2+})	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.013	0.08	0.00	1.25
28	Chromium (Cr^{2+})	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.05
29	Cobalt (Co^{2+})	mg/l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
30	Iron (Fe^{2+})	mg/l	0.114	0.126	0.029	0.118	1.006	0.096	1.434	2.963	1.008	0.122	0.3
31	Nickel (Ni^{2+})	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.13	0.108	0.00	0.07
32	Mercury	µg/l	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.001
33	Lead	µg/l	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.001
34	Manganese	mg/l	0.1	0.0	0.3	0.0	0.0	0.1	0.2	0.3	0.2	0.0	0.2
E)	Organic												
35	Phenols	mg/l	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.04	0.04	0.001	0.05
36	Oil & Grease	mg/l	0	0	0	0	0	0	1	0	0	0	10
37	BTEX	mg/l	0	0	0	0	0	0	0	0	0	0	Nil
F)	Microbiological												
38	E-Coli	cfu/ml	0	0	0	0	0	0	3	4	1	0	Nil
39	Total Coliform	cfu/ml	2	4	0	0	1	2	19	126	23	1	10

Source: Field Data ESIA of Greenville CNG Mother Station Project, 2026

4.3.3.1 Result Discussions on Water Analysis

The **hydrogen ion concentration (pH)** of the groundwater ranged from 6.5 to 6.9, while surface water recorded values between 6.7 and 7.1. The control sample had a pH of 7.3. All measured values fall within the FMEnv acceptable range of 6.5 to 8.5, indicating neutral to slightly acidic conditions that are favourable for aquatic life and domestic water supply. The results suggest that the water resources have not been affected by acidification or alkaline contamination and that the natural geochemical conditions of the aquifer remain largely intact. The observed groundwater pH values are characteristic of shallow basement aquifers in central Nigeria where the dissolution of carbon dioxide and natural weathering processes produce mildly acidic groundwater.

Turbidity values ranged from 0 to 2 NTU in groundwater and 15 to 19 NTU in surface water, remaining well below the FMEnv limit of 50 NTU. The exceptionally low groundwater turbidity demonstrates the effective filtration capacity of the underlying geological formations, while the relatively higher values recorded in surface water reflect the influence of suspended sediments, runoff and organic matter commonly associated with natural streams. Despite these differences, all samples comply with the regulatory standard, indicating that suspended solids do not presently constitute a significant environmental concern.

Total dissolved solids (TDS) ranged from 190 to 255 mg/L in groundwater and 105 to 155 mg/L in surface water, all significantly below the FMEnv permissible limit of 500 mg/L. These low concentrations indicate that both groundwater and surface water possess low mineralization and are free from excessive dissolved salts. Similarly, electrical conductivity values ranged from 345 to 445 µS/cm in groundwater and 185 to 265 µS/cm in surface water, remaining well below the FMEnv limit of 1,000 µS/cm. The low TDS and conductivity values indicate that the water resources have not been impacted by saline intrusion, industrial effluents or excessive mineral dissolution and are generally of good chemical quality.

Total suspended solids (TSS) were very low, ranging from 0 to 1 mg/L in groundwater and 9 to 11 mg/L in surface water, which are substantially below the FMEnv limit of 20 mg/L. These results indicate limited particulate loading and confirm that the groundwater is naturally well filtered, while the surface water remains relatively clear despite receiving sediments through natural runoff processes. Dissolved oxygen concentrations ranged from 4.9 to 6.0 mg/L in groundwater and 6.5 to 7.8 mg/L in surface water, falling within the FMEnv acceptable range of 2 to 8 mg/L.

The relatively high dissolved oxygen concentrations indicate that the water bodies are well oxygenated and capable of supporting aquatic life. Furthermore, the low **biochemical oxygen demand (BOD)** values of 0.9 to 2.7 mg/L suggest minimal organic pollution and limited microbial decomposition of organic matter within the water bodies.

The concentrations of the major cations, including calcium, magnesium, sodium and potassium, were generally low and complied with the applicable FMEnv limits. Calcium concentrations ranged from 0.96 to 3.16 mg/L, which is substantially below the permissible limit of 200 mg/L, while magnesium varied from 1.22 to 4.43 mg/L, remaining below the FMEnv limit of 20 mg/L. Sodium concentrations were generally below the regulatory limit of 20 mg/L, although one surface water sample recorded 28 mg/L, indicating localized enrichment that may be associated with natural mineral weathering or runoff. Overall, the major ion chemistry suggests that the water resources are naturally soft and have not experienced significant contamination from anthropogenic sources.

Sulphate concentrations ranged between 14 and 35 mg/L in groundwater and 59 to 67 mg/L in surface water. All groundwater samples complied with the FMEnv limit of 50 mg/L, whereas the surface water samples exceeded this standard. The elevated sulphate concentrations in surface water may be attributed to natural weathering of sulphate-bearing minerals, agricultural runoff or decomposition of organic matter transported into the streams during surface runoff. Although the exceedance is relatively modest, prolonged increases in sulphate concentration may affect the aesthetic quality of water and should be monitored throughout project implementation.

Phosphate concentrations ranged from 0.03 to 0.62 mg/L in groundwater and 1.12 to 1.86 mg/L in surface water, compared with the FMEnv guideline value of 0.2 mg/L. Several groundwater samples and all surface water samples exceeded the regulatory limit. Elevated phosphate concentrations are commonly associated with fertilizer application, domestic wastewater discharge and natural decomposition of organic materials. Excessive phosphate in surface water is environmentally significant because it promotes eutrophication, excessive algal growth and subsequent depletion of dissolved oxygen, thereby affecting aquatic ecosystem health. Although the proposed project has not yet commenced operation, these results indicate that nutrient enrichment already exists within the local watershed.

The heavy metal assessment indicates generally good water quality with localized exceedances. Zinc concentrations ranged from 1.05 to 2.86 mg/L, remaining below the FMEnv limit of 3.0 mg/L, while copper concentrations varied from 0.00 to 0.96 mg/L, complying with the permissible limit of 1.25 mg/L. Chromium concentrations ranged between 0.00 and 0.02 mg/L, well below the regulatory limit of 0.05 mg/L, and cobalt was not detected in any sample. These results demonstrate that contamination from these trace metals is presently insignificant within the study area.

Iron concentrations ranged from 0.029 to 1.006 mg/L in groundwater and 1.008 to 2.963 mg/L in surface water. These values exceed the FMEnv guideline value of 0.3 mg/L in several groundwater samples and in all surface water samples. Elevated iron concentrations are common in groundwater derived from crystalline basement rocks because of natural weathering of iron-bearing minerals. Although iron is not generally considered a major toxic contaminant at these concentrations, excessive levels may impart an unpleasant metallic taste, cause reddish-brown staining of plumbing fixtures and promote the growth of iron bacteria in water distribution systems. The observed concentrations therefore appear to reflect the natural geochemistry of the area rather than anthropogenic pollution.

Nickel was not detected in groundwater but ranged from 0.09 to 0.13 mg/L in surface water, exceeding the FMEnv permissible limit of 0.07 mg/L. This localized exceedance may result from natural geological sources or diffuse anthropogenic inputs such as runoff from surrounding land uses. Continuous monitoring of nickel is recommended during project implementation to determine whether future project activities contribute to any increase in concentration. Mercury and lead were not detected in any sample and therefore fully comply with FMEnv standards, indicating the absence of contamination by these highly toxic metals.

Organic contamination within the project area is minimal. Phenol concentrations ranged between 0.00 and 0.04 mg/L, remaining below the FMEnv limit of 0.05 mg/L, while oil and grease concentrations ranged from 0 to 1 mg/L, which is significantly lower than the permissible limit of 10 mg/L. Most importantly, BTEX compounds were not detected in either groundwater or surface water samples. This finding is particularly significant because BTEX compounds are reliable indicators of petroleum hydrocarbon contamination. Their absence confirms that the project site has not been impacted by fuel leakage or hydrocarbon pollution prior to commencement of the proposed CNG facility.

The microbiological assessment revealed clear differences between groundwater and surface water quality. E. coli was absent in all groundwater samples, demonstrating that the aquifer is microbiologically protected. In contrast, surface water contained 1 to 4 cfu/mL of E. coli, exceeding the FMEnv requirement of zero detectable organisms. Similarly, total coliform concentrations ranged from 0 to 4 cfu/mL in groundwater but increased to 19 to 126 cfu/mL in surface water, exceeding the FMEnv guideline value of 10 cfu/mL. These results indicate faecal contamination of the surface water, most likely resulting from livestock activities, surface runoff and other diffuse sources within the watershed. Consequently, untreated surface water from the study area is unsuitable for direct domestic consumption without adequate treatment and disinfection.

Generally, the baseline water quality assessment indicates that the groundwater resources within the proposed Greenville LNG CNG Mother Station are generally of good quality, complying with FMEnv standards for most physicochemical parameters, major ions, heavy metals and organic contaminants. However, localized exceedances of iron and phosphate were observed in some groundwater samples. Surface water quality also demonstrates generally acceptable physicochemical characteristics, but elevated concentrations of sulphate, phosphate, iron, nickel, E. coli and total coliform indicate nutrient enrichment, naturally elevated iron content and microbiological contamination. The absence of BTEX, mercury and lead confirms that the project area has not experienced petroleum hydrocarbon contamination or hazardous metal pollution before project development. These results provide a robust baseline dataset against which any future impacts arising from the construction and operation of the proposed CNG Mother Station can be evaluated.

4.3.4 Soil Quality Assessment

The baseline soil quality assessment was undertaken to determine the existing environmental condition of soils within the proposed Greenville LNG CNG Mother Station at Izom, Gwagwalada Area Council, FCT Abuja. Thirty (30) soil samples were collected across the project site, while three (3) additional samples served as control locations outside the proposed development area. The laboratory analyses covered soil physicochemical properties, exchangeable cations and anions, heavy metals, organic contaminants, soil texture and microbiological characteristics. The analytical results provide a reliable baseline against which future changes arising from construction and operation of the proposed facility can be evaluated. The result of the soil analysis is presented on table 4.5a&b below

Table 4.5a: Physio-chemical Analysis of Soil Sample of the proposed project site

S/N	Parameter	Unit	GIP SS 01	GIP SS 02	GIP SS 03	GIP SS 04	GIP SS 05	GIP SS 06	GIP SS 07	GIP SS 08	GIP SS 09	GIP SS 10	GIP SS 11	GIP SS 12	GIP SS 13	GIP SS 14	GIP SS 15	GIP SS 16	GIP SS 17
A)	**Coordinate**																		
1	Latitude	N	9.232781	9.23278	9.23276	9.23278	9.23277	9.23151	9.23215	9.23215	9.23215	9.232151	9.231520	9.231520	9.231520	9.23152	9.23152	9.23088	9.23088
2	Longitude	E	6.990886	6.99152	6.99249	6.99345	6.99409	6.99848	6.99152	6.9924	6.99345	6.994094	6.990886	6.991529	6.992490	6.99345	6.99409	6.99088	6.99152
B)	**Physical Test**																		
4	pH	-	6.15	6.36	5.79	6.31	6.92	6.73	6.59	6.82	6.01	5.88	6.07	8.31	6.77	6.89	8.77	8.89	6.07
5	Colour	TCU	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Grayish Brown	Grayish Brown	Grayish Brown	Dark Brown	Brown	Brown	Brown	Dark Brown	Black Brown	Blackish	Dark Brown	Brown	Brown
6	Electrical	µS/cm	1736	1066	2964	2330	968	1358	1568	386	1346	1351	1209	1225	1371	1148	1261	1441	2051
7	Temperature	°C	33.1	30.1	29.4	28.9	29.9	30.0	28.1	27.9	29.3	29.1	29.0	29.0	29.0	29.0	28.2	31.1	30.2
C)	**Exchangeable**																		
8	Ammonium	mg/kg	3.083	1.261	2.057	2.556	1.892	0.992	3.062	1.538	1.266	1.059	2.006	0.914	0.326	1.114	0.261	1.053	0.556
9	Calcium	mg/kg	3.24	3.01	3.16	2.94	3.51	3.01	2.44	2.01	3.05	2.86	4.55	3.61	4.23	4.53	6.21	3.51	3.01
10	Magnesium	mg/kg	1.24	0.90	1.82	1.04	1.85	1.00	1.02	1.84	1.00	1.01	1.03	1.00	1.86	1.31	1.43	1.18	1.04
11	Sodium	mg/kg	28	17	21	34	6	19	12	26	8	15	18	9	31	25	11	14	7
12	Potassium	mg/kg	5.5	4.2	6.3	2.2	2.9	3.1	4.6	3.1	2.0	3.6	5.3	4.1	2.1		5.1	3.3	1.4
D)	**Exchangeable**																		
13	Sulphate	mg/kg	51	33	28	62	30	29	38	40	50	44	42	39	63	41	27	58	33
14	Nitrate	mg/kg	4.2	3.6	3.6	4.0	4.6	4.0	4.1	3.8	3.7	2.7	3.9	2.7	7.3	6.8	3.8	4.1	2.9
15	Nitrite	mg/kg	0.01	0.06	0.01	0.03	0.03	0.00	0.01	0.04	0.04	0.03	0.01	0.01	0.03	0.02	0.01	0.02	0.00
16	Phosphate	mg/kg	2.5	3.4	2.9	2.9	3.6	1.3	3.6	1.2	2.7	2.0	1.4	3.3	1.8	2.3	2.8	1.9	2.7
17	Chloride	mg/kg	1.6	1.7	0.6	1.7	1.2	2.8	1.8	2.8	3.2	1.2	1.7	0.9	3.4	2.0	2.0	3.8	1.9
E)	**Heavy Metals**																		
18	Iron (Fe^{2+})	mg/kg	0.48	0.33	0.18	0.27	1.86	2.49	1.62	1.47	2.01	1.47	1.05	2.21	2.41	3.68	2.71	2.99	1.46
19	Zinc (Zn^{2+})	mg/kg	1.334	0.651	1.663	0.962	0.174	1.271	1.230	1.261	1.041	0.225	2.051	1.862	1.281	1.119	0.041	0.261	0.113
20	Copper	mg/kg	0.14	0.73	0.81	0.05	0.02	0.03	1.00	0.05	0.07	0.01	0.05	0.49	0.22	0.01	0.05	0.22	0.01
21	Cobalt	mg/kg	0.013	0.017	0.134	0.112	0.174	0.168	0.129	0.124	0.163	0.014	0.136	0.130	0.128	0.143	0.201	0.411	0.261
22	Manganese	mg/kg	0.25	0.26	0.18	0.42	0.96	0.14	0.23	0.18	0.21	0.22	0.18	0.26	0.51	0.27	1.00	0.04	0.02
23	Chromium	mg/kg	0.06	0.05	0.02	0.00	0.02	0.01	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
24	Nickel (Ni^{2+})	mg/kg	0.006	0.005	0.001	0.002	0.010	0.000	0.003	0.001	0.001	0.002	0.011	0.001	0.002	0.002	0.003	0.000	0.001

S/N	Parameter	Unit	GIP SS 01	GIP SS 02	GIP SS 03	GIP SS 04	GIP SS 05	GIP SS 06	GIP SS 07	GIP SS 08	GIP SS 09	GIP SS 10	GIP SS 11	GIP SS 12	GIP SS 13	GIP SS 14	GIP SS 15	GIP SS 16	GIP SS 17
25	Mercury	mg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	Lead	mg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F)	**Organic**																		
27	Phenols	mg/kg	0.041	0.06	0.51	0.36	0.86	0.71	1.21	0.61	0.47	0.88	0.91	0.31	0.08	0.26	0.14	0.05	0.01
28	BTEX	mg/kg	0	0	0	0	0	0	0	7.0	0	0	0	0	2.3	0	2.3	0	0
29	Oil & Grease	mg/kg	0	0	0	0	0	0	0	1.6	0	0	0	0	0	0.8	0.8	0.1	0
G)	**Soil**																		
30	Sandy	%	19	31	18	13	22	7	16	12	1	8	11	18	13	18	20	18	39
31	Loam	%	59	48	60	5	33	42	51	57	69	49	23	23	39	54	37	60	41
32	Clay	%	21	8	12	71	26	33	15	12	20	16	37	19	8	11	21	19	15
33	Silt	%	6	13	10	11	19	18	21	19	10	27	21	35	40	17	22	3	5
H)	**Microbiological**																		
34	E.Coli	cfu/100	24	96	35	27	18	21	19	19	8	11	11	20	16	34	6	23	8
35	Fungal	cfu/100	117	63	262	51	43	117	38	118	54	56	61	206	283	299	241	196	74

Table 4.5b: Physio-chemical Analysis of Soil Sample of the proposed project site

S/N	Parameter	Unit	GIP SS 18	GIP SS 19	GIP SS 20	GIP SS 21	GIP SS 22	GIP SS 23	GIP SS 24	GIP SS 25	GIP SS 26	GIP SS 27	GIP SS 28	GIP SS 29	GIP SS 30	GIP SS 31	GIP SS 32	GIP SS 33
A)	**Coordinate**																	
1	Latitude	N	9.2308	9.2308	9.2308	9.2302	9.2302	9.2302	9.2302	9.2302	9.2300	9.230700	9.231300	9.232000	9.231700	9.2387	9.2243	9.2315
2	Longitude	E	6.9924	6.9934	6.9940	6.9908	6.9915	6.9924	6.9934	6.9940	6.9912	6.993900	6.994600	6.993000	6.991000	6.9924	6.9851	7.0008
B)	**Physical Test**																	
4	pH	-	8.32	8.74	8.88	8.01	7.53	7.86	7.05	8.52	7.79	8.19	8.22	8.56	8.11	8.02	8.35	7.56
5	Colour	TCU	Brown	Brown	Dark Brown	Dark Brown	Brown	Brown	Dark Brown	Brown	Dark Brown	Brown	Brown	Dark Brown	Grayish Brown	Reddish	Brown	Brown
6	Electrical	µS/cm	1863	1022	1364	1114	1026	1201	1481	1631	1022	1251	1134	1025	873	964	1103	1341
7	Temperature	°C	29.4	30.1	30.5	31.2	30.0	30.1	29.3	28.5	25.9	28.3	27.1	28.4	29.6	29.8	27.4	28.6
C)	**Exchangeable**																	
8	Ammonium	mg/kg	0.362	0.251	0.261	0.043	0.325	1.883	0.901	0.026	2.833	1.432	2.561	0.862	0.591	0.081	0.96	1.561
9	Calcium	mg/kg	3.66	4.32	4.51	4.06	3.68	2.99	3.01	3.43	4.00	3.51	3.68	3.26	3.51	3.51	3.57	3.70

S/N	Parameter	Unit	GIP SS 18	GIP SS 19	GIP SS 20	GIP SS 21	GIP SS 22	GIP SS 23	GIP SS 24	GIP SS 25	GIP SS 26	GIP SS 27	GIP SS 28	GIP SS 29	GIP SS 30	GIP SS 31	GIP SS 32	GIP SS 33
10	Magnesium	mg/kg	1.00	1.31	1.33	1.96	1.46	1.71	1.08	1.92	1.84	1.05	1.14	1.27	1.86	1.00	1.07	1.17
11	Sodium	mg/kg	24	18	23	15	36	3	29	14	33	24	20	19	14	10	25	27
12	Potassium	mg/kg	3.2	0.4	1.2	6.3	1.3	0.8	2.1	1.7	2.2	2.2	2.2	3.6	1.8	1.7	2.8	2.9
D)	**Exchangeable**																	
13	Sulphate	mg/kg	39	27	43	44	44	49	46	21	30	58	84	62	74	53	56	60
14	Nitrate	mg/kg	4.1	3.4	5.7	3.0	3.1	5.7	4.1	3.0	3.3	3.4	4.6	3.7	4.9	2.2	3.6	3.2
15	Nitrite	mg/kg	0.09	0.01	0.13	0.00	0.14	0.00	0.00	0.00	0.06	0.26	0.03	0.03	0.12	0.00	0.00	0.17
E)	Phosphate	mg/kg	1.6	2.4	3.2	1.6	1.3	2.0	1.7	1.2	2.1	2.0	2.3	8.4	2.7	1.1	1.5	1.9
16	Chloride	mg/kg	3.1	1.7	3.4	4.7	4.9	2.1	1.8	2.6	1.3	0.7	1.2	1.9	2.8	0.3	4.7	5.1
17	**Heavy Metals**																	
18	Iron (Fe^{2+})	mg/kg	2.02	2.86	1.93	2.86	1.14	1.03	0.86	1.99	0.73	1.57	0.62	1.11	0.89	0.04	1.15	0.94
19	Zinc (Zn^{2+})	mg/kg	1.226	0.021	0.052	2.701	2.586	1.971	2.863	2.004	2.189	1.963	1.424	1.562	1.007	1.020	2.546	1.56
20	Copper (Cu^{2+})	mg/kg	0.08	0.01	0.03	0.05	0.11	0.17	0.28	0.24	0.11	0.18	0.26	0.17	0.12	0.05	0.12	0.94
21	Cobalt (Co^{2+})	mg/kg	0.110	0.206	0.148	0.121	0.126	0.018	0.012	0.011	0.122	0.013	0.016	0.018	0.004	0.002	0.157	0.037
22	Manganese	mg/kg	0.05	0.03	0.17	0.05	0.025	0.14	0.26	0.18	0.09	0.18	0.07	0.13	0.09	0.01	0.08	0.52
23	Chromium	mg/kg	0.02	0.01	0.00	0.03	0.00	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.01
24	Nickel (Ni^{2+})	mg/kg	0.001	0.000	0.000	0.000	0.011	0.024	0.000	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
25	Mercury (Hg^{2+})	mg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	Lead (Pb^{4+})	mg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F)	**Organic**																	
27	Phenols	mg/kg	0.03	0.02	0.36	0.48	0.21	0.16	0.02	0.00	0.89	1.47	0.59	0.13	0.23	0.18	0.14	0.18
28	BTEX	mg/kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Oil & Grease	mg/kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G)	Soil																	
30	Sandy	%	39	44	24	35	27	23	18	25	38	25	17	45	35	45	19	25
31	Loam	%	41	25	49	29	28	13	39	40	51	29	35	24	39	30	28	24
32	Clay	%	15	24	13	15	31	50	35	27	11	19	18	14	13	29	48	27
33	Silt	%	5	7	14	21	14	14	8	8	0	27	11	6	12	9	15	0
H)	**Microbiological**																	
34	E.Coli	cfu/100k	8	15	6	21	2	18	7	31	16	12	19	6	14	13	9	18
35	Fungal	cfu/100k	74	64	189	74	66	211	51	48	356	39	86	12	57	10	14	241

Source: Field Data ESIA of Greenville CNG Mother Station Project, 2026.

4.3.4.1 Result Discussion on Soil Analysis of the Project Site

The soils were predominantly brown, pale brown and dark brown, with one sampling location exhibiting a pale greyish colour. These colour variations reflect differences in organic matter content, drainage characteristics and parent geological materials. Brown and dark brown soils generally indicate moderate organic matter accumulation and good aeration, whereas the pale greyish soil may be associated with localized poor drainage or prolonged moisture retention. The observed colour distribution is characteristic of tropical ferruginous soils commonly found within the Guinea Savannah ecological zone of central Nigeria and suggests that the soils have not undergone severe degradation or contamination.

The soil pH ranged from 5.79 to 8.89, while the control locations recorded values between 7.56 and 8.35. The results indicate that the project area consists of soils varying from slightly acidic through neutral to moderately alkaline conditions. Most sampling locations recorded pH values between 6.0 and 8.5, which fall within the range generally regarded as suitable for agricultural productivity, microbial activity and engineering applications. The few locations with pH values above 8.5 represent localized alkaline conditions that are likely attributable to natural variations in parent geological materials rather than contamination. Likewise, the isolated slightly acidic soils (pH 5.79 and 5.88) are typical of tropical soils subjected to prolonged weathering and leaching. Overall, the measured pH values indicate that the proposed project site has not been adversely affected by acidic or alkaline pollution and possesses favourable soil chemical conditions.

Electrical conductivity (EC) ranged from 386 to 2,964 µS/cm, while the control soils recorded values between 964 and 1,341 µS/cm. These values indicate low to moderate concentrations of soluble salts within the soils. Although some locations exhibited relatively higher conductivity, none approached the salinity levels typically associated with degraded or saline soils. The results therefore indicate that salt accumulation is not presently an environmental concern and that the soils remain suitable for vegetation establishment and engineering construction. The relatively higher conductivity observed at a few sampling points is more likely associated with natural mineral composition than anthropogenic contamination.

Soil temperature ranged between 25.9 and 33.1°C, reflecting normal tropical environmental conditions. These temperatures support active microbial activity, organic matter decomposition and nutrient cycling. The absence of abnormally elevated temperatures indicates that the project site has not experienced thermal impacts associated with industrial activities.

The concentrations of exchangeable cations demonstrate that the soils possess moderate nutrient status. Ammonium concentrations ranged from 0.026 to 3.083 mg/kg, indicating relatively low nitrogen accumulation and minimal influence from anthropogenic nitrogen inputs. Calcium concentrations varied between 2.01 and 6.21 mg/kg, while magnesium ranged from 0.90 to 1.96 mg/kg. These nutrients contribute to favourable soil structure, nutrient availability and root development. Sodium concentrations ranged from 3 to 36 mg/kg, remaining relatively low and indicating that the soils are non-sodic and therefore not susceptible to structural deterioration caused by excessive sodium accumulation. Potassium concentrations varied from 0.4 to 6.3 mg/kg, reflecting moderate potassium availability capable of supporting natural vegetation. Collectively, these results indicate that the soils possess balanced exchangeable cation concentrations and have not been significantly altered by industrial contamination or excessive fertilizer application.

Exchangeable anions also occurred at relatively low concentrations. Sulphate ranged from 21 to 84 mg/kg, nitrate from 2.2 to 7.3 mg/kg, nitrite from 0.00 to 0.26 mg/kg, phosphate from 1.1 to 8.4 mg/kg, and chloride from 0.3 to 5.1 mg/kg. These values are characteristic of natural tropical soils and indicate moderate nutrient availability without evidence of excessive nutrient enrichment or chemical contamination. The relatively low nitrate concentrations suggest limited accumulation of nitrogenous wastes, while the moderate phosphate concentrations indicate adequate phosphorus availability for vegetation without suggesting significant fertilizer contamination. Overall, the anion concentrations reflect stable soil chemical conditions suitable for sustaining vegetation and supporting the proposed development.

The heavy metal assessment indicates that the project area has not been affected by significant metal contamination. Iron concentrations ranged from 0.04 to 3.68 mg/kg, representing natural background levels commonly associated with ferruginous tropical soils. Zinc concentrations ranged from 0.021 to 2.863 mg/kg, copper from 0.01 to 1.00 mg/kg, chromium from 0.00 to 0.64 mg/kg, nickel from 0.000 to 0.024 mg/kg, cobalt from 0.002 to 0.411 mg/kg, while mercury and lead were not detected in any sample. These concentrations are substantially lower than the target and intervention values specified under the Department of Petroleum Resources (now Nigerian Upstream Petroleum Regulatory Commission) Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN, 2018). The absence of detectable mercury and lead, together with the extremely low concentrations of other trace metals, demonstrates that the soils have not experienced contamination from petroleum products, industrial wastes or hazardous materials and therefore represent natural background conditions.

The concentrations of organic contaminants were generally very low. Phenol concentrations ranged from 0.00 to 1.47 mg/kg, indicating only minor organic inputs within the study area. Oil and grease concentrations varied between 0 and 1.6 mg/kg, demonstrating the absence of significant petroleum contamination. BTEX compounds were not detected in the majority of samples, although isolated detections of 2.3 mg/kg and 7.0 mg/kg occurred at a few sampling locations. These isolated occurrences are relatively low and may reflect localized anthropogenic activities such as vehicular movement or previous small-scale fuel handling rather than widespread hydrocarbon contamination. Importantly, the overall distribution of BTEX indicates that petroleum pollution has not significantly affected the project site prior to development.

Particle size analysis indicates that the soils are dominated by loamy, sandy loam and clay loam textures, with sand ranging from 11 to 45%, loam from 13 to 69%, clay from 8 to 71%, and silt from 0 to 40%. The predominance of loamy soils provides favourable physical properties, including moderate permeability, good drainage, adequate moisture retention and satisfactory bearing capacity for civil engineering works. Areas containing higher clay contents may exhibit localized shrink-swell characteristics during seasonal moisture fluctuations; however, these are unlikely to present significant engineering constraints provided that appropriate geotechnical investigations are undertaken during detailed design. Overall, the soil texture is suitable for supporting both vegetation and infrastructure development.

Microbiological analysis revealed E. coli concentrations ranging from 2 to 96 cfu/100 kg, while fungal counts ranged from 10 to 356 cfu/100 kg. These microbial populations are typical of productive tropical soils where active decomposition of organic matter occurs. The presence of soil microorganisms reflects healthy biological activity and contributes to nutrient cycling, organic matter mineralization and soil fertility. The observed microbial counts are therefore indicative of natural ecological processes rather than environmental degradation.

Generally, the baseline soil quality within the proposed Greenville LNG CNG Mother Station is good and suitable for the proposed development. The soils exhibit favourable physicochemical characteristics, balanced nutrient status, low salinity and predominantly loamy textures that provide suitable conditions for construction activities. Heavy metals occur at concentrations consistent with natural background levels and are substantially below the applicable EGASPIN (2018) guideline values, while mercury and lead were not detected. Organic contamination is minimal, with only isolated low-level BTEX detections and negligible oil and grease concentrations, indicating the absence of widespread hydrocarbon pollution. Consequently, the results establish that the project area has not been significantly impacted by previous industrial activities and provides a robust environmental baseline against which future construction and operational impacts of the proposed CNG Mother Station can be monitored and evaluated.

4.3.5 Geology and Hydrogeology of the Project Area

Geology: The study area is located within the Central Nigeria Precambrian Basement Complex. (Figure 4.12) The geology of the area has been studied and discussed by previous publications like Oyawoye (1972), McCurry (1976) etc. They described the rocks as comprising mostly granite, gneisses, mica schists, hornblende and feldspathic schists and migmatites. The rocks are highly fractured and jointed showing essentially two fracture patterns, NE – SW and NW – SE. These fractures control the drainage and flow patterns of rivers in the area. However, minor Cretaceous deposits of Nupe sandstones occur in the southern part of FCT between Gwagwalada and Abaji, extending to Rubochi and the border with Nasarawa State. Similarly, metasediments have also been mapped along a general NNE-SSW direction through the west of Kusaki (in the south) and east of Takushara (in the north) (USGS 1977).

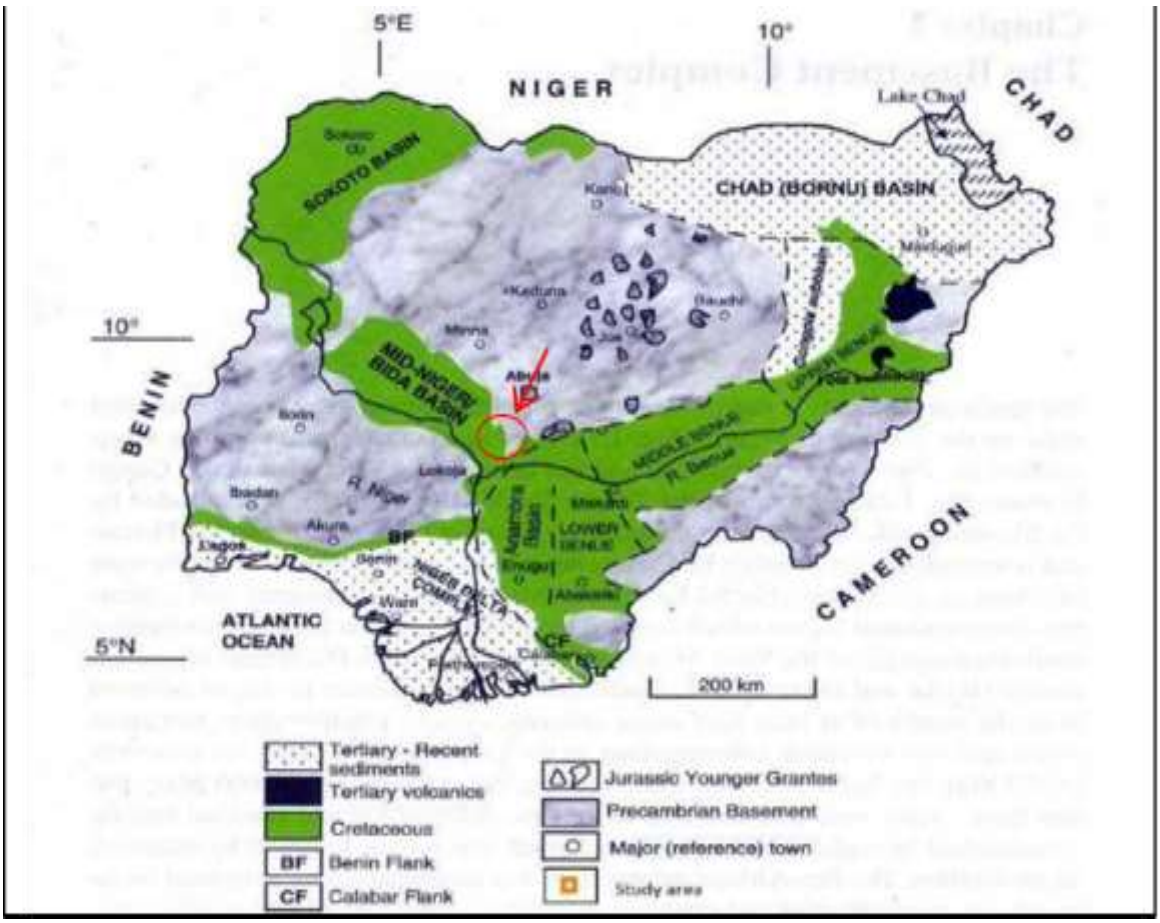

Figure 4.6: Geological Map of Nigeria showing the Project location (Source: Obrike *et al*)

Hydrogeology

The water resources of the area comprise both the surface and groundwater sources. The groundwater component of the water resources of the area is contained in the aquifers

and basement rocks. Hydrogeological, two types of aquifers are recognized namely, the regolith or weathered basement aquifers and the fractured zone aquifers. Therefore, geology and climate are the limiting factors of groundwater occurrence in hard rocks. Fortunately, there exists in the area a thick loose and discontinuous blanket of decayed and decaying rock debris (regolith). A combination of thick regolith and high rainfall and favorable temperature pattern in the FCT offers a conducive condition for occurrence of groundwater. The decayed/decaying and fresh rock fragments lie on top of, below and adjacent one another in an irregular manner creating intergranular spaces between rock fragments lying together. Precipitation introduces water into the regolith through the usually numerous pore spaces. The regolith therefore acts as a storage medium for water from rainfall and can also transmit water vertically and horizontally to underlying rocks. If the underlying bed rock has high fracture density, regolith can serve to transmit water to underlying bedrock storage sites (Abam et al., 2013).

Hydrology

The region's topography is predominantly undulating, with elevations ranging from about 76 meters above sea level in the southwestern floodplains of the River Gurara to over 1,000 meters in the northwestern highlands. The landscape features broad plains interspersed with hills and prominent inselbergs such as Zuma Rock. Hydrologically, Abuja is defined by a complex network of surface and groundwater systems that are vital to the region's water resources. The Gurara River originates from the highlands in Kaduna State, cutting course through parts of Kaduna and Niger States before joining the River Niger. Along its journey, the river passes the well-known Gurara Waterfalls, a major natural attraction in Niger State. A portion of the Gurara River's flow is channeled into the Federal Capital Territory (FCT), where it serves as a vital water source.

Within the FCT, it feeds into and sustains several smaller streams, including the Rubia, Gwagwalada, and Usmanu streams, which traverse different districts of the territory, supporting local ecosystems and providing water for domestic and agricultural use. These streams generally follow a west-southwest (WSW) flow direction, reflecting the regional slope from northeast to southwest. The area exhibits a dendritic to trellis drainage pattern, typical of terrain shaped by structural controls and the weathering of basement complex rocks. Many of the streams display seasonal flow behavior, with temporary channels becoming active during periods of heavy rainfall, playing an important role in surface water transport and groundwater recharge.

4.3.6 Terrestrial Flora and Fauna

4.3.6.1 Ecoregion and Landscapes

The proposed project area falls within the guinea savannah ecological zone of Nigeria. In a broader perspective, the vegetation unit within the ecoregion is characterized by large wooded savannah trees and shrubs, with patches of fallow land interspersed within agricultural fields. Habitat in this ecoregion has been reduced, degraded and fragmented by agricultural activities, fire and other changes to the land use. There are considerable pressures on the land from seasonal farming, grazing animals, cutting trees and bushes for wood, burning woody material for charcoal, and from wild fires.

4.3.6.2 Biodiversity and Conservation

Some relevant datasets have been considered and reviewed to provide a suitable description of the project area, whilst also considering the surrounding areas. Key among this is the dataset of Protected Areas across Nigeria based on the IUCN and UNEP-WCMC (2016) categorization. This dataset displays areas that are legally protected according to various designations and managed to achieve conservation objectives. The project area is not located in a protected area, but a number of areas classified as Forest reserve and "not reported" are located in the larger region. Based on this, the nearest protected area within proximity to the proposed project area are the Odu and Galadima Forest reserve, located approximately 15 km-south-east and north of the project area, and is not relevant to the project.

4.3.6.3 Habitats Types

Modified Woodland, Fallow Land and Agricultural fields

This habitat consisted mostly of degraded woodland resulting from loss of primary savannah forest and fallow land (arable land used for rotational crop cultivation) in various states of utilization and recovery. This habitat also comprised of existing agricultural fields consisting of cultivation of mature cereal crops, mostly millet and guinea corn. Further observed in-between these areas were patches of modified shrubland as well as dense and scattered stands of matured trees. These patches have been further modified by livestock grazing within the area. Considering that the agricultural fields and crop cultivations were created through opening of existing forest, these areas formed a mosaic with the woodland and fallow land and therefore could not be delineated as a unit on its own.

This habitat type has undergone large direct impacts associated with the local community including harvest of wood for charcoal production and fuel wood. The vegetation found here consist of mostly of shrubs and grasses that are known to grow in disturbed areas. The flora species composition within this area indicated they all have medicinal and food

properties with evidence of harvesting seen in some instances. No IUCN Red-listed plant species were recorded within this habitat.

4.3.6.4 Flora Assessment

The flora study covered the assessment of all the vegetation units and habitat types within the project AoI. The assessment was focused on the proposed area for the development, with special attention to habitat types as well as occurrence of any IUCN red list-data species. A literature review was conducted as part of the assessment to identify the potential habitats present within the project area. The flora species expected in the project area was based on review of research articles covering the project area. This was further complimented with the review of flora species list on the IUCN (2025) site covering the project area.

As part of the floristic survey, a rapid floristic assessment was adopted which entailed traversing the proposed project area by motor-bike and on foot. The floristic diversity and search for flora Species of Conservation Concern (SCC) was conducted through timed meandering of the project footprint and surrounding AoI within a 1km buffering created from the project footprint boundary. The species encountered were recorded within a specified amount of time, with additional time added based on complexity of accessing some sections the project area. The approach is 'plotless' and therefore requires no pre-determined points. In addition, opportunistic observations were made while moving through the project area. Species identification was done in the field when possible, using the flora field guides.

All the species recorded were non-endemic and there were no Species of Conservation Concern (SCC). This finding is indicative of some level of habitat disturbance, likely resulting from loss of primary forest and ongoing anthropogenic activities such as farming, mining, and fuelwood harvesting within the project area. A selection of some of the flora species observed during the field survey are shown in Plate 4.5 below.

The wet season survey revealed a more luxuriant and diverse vegetation cover compared to the dry season. Herbaceous species such as Chromolaena odorata, Ageratum conyzoides, and Panicum maximum exhibited vigorous growth due to increased soil moisture, while annual weeds were in full bloom and contributed to the green canopy observed across the area. Several ephemeral herbs were recorded only during this period, highlighting the seasonal dynamics of the vegetation.

Tree species such as Daniellia oliveri, Parkia biglobosa, and Vitellaria paradoxa exhibited new flushes of leaves and flowering, providing important ecosystem services such as shade, fodder, and nectar sources for pollinators. The wet season also promoted regeneration of fallow lands and the growth of grasses that serve as grazing fodder for

livestock. Overall, the wet season data suggest that the ecosystem demonstrates moderate resilience, with active regeneration potential despite anthropogenic pressures.

Table 4:6: Flora Species Recorded in the Proposed Project Area

Scientific Name	Common Name	Family	IUCN Status	Endemic Status	Growth Form	Uses
Azadirachta indica	Neem tree	Meliaceae	LC	Non-Endemic	Tree	Medicinal use
Adansonia digitata	Baobab	Bombacaceae	LC	Non-Endemic	Tree	Medicinal use & food
Isoberlina doka	-	Caesalpinioideae	LC	Non-Endemic	Tree	Medicinal use
Amaranthus spinosus	-	Amaranthaceae	LC	Non-Endemic	Tree	Medicinal use & food
Mangifera indica	Mango	Anacardiaceae	LC	Non-Endemic	Tree	Consumed as food
Calotropis procera	Swallow wort	Apocynaceae	LC	Non-Endemic	Shrub	Medicinal use
Balanites aegyptiaca	Thorn tree	Balanitaceae	LC	Non-Endemic	Tree	Medicinal use & food
Guiera senegalensis	-	Combretaceae	LC	Non-Endemic	Grass	Medicinal use
Chamaecrista mimosoides	Fishbone cassia	Fabaceae	LC	Non-Endemic	Herb	Medicinal use
Crotalaria pallida	Small Rattlebox	Fabaceae	LC	Non-Endemic	Shrub	Ground cover crop
Mimosa pigra	Black Mimosa	Fabaceae	LC	Non-Endemic	Shrub	Medicinal use
Mesosphaerum suaveolens	Wide Spikenard	Lamiaceae	LC	Non-Endemic	Herb	Medicinal use
Bombax costatum	Red kapok tree	Bombacaceae	LC	Non-Endemic	Shrub	Medicinal use & food
Sida cordifolia	Flannel weed	Malvaceae	LC	Non-Endemic	Shrub	Medicinal use
Sida acuta	Broom weed	Malvaceae	LC	Non-Endemic	Herb	Medicinal use
Acacia nilotica	Egyptian mimosa	Mimosoideae	LC	Non-Endemic	Tree	Medicinal use & food
Moringa oleifera	Never die	Moringaceae	LC	Non-Endemic	Tree	Medicinal use & food
Eucalyptus tereticornis	Forest redgum	Myrtaceae	LC	Non-Endemic	Tree	Medicinal use & food
Cenchrus biflorus	Hedgehog grass	Poaceae	LC	Non-Endemic	Grass	Medicinal use & food
Anacardium occidentalis	Cashew tree	Anacardiaceae	LC	Non-Endemic	Tree	Medicinal use & food
Annona senegalensis	Wild custard apple	Annonaceae	LC	Non-Endemic	Tree	Medicinal use & food
Anogeissus leiocarpus	African birch	Combretaceae	LC	Non-Endemic	Tree	Medicinal use
Anthocleista djalonesis	Cabbage tree	Loganiaceae	LC	Non-Endemic	Tree	Medicinal use
Daniela oliveri	African Copaiba balsam	Caesalpinioideae	LC	Non-Endemic	Tree	Medicinal use
Gmelina arborea	Gmelina	Verbenaceae	LC	Non-Endemic	True	Medicinal use and timber
Elaeis guineensis	Oil Palm	Arecaceae	LC	Non-Endemic	Tree	Consumed as food
Ageratum conyzoides	Goat weed	Asteraceae	LC	Non-Endemic	Herb	Medicinal use
Cocos nucifera	Coconut	Arecaceae	LC	Non-Endemic	Tree	Consumed as food
Saccharum officinalis	Sugar cane	Poaceae	LC	Non-Endemic	Grass	Consumed as food
Chromolaena odorata	Chromolaena	Asteraceae	LC	Non-Endemic	Herb	Medicinal use
Khaya senegalensis	Dry zone mahogany	Meliaceae	LC	Non-Endemic	Tree	Medicinal use

Scientific Name	Common Name	Family	IUCN Status	Endemic Status	Growth Form	Uses
Lophira lanceolata	Red oak	Ochnaceae	LC	Non-Endemic	Tree	Medicinal use
Parkia biglobosa	African locust bean	Mimosoideae	LC	Non-Endemic	Tree	Medicinal use & food
Piliostigma thonningii	Camel's foot	Caesalpinioideae	LC	Non-Endemic	Shrub	Medicinal use
Spondias monbin	Hog plum	Anacardiaceae	LC	Non-Endemic	Tree	Medicinal use
Ficus sycomorus	Bush fig	Moraceae	LC	Non-Endemic	Tree	Medicinal use
Ficus exasperate	Sandpaper tree	Moraceae	LC	Non-Endemic	Tree	Consumed as food
Psidium guajava	Guava	Myrtaceae	LC	Non-Endemic	Tree	Medicinal use & food
Tamarindus indica	Tamarind	Caesalpinioideae	LC	Non-Endemic	Tree	Consumed as food
Triplochiton scleroxylon	African silk moth tree	Sterculiaceae	LC	Non-Endemic	Tree	Medicinal use
Uapaca togoensis	Uapaca	Euphorbiaceae	LC	Non-Endemic	Tree	Medicinal use
Vitex doniana	Black plum	Verbenaceae	LC	Non-Endemic	Tree	Medicinal use
Sarcocephalus latifolius	African peach	Rubiaceae	LC	Non-Endemic	Tree	Medicinal use
Sterculia setigera	Karaya gum tree	Sterculiaceae	LC	Non-Endemic	Tree	Medicinal use
Pericopsis laxiflora	Satin wood	Fabaceae	LC	Non-Endemic	Tree	Medicinal use

4.3.6.5 Faunal Assessment

Understanding the habitat requirements (habitat utilization) of a species at the project site is important for the prediction of environmental impact and any mitigation measure that can be predicted for the conservation of such endemic species. To effectively understand the faunal species composition, present in the proposed project area, a desktop review was undertaken, utilizing research articles and dataset of faunal composition within the project area. The desktop review and assessment approach involved undertaking various activities such as; review of expected species lists and identification of any red-list data or species of conservation concern (SCC) present or potentially occurring in the area. This was done with emphasizes on the probability of occurrence of species of conservation importance.

The fauna field survey approach for the proposed project was undertaken by adopting the direct and indirect approach. The direct survey techniques include but not limited to recording species based on visual observation with eyes. Calls as well as binoculars digital cameras were utilised for especially for avifauna survey. Field guides were utilised to aid in proper identification of the different fauna species within the project area. The herpetofauna survey was undertaken based on a variety of active and passive techniques, as the cryptic nature and habits of herpetofauna species implies that certain species within the project area could not have been recorded. This necessitated approach such as diurnal active hand search especially for reptile species that shelter in or under micro-habitats such as the rocks, woody debris, leaf litter, etc. On the other hand, the indirect survey approach involved recording of fauna species based on identification of faecal droppings, trails, burrows. Local knowledge of fauna species within the area was obtained through interviews with members of local community especially hunters and farmers.

A large portion of the project area is made up of modified forest, which results in more occurrence of terrestrial species. During field observations a greater number of fauna species comprised of avifauna, with fewer numbers of mammal and herpetofauna species. The scarcity of mammal species result of the field observations is likely due to the habitat conditions and the disturbed nature of the area from farming and mining activities as well as other anthropogenic activities in the area. The fauna species as observed during the field assessment is listed in *Table 4.7* below. A total of forty-eight (48) species were observed during the field assessment. None of the species recorded are species of conservation concern.

Table 4.7: Fauna Species in the Project area

Scientific Name	Common Name	IUCN Status	Endemic Status
Avifauna			
Milvus migrans	Yellow-billed Kite	LC	Not endemic
Eurystomus glaucurus	Broad-billed Roller	LC	Not endemic
Polyboroides typus	African Harrier Hawk	LC	Not endemic
Halcyon senegalensis	Woodland Kingfisher	LC	Not endemic
Cinnyris venustus	Variable Sunbird	LC	Not endemic
Corvus albus	Pied Crow	LC	Not endemic
Crinifer piscator	Western Grey Plantain-eater	LC	Not endemic
Crithagra mozambica	Yellow-fronted Canary	LC	Not endemic
Phalacrocorax africanus	Reed Cormorant	LC	Not endemic
Turtur tympanistria	Tambourine Dove	LC	Not endemic
Ploceus cucllatus	Village Weaver	LC	Not endemic
Chrysococcyx klaas	Klaas's Cuckoo	LC	Not endemic
Poicephalus senegalus	Senegal Parrot	LC	Not endemic
Scopus umbretta	Hamerkop	LC	Not endemic
Chrysococcyx caprius	Diederik Cuckoo	LC	Not endemic
Cyanomitra olivacea	Olive Sunbird	LC	Not endemic
Turdus pelios	African Thrush	LC	Not endemic
Streptopelia semitorquata	Red-eyed Dove	LC	Not endemic
Falco tinnunculus	Common Kestrel	LC	Not endemic
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	LC	Not endemic
Cinnyris coccinigastrus	Splendid Sunbird	LC	Not endemic
Camaroptera brevicaudata	Grey-backed Camaroptera	LC	Not endemic
Pycnonotus barbatus	Common Bulbul	LC	Not endemic
Pternistis bicalcaratus	Double-spurred Francolin	LC	Not endemic
Tringa tetanus	Senegal Coucal	LC	Not endemic
Prinia subflava	Tawny-flanked Prinia	LC	Not endemic
Terpsiphone rufiventer	Red-billed Paradise	LC	Not endemic
Passer griseus	Northern Grey-headed	LC	Not endemic
Cypsiurus parvus	African Palm Swift	LC	Not endemic
Ardea cinerea	Grey Heron	LC	Not endemic
Kaupifalco monogrammicus	Lizard Buzzard	LC	Not endemic
Tockus nasutus	African grey hornbill	LC	Not endemic
Lamprotornis caudatus	Long-tailed Glossy Starling	LC	Not endemic
Spermestes cucullata	Bronze Mannikin	LC	Not endemic
Turtur afer	Blue-spotted Wood Dove	LC	Not endemic
Coracias abyssinicus	Abyssinian Roller	LC	Not endemic
Halcyon malimbica	Blue-breasted Kingfisher	LC	Not endemic
Columba guinea	Speckled Pigeon	LC	Not endemic
Bubulcus ibis	Cattle Egret	LC	Not endemic
Butorides striata	Striated Heron	LC	Not endemic
Streptopelia vinacea	Vinaceous Dove	LC	Not endemic
Tchagra senegalus	Black-crowned Tchagra	LC	Not endemic
Mammals			
Thryonomys swinderianus	Grasscutter	LC	Not endemic
Cricetomys gambianus	Giant Rat	LC	Not endemic
Protexerus stranger	Giant Squirrel	LC	Not endemic
Reptile			
Trachylepis homalocephala	Red-sided Skink	LC	Non-endemic

Scientific Name	Common Name	IUCN Status	Endemic Status
Agama agama	Common Agama	LC	Non-endemic
Amphibians			
Hyperolius spatzi	African reed frog	LC	Non-Endemic

4.4 Socio-Economics

The socioeconomic study was conducted in Izom Community, located within Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja. Izom is a predominantly rural agrarian settlement situated along the Abuja-Kaduna-Kano (AKK) Gas Pipeline corridor where the proposed Compressed Natural Gas (CNG) Mother Station Project is planned.

The community is strategically located along the boundary between the Federal Capital Territory and Niger State, with parts of the larger Izom settlement extending into Gurara Local Government Area of Niger State. The community is predominantly inhabited by the Gbagyi ethnic group and has a well-established traditional governance system headed by the Dagacin of Izom, supported by community elders, youth leaders, women leaders, and other traditional title holders.

The study covered households, community leaders, women groups, youth representatives, farmers, traders, fishermen, transport operators, and other relevant stakeholders within the project area of influence.

The study area was selected because it falls within the zone likely to experience direct and indirect socioeconomic impacts associated with the construction and operation of the proposed CNG Mother Station Project.

4.4.1 Sampling Technique and Sample Size Determination

A household-based survey approach was adopted for the study. The sampling process was designed to ensure adequate representation of various socioeconomic groups within the community.

The determination of sample size was guided by the Yamane (1967) formula for finite populations at a 95% confidence level and 5% margin of error.

The formula is expressed as:

$n = N / [1 + N(e^2)]$

Where:

n = Required sample size

N = Estimated household population

e = Level of precision (0.05)

Based on reconnaissance survey, stakeholder consultations, and available community information, Izom Community was estimated to contain approximately 1,200 households.

Applying the formula:

$n = 1200 / [1 + 1200(0.05^2)]$

$n = 1200 / 4$

$n = 300$

Therefore, a total of three hundred (300) questionnaires were administered across the community.

Table 4.8: Sample Size Determination

Parameter	**Value**
Estimated Number of Households	1,200
Confidence Level	95%
Margin of Error	5%
Formula Used	Yamane (1967)
Calculated Sample Size	300
Questionnaires Administered	300

To ensure broad representation, respondents were selected from different sections of the community, including residential areas, farming settlements, commercial areas, and locations situated close to the proposed project site.

4.4.2 Data Collection Methods

Both primary and secondary data collection methods were employed during the socioeconomic assessment.

Primary Data Collection: Primary data were obtained through:

a. Household Questionnaire Survey

Structured questionnaires were administered to 300 household heads and adult residents across the community. Information collected included:

- Demographic characteristics
- Household size
- Occupation and income
- Education level
- Housing conditions
- Water supply sources
- Healthcare access
- Waste management practices
- Community perceptions of the proposed project

b. Key Informant Interviews (KII)

Interviews were conducted with selected stakeholders and community leaders to obtain in-depth information on community history, governance structure, cultural heritage, existing infrastructure, livelihood activities, and expectations regarding the proposed project.

Key informants included:

- Dagacin of Izom
- Community elders
- Youth leaders
- Women leaders
- Religious leaders
- Farmers and fishermen representatives

c. Stakeholder Consultation Meetings

Community consultation meetings were organized to provide information on the proposed project and obtain feedback from stakeholders.

Participants included:

- Traditional authorities
- Community members
- Youth groups
- Women groups
- Representatives of government agencies
- Project proponents
- Environmental consultants

Issues discussed included potential project benefits, environmental concerns, employment opportunities, local content participation, and community development expectations.

d. Field Observation

Direct observations were undertaken throughout the study area to assess:

- Housing conditions
- Community infrastructure
- Water supply facilities
- Road network
- Healthcare facilities

- Educational facilities
- Environmental sanitation conditions

Observations made during the field exercise were used to validate information obtained from questionnaires and interviews.

Secondary Data Collection

Secondary information was obtained from:

- National Population Commission (NPC) publications
- Academic literature
- Government publications

The secondary data provided useful background information on demographic characteristics, environmental conditions, and socioeconomic conditions within the study area.

4.4.3 Data Analysis

Completed questionnaires were checked, coded, and entered into Statistical Package for Social Sciences (SPSS) software for analysis.

Descriptive statistical techniques were employed to analyze the data. These included:

1. Frequency distribution
2. Percentages
3. Cross-tabulations
4. tables

Results were presented in tabular and narrative formats to facilitate interpretation and reporting.

Qualitative information obtained from stakeholder consultations, key informant interviews, and field observations was analyzed using content analysis techniques. Responses were grouped according to common themes and integrated into the assessment findings.

The analysis focused on identifying the existing socioeconomic conditions of Izom Community, stakeholder perceptions of the proposed project, potential socioeconomic impacts, and issues requiring consideration during project implementation.

The outcome of the analysis formed the basis for assessing potential project impacts and developing appropriate mitigation and community development measures in accordance with the requirements of the Federal Ministry of Environment.

4.5 Profile of the Study Area

This section presents the profile of Izom Community, Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja. The description focuses on the location,

administrative arrangement, traditional governance system, and cultural setting of the community. This provides background information necessary for understanding the socioeconomic conditions of the study area.

4.5.1 Location and Administration

Izom Community is located within Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja. The community lies along the Abuja-Kaduna highway corridor and serves as one of the major settlements situated along the Abuja-Kaduna-Kano (AKK) Natural Gas Pipeline route. The proposed Compressed Natural Gas (CNG) Mother Station Project is planned within the Izom axis, making the community part of the project's area of influence.

Izom occupies a strategic location along the boundary between the Federal Capital Territory and Niger State. While the principal settlement falls within Gwagwalada Area Council of the FCT, portions of the wider Izom settlement extend into Gurara Local Government Area of Niger State. This unique location has encouraged social and economic interactions between residents of both administrative areas. The community is predominantly inhabited by the Gbagyi ethnic group, who constitute the indigenous population. Farming remains the dominant economic activity, while trading, fishing, transportation services, and small-scale businesses provide supplementary sources of livelihood.

Administratively, Izom falls under the authority of Gwagwalada Area Council and operates a traditional governance system recognized by the local population. Community affairs are coordinated through the traditional institution headed by the Dagacin of Izom, who serves as the principal custodian of culture, customs, and community administration.

Table 4.9: Administrative Profile of Izom Community

Item	Description
Community	Izom
Area Council	Gwagwalada Area Council
Territory	Federal Capital Territory (FCT)
Neighbouring State	Niger State
Major Ethnic Group	Gbagyi
Predominant Religion	Islam
Main Language	Gbagyi

Item	Description
Major Occupation	Farming
Secondary Occupations	Trading, Fishing, Artisanship and Civil Service
Traditional Head	Hon. Judge Abubakar Lado Ahmad (Dagacin of Izom)

4.5.2 Traditional Governance Structure

The traditional institution remains an important component of governance and social organization within Izom Community. The system provides leadership, conflict resolution, cultural preservation, and liaison between the community and government agencies.

The traditional leadership structure is headed by the Dagacin of Izom, who is supported by other traditional title holders, elders, youth leaders, women leaders, and community representatives. During stakeholder consultations conducted for this study, the Dagacin of Izom, community elders, youth representatives, women leaders, and other traditional authorities actively participated in discussions relating to the proposed project.

The current traditional ruler of Izom Community is Hon. Judge Abubakar Lado Ahmad, who serves as the Dagacin of Izom.

Figure 4.7 Traditional Governance Structure

The traditional governance system remains effective in mobilizing community members, resolving disputes, facilitating development initiatives, and coordinating engagement with external stakeholders.

4.5.3 Ethnicity and Cultural Heritage

The population of Izom Community is predominantly composed of the Gbagyi ethnic group, one of the major indigenous ethnic nationalities within the Federal Capital Territory and parts of Niger State. The Gbagyi people are widely known for their agricultural heritage, communal lifestyle, respect for traditional authority, and strong attachment to ancestral land.

The Gbagyi language is the primary means of communication among community members, although Hausa and English are also spoken, particularly among traders, government workers, and younger residents.

Religion

The community is predominantly Muslim. Findings from the socioeconomic survey revealed that approximately 86% of respondents practice Islam, while Christianity accounts for about 13% of the population. Traditional religious practices are observed by a small proportion of residents, often alongside mainstream religious beliefs.

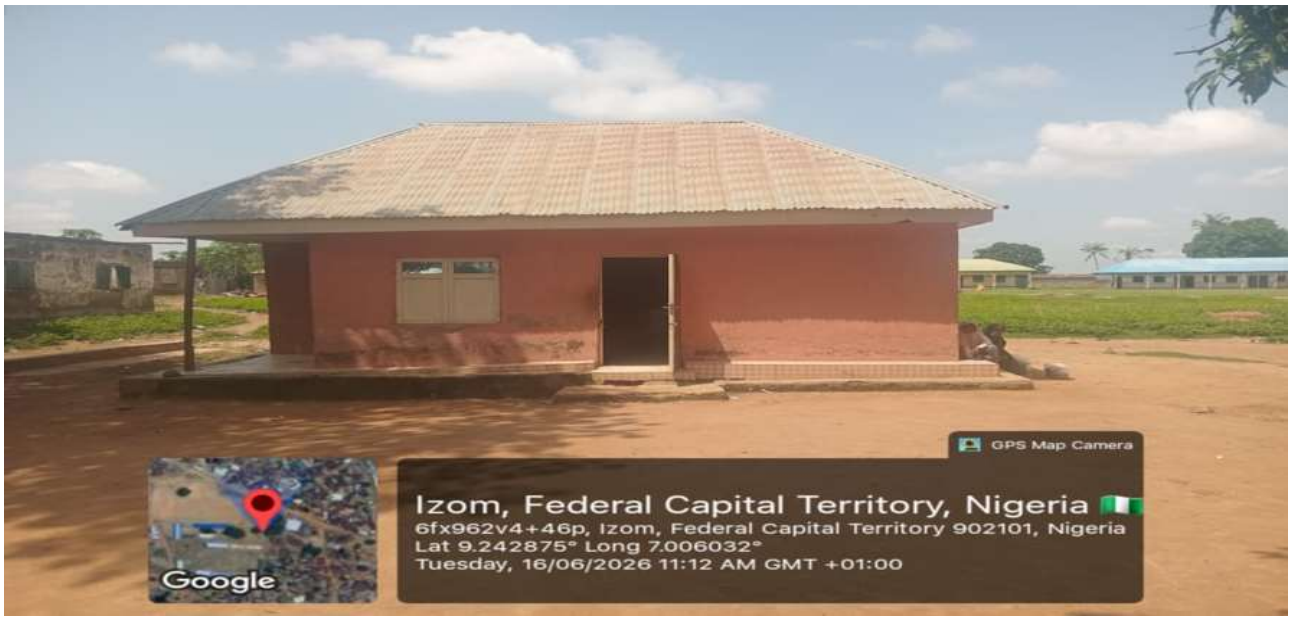

Plate 4.3: Mosques at Izom Community

Religion plays an important role in community life and influences social behaviour, festivals, conflict resolution mechanisms, and communal activities.

Cultural Practices and Heritage

The people of Izom maintain several cultural traditions inherited from their ancestors. These traditions promote social cohesion, respect for elders, peaceful coexistence, and communal development.

Important cultural characteristics observed during the study include:

- Respect for traditional authority and elders.
- Strong family and kinship relationships.
- Community participation in social and development activities.
- Collective decision-making through consultation with traditional leaders.
- Preservation of indigenous customs and local language.

Cultural Sites and Sacred Areas

Consultations with community leaders indicated that there are locations regarded as culturally significant within the community. Such locations may include ancestral sites, sacred trees, traditional worship areas, and burial grounds that are respected by local residents.

Project activities should avoid disturbance of any sacred or culturally significant locations identified by the community during project implementation. Where previously unknown cultural materials or heritage resources are encountered, appropriate chance-find procedures should be followed in accordance with Federal Ministry of Environment requirements and relevant cultural heritage regulations.

Traditional Festivals

The community observes traditional and religious celebrations that bring together residents from different sections of the settlement. Islamic festivals such as Eid-el-Fitr and Eid-el-Kabir are widely celebrated and attract significant community participation.

These events promote unity, strengthen social relationships, and contribute to the preservation of community identity.

Community Restrictions and Norms

Community consultations revealed the existence of certain customary norms and expectations that visitors and project personnel are expected to respect. These include:

- Respect for traditional authorities and community leaders.
- Consultation with community leadership before undertaking major activities affecting communal interests.

- Respect for cultural and religious values.
- Avoidance of disturbance to sacred or culturally important locations.
- Promotion of peaceful coexistence with community members.

Observance of these cultural norms will enhance community acceptance of the proposed project and contribute to positive stakeholder relationships throughout the project lifecycle.

4.6 Demographic Characteristics

This section presents the demographic characteristics of respondents within the study area. Understanding the demographic profile of the host community is important for assessing the potential social impacts of the proposed CNG Mother Station Project and for developing appropriate mitigation and community development measures.

4.6.1 Population Size and Households

The demographic characteristics of a community provide important information for understanding the social environment within which a project will be implemented. Information obtained from the household survey revealed that Izom Community is a growing rural settlement with relatively large household sizes, reflecting the prevailing family structure and cultural practices of the Gbagyi people.

Based on reconnaissance surveys, stakeholder consultations, and field observations, the community is estimated to contain approximately 1,200 households. To ensure adequate representation of the population, a total of 300 respondents were sampled during the socioeconomic survey.

The survey further revealed that household sizes are generally large, with most households comprising between six and ten persons. This reflects the prevalence of extended family systems and polygamous family arrangements commonly found within the community.

Table 4.10: Estimated Household and Survey Coverage

Parameter	Value
Estimated Number of Households	1,200
Number of Respondents Surveyed	300
Sampling Technique	Household Survey
Confidence Level	95%
Margin of Error	5%

The demographic profile obtained from the survey is considered representative of the socioeconomic conditions of the community and provides a reliable basis for assessing potential project impacts.

4.6.2 Gender Distribution

Gender distribution is an important demographic indicator that assists in understanding population structure and potential project impacts on different social groups.

The survey results indicate that males constituted the majority of respondents, accounting for 62.7% of the total sample, while females accounted for 37.3%.

The higher proportion of male respondents is attributed to the fact that males are traditionally recognized as household heads and were more available during the survey period. Nevertheless, female respondents also participated significantly in the study, providing valuable information on household welfare, education, healthcare, and community development issues.

Table 4.11: Gender Distribution of Respondents

Gender	Frequency	Percentage (%)
Male	188	62.7
Female	112	37.3
Total	300	100.0

The findings indicate reasonable participation of both genders in the survey process.

4.6.3 Age Distribution

Age distribution provides insight into the productive capacity of the population and helps identify the dominant age groups within the community.

The survey revealed that the majority of respondents (57.0%) were within the age range of 18 to 40 years. Respondents aged between 41 and 60 years accounted for 33.0%, while those above 60 years represented 10.0% of the sample population.

The dominance of the economically active age group suggests the availability of a substantial labour force that may benefit from employment opportunities associated with the proposed project.

Table 4.12: Age Distribution of Respondents

Age Category	Frequency	Percentage (%)
18 - 40	171	57.0
41 - 60	99	33.0
Above 60	30	10.0
Total	300	100.0

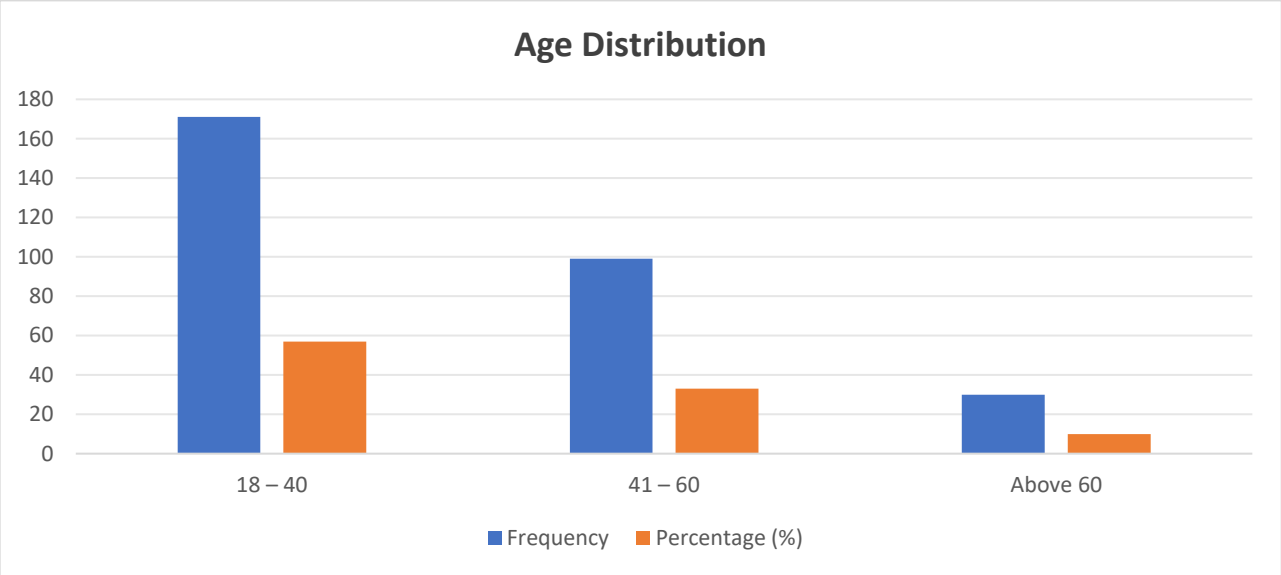

Figure 4.8: Age Distribution of Respondent

The data show that respondents between 18 and 40 years constitute the largest age group (57%). Respondents aged 41 to 60 years account for 33%, while those above 60 years represent 10%.

This age structure indicates the presence of a sizeable labour force that could potentially benefit from employment opportunities associated with the proposed project.

4.6.4 Religion

Religion plays a significant role in shaping social values, community interactions, and cultural practices within the study area.

The survey findings indicate that Islam is the dominant religion, accounting for 86.0% of respondents. Christianity represents 13.0% of respondents, while traditional religious beliefs account for 1.0%.

The predominance of Islam reflects the religious composition of the community and should be considered during project planning and stakeholder engagement activities, particularly when scheduling meetings and community consultations.

Table 4.13: Religious Affiliation of Respondents

Religion	Frequency	Percentage (%)
Islam	258	86.0
Christianity	39	13.0
Traditional Religion	3	1.0
Total	300	100.0

The religious composition suggests a largely homogeneous religious environment characterized by strong community cohesion and respect for traditional and religious leadership.

4.6.5 Marital Status

Marital status influences household responsibilities, income distribution, and social support systems.

Results from the survey show that married respondents constitute the largest category, accounting for 79.0% of the total respondents. Single respondents account for 13.0%, while divorced and widowed respondents represent 8.0%.

The high proportion of married respondents reflects the family-oriented nature of the community and contributes to the relatively large household sizes observed during the survey.

Table 4.14: Marital Status of Respondents

Marital Status	Frequency	Percentage (%)
Single	39	13.0
Married	237	79.0
Divorced/Widowed	24	8.0
Total	300	100.0

The results indicate that family-based households dominate the social structure of the community.

4.6.6 Household Size

Household size is an important indicator of living conditions and social welfare within a community.

The survey findings show that households comprising six to ten persons constitute the largest category, accounting for 61.0% of respondents. Households with more than eleven persons account for 22.0%, while households with one to five persons account for 17.0%.

The relatively large household sizes recorded in the community are consistent with the prevalence of extended family systems and polygamous households.

Table 4.15: Household Size of Respondents

Household Size	Frequency	Percentage (%)
1 - 5 Persons	51	17.0
6 - 10 Persons	183	61.0
11 Persons and Above	66	22.0
Total	300	100.0

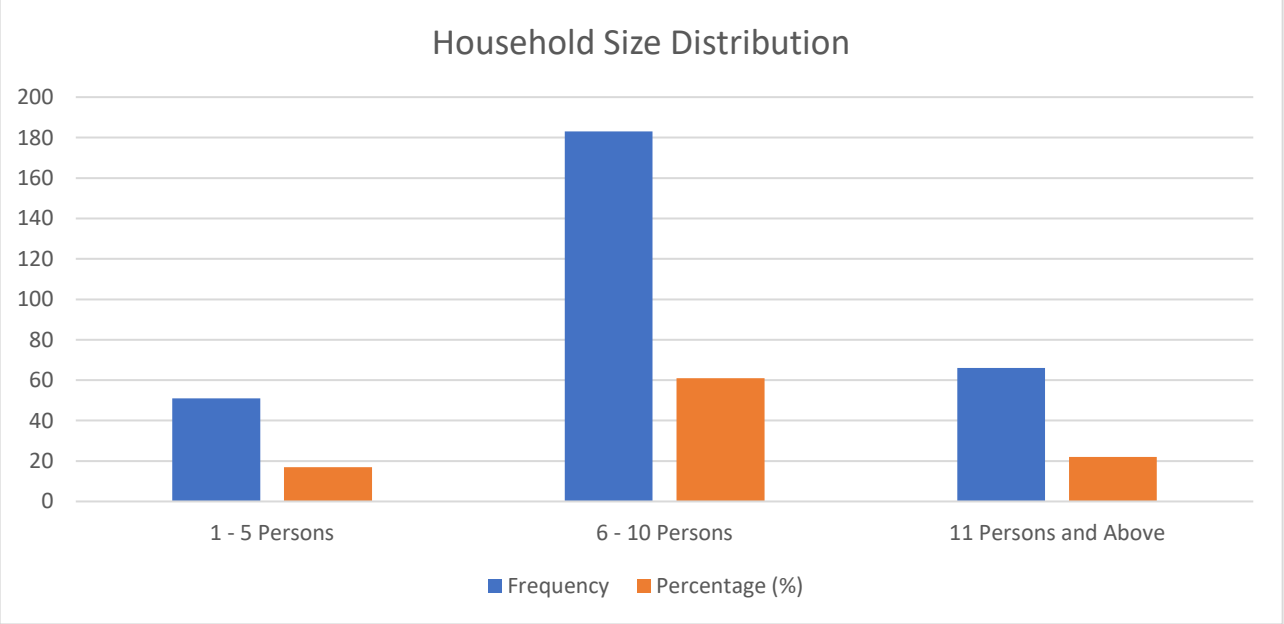

Figure 4.9: Household Size Distribution

The findings indicate that most households in Izom Community consist of medium to large family units, which may influence household expenditure patterns, educational needs, healthcare demands, and future community development requirements.

Summary on Demographic characteristics, the demographic assessment revealed that Izom Community is predominantly inhabited by the Gbagyi ethnic group and is characterized by a youthful and economically active population. Islam is the dominant religion, while married individuals constitute the majority of respondents. Household sizes are generally large, reflecting the prevailing family structure within the community. These demographic characteristics provide important context for understanding community needs, stakeholder expectations, and potential socioeconomic impacts associated with the proposed CNG Mother Station Project.

4.7 Economic Livelihoods

This section presents the economic characteristics of the study area. It examines the major livelihood activities, household income levels, and expenditure patterns of respondents within Izom Community. Understanding the economic conditions of the host community is important for assessing potential project impacts on livelihoods, employment, income generation, and local economic development.

The findings presented in this section are based on responses obtained from the 300 household questionnaires administered during the socioeconomic survey.

4.7.1 Main Occupations

Economic activities within Izom Community are largely influenced by the availability of agricultural land, water resources, and access to local markets. Findings from the socioeconomic survey indicate that farming is the dominant occupation among residents. The fertile agricultural land surrounding the community supports the cultivation of food crops, which serve as the primary source of livelihood for many households.

Apart from farming, residents engage in trading, fishing, civil service, artisanship, and other small-scale economic activities. Trading activities are particularly common among women, who are involved in the sale of agricultural produce, food items, and household goods within the community and neighbouring settlements.

Fishing is also practiced by a section of the population due to the presence of River Gurara, which traverses the area and provides livelihood opportunities for local fishermen.

Table 4.16: Main Occupations of Respondents

Occupation	Frequency	Percentage (%)
Farming	177	59.0
Trading	57	19.0
Fishing	24	8.0
Civil Servant	18	6.0
Artisan	12	4.0
Labour/Industry	6	2.0
Others	6	2.0
Total	300	100.0
Farming	177	59.0

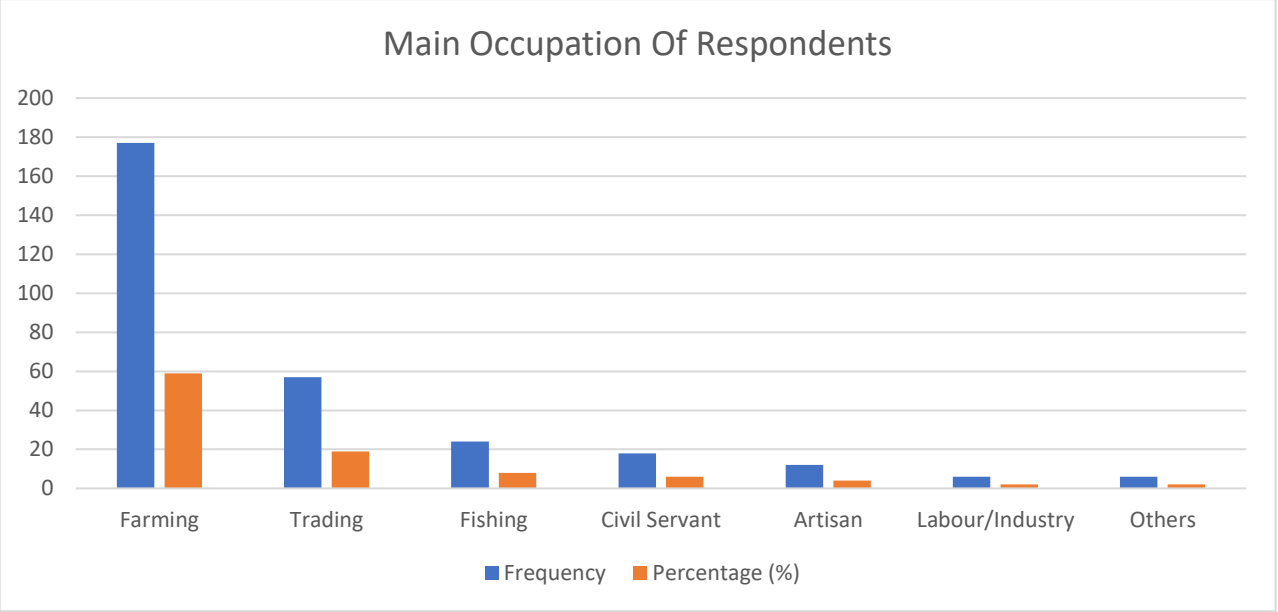

Figure 4.10: Main Occupations of Respondents

The findings indicate that agriculture remains the backbone of the local economy. Consequently, any project activities that may affect farmland, agricultural productivity, or access to farming areas should be carefully managed to minimize adverse impacts on community livelihoods.

River Gurara and Livelihood Activities

River Gurara is an important natural resource within the area. The river supports fishing activities and contributes to local livelihood sustenance. Community

members reported that the river serves as a source of fish and provides supplementary income for households engaged in fishing activities.
The presence of the river also supports certain agricultural activities, particularly during the dry season when water availability becomes critical.

Plate 4.4: Gurara River within the host community

4.7.2 Monthly Income Levels

Household income provides an indication of the economic wellbeing of residents and their ability to meet daily needs and social obligations.

The survey results show that most households earn relatively modest incomes. The largest proportion of respondents (31.0%) reported earning between ₦61,000 and ₦90,000 monthly, while 29.0% reported monthly earnings between ₦31,000 and ₦60,000.

Only a small proportion of households reported monthly incomes above ₦120,000. This reflects the predominantly rural and agriculture-based nature of the community economy.

Table 4.17: Monthly Household Income Levels

Monthly Income Range	Frequency	Percentage (%)
Less than ₦30,000	39	13.0
₦31,000 - ₦60,000	87	29.0
₦61,000 - ₦90,000	93	31.0
₦91,000 - ₦120,000	51	17.0
Above ₦120,000	30	10.0
Total	300	100.0

The income profile suggests that many households may be economically vulnerable to unexpected financial shocks. Therefore, employment opportunities arising from the proposed project are likely to contribute positively to household income levels and local economic development.

4.7.3 Household Expenditure Priorities

Household expenditure patterns provide insight into the needs and priorities of residents.

The survey findings indicate that food constitutes the highest expenditure item among households, accounting for 47.0% of responses. Education represents the second most significant expenditure category at 26.0%, followed by healthcare at 18.0%. The expenditure pattern reflects the importance placed on family welfare, child education, and healthcare services within the community.

Table 4.18: Major Household Expenditure Priorities

Expenditure Item	Frequency	Percentage (%)
Food	141	47.0
Education	78	26.0
Healthcare	54	18.0
Transport	15	5.0
Housing	12	4.0
Total	300	100.0

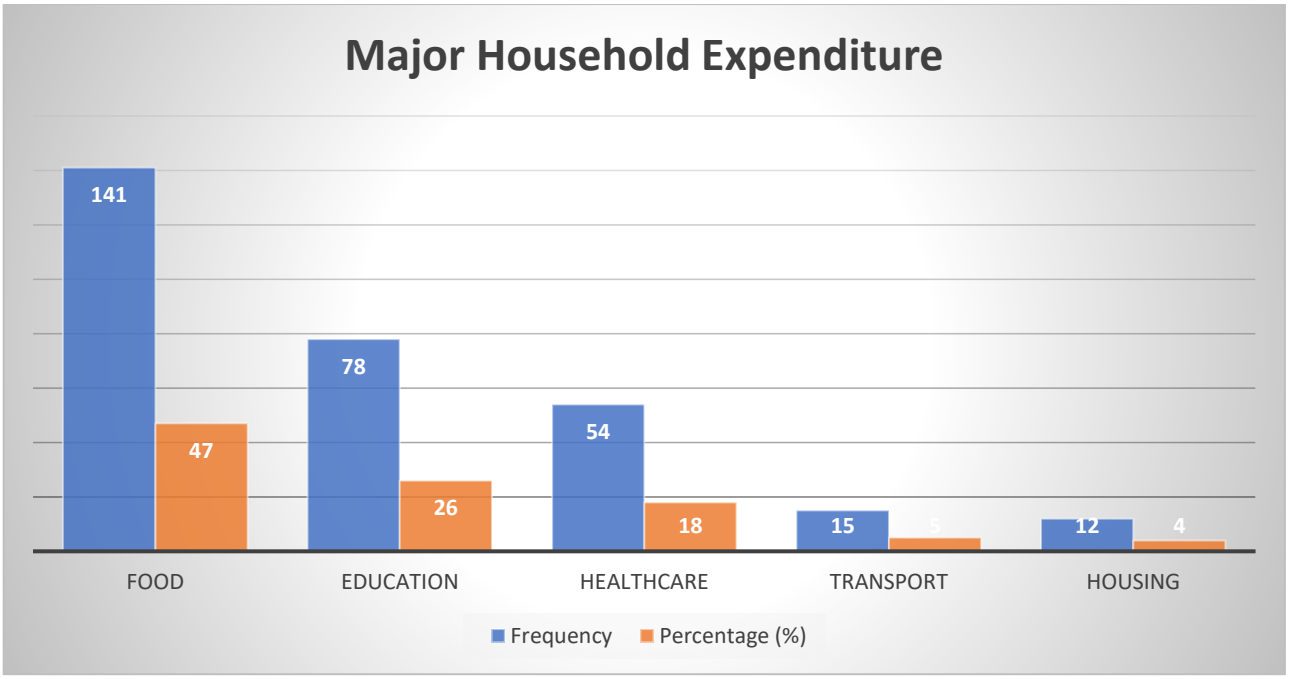

Figure 4.11: Major Household Expenditure Priorities

The high expenditure on food is consistent with the large household sizes recorded during the survey. Similarly, significant spending on education demonstrates the community's commitment to improving literacy and educational attainment among younger generations.

Economic Development Potential

The proposed CNG Mother Station Project has the potential to contribute positively to the local economy through:

- Creation of direct and indirect employment opportunities.
- Increased patronage of local businesses.
- Opportunities for local contractors and service providers.
- Improved household income levels.
- Development of technical and vocational skills among community members.
- Stimulation of commercial activities within the project area.

During stakeholder consultations, community members emphasized the need for local employment opportunities, particularly for qualified youths and professionals from the community. Respondents expressed the desire for local participation not only in unskilled jobs but also in technical, engineering, administrative, and operational positions.

Community leaders also requested that qualified local contractors and suppliers be given fair opportunities to participate in project-related procurement and service delivery activities.

In Summary on Economic Livelihoods, the economy of Izom Community is predominantly agrarian, with farming serving as the principal occupation of most households. Other important economic activities include trading, fishing, civil service, and artisanship. Household income levels are generally moderate, reflecting the rural nature of the community. Food, education, and healthcare constitute the major expenditure priorities of residents. The findings indicate that the proposed project has significant potential to enhance local economic development through employment creation, increased business opportunities, and support for local content participation. Effective implementation of local employment and procurement policies will be important in maximizing the socioeconomic benefits of the project.

4.8 Education and Health

This section presents the educational and health characteristics of the study area. Education and health are important indicators of community wellbeing and human development. The assessment examined educational attainment, availability of educational and healthcare facilities, and the common health challenges affecting residents of Izom Community.

The findings are based on responses obtained from the 300 household questionnaires administered during the socioeconomic survey, stakeholder consultations, and field observations.

4.8.1 Educational Institutions and Literacy Levels

Education is an important social indicator used in assessing the development status of a community. Information obtained during the socioeconomic survey and stakeholder consultations indicates that Izom Community has access to both public and private educational institutions.

The community is served by public and private primary schools as well as secondary schools, which provide educational opportunities for children within the community and neighbouring settlements. Despite the availability of these institutions, some respondents expressed concerns regarding the need for improvement in educational facilities, teaching resources, and infrastructure.

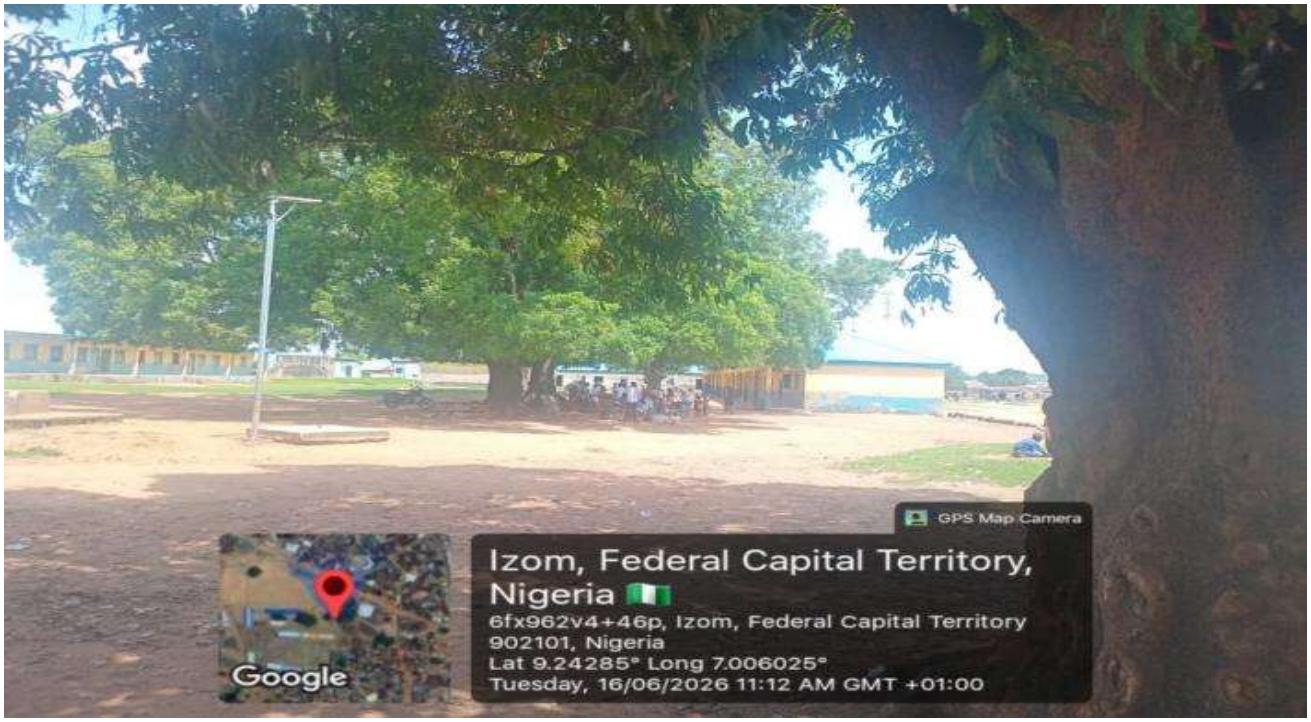

Plate 4.5: Educational Institution within Izom Community

The literacy profile of respondents shows that a significant proportion of the population has attained formal education. The survey revealed that respondents with secondary school education constitute the largest educational group, accounting for 49.0% of the sample population. This finding is consistent with field observations which showed that many residents possess secondary school certificates.

Table 4.19: Educational Attainment of Respondents

Educational Level	Frequency	Percentage (%)
No Formal Education	36	12.0
Primary Education	51	17.0
Secondary Education	147	49.0
Tertiary Education	66	22.0
Total	300	100.0

The results indicate that 88.0% of respondents have acquired one form of formal education or another. This level of literacy presents opportunities for local participation in project-related employment, training programmes, and other socioeconomic development initiatives.

Educational Facilities within the Community

Table 4.20 presents the major educational facilities available within Izom Community based on field observations and stakeholder consultations.

Table 4.20: Educational Facilities in Izom Community

Facility Type	Availability
Public Primary Schools	Available
Private Primary Schools	Available
Public Secondary Schools	Available
Private Secondary Schools	Available
Tertiary Institution	Not Available Within Community

The availability of educational facilities has contributed to the relatively high level of secondary school attainment observed among respondents.

4.5.2 Healthcare Facilities and Common Diseases

Access to healthcare services is an important determinant of community wellbeing. Information gathered during the survey indicates that residents obtain healthcare services from primary healthcare centres, private clinics, hospitals, and nearby health facilities located within and around the project area.

The survey revealed that 57.0% of respondents have access to a clinic or primary healthcare centre as their nearest health facility, while 27.0% reported hospitals as their nearest source of healthcare services. However, 16.0% of respondents indicated that the nearest healthcare facility is located more than five kilometres from their residence.

Table 4.21: Nearest Healthcare Facility Accessed by Respondents

Healthcare Facility	Frequency	Percentage (%)
Clinic/Primary Healthcare Centre	171	57.0
Hospital	81	27.0
None Within 5 km	48	16.0
Total	300	100.0

The findings suggest that while healthcare services are available to a significant proportion of residents, accessibility challenges still exist for some households.

4.5.2.1 Common Diseases and Health Conditions

The survey identified malaria as the most common illness affecting households within the community. This is consistent with environmental conditions in many rural communities where mosquito breeding sites are common, particularly during the rainy season.

Respiratory illnesses and diarrhoeal diseases were also reported by respondents, although at lower levels.

Table 4.22: Common Diseases Reported by Respondents

Common Illness	Frequency	Percentage (%)
Malaria	198	66.0
Respiratory Illness	63	21.0
Diarrhoea	39	13.0
Total	300	100.0

The high prevalence of malaria highlights the need for continued public health awareness programmes, environmental sanitation, and improved healthcare services within the community.

4.5.2.2 General Health Conditions

Discussions with community members indicated that common health concerns include:

- Malaria and fever-related illnesses.
- Respiratory infections.
- Water-related diseases.
- Maternal and child health challenges.
- Limited access to specialized healthcare services.

These health conditions are typical of rural communities and should be considered during project planning and implementation.

4.5.3 Frequency of Hospital Visits

The socioeconomic questionnaire did not directly capture information on the frequency of hospital visits by respondents. However, the availability of healthcare facilities and the prevalence of common illnesses provide an indication of healthcare utilization within the community.

The high occurrence of malaria and other common ailments suggests regular demand for healthcare services among households. During consultations, residents indicated that they seek medical attention from primary healthcare centres, private clinics, hospitals, and patent medicine vendors depending on the nature of illness, accessibility, and financial capacity.

Healthcare utilization within the community is influenced by several factors including:

- Distance to health facilities.
- Cost of treatment.
- Household income levels.
- Severity of illness.
- Availability of healthcare personnel and medicines.

Given that 16.0% of respondents reported having no healthcare facility within five kilometres of their residence, access to healthcare remains a challenge for some sections of the community.

4.5.4 Assessment of Healthcare Access

Table 4.23 provides a summary assessment of healthcare access conditions within Izom Community.

Table 4.23: Summary of Healthcare Access Conditions

Indicator	Observation
Availability of Clinics/PHCs	Moderate
Availability of Hospitals	Moderate
Access to Healthcare Services	Fair
Distance Challenges	Present in Some Areas
Most Common Disease	Malaria
Community Health Status	Generally Stable but Requires Improvement

Summary on Education and health, the assessment revealed that Izom Community possesses a relatively good educational foundation, with secondary school

education representing the highest level of attainment among respondents. Public and private primary and secondary schools are available within the community, contributing to literacy and human capital development.

Healthcare services are provided through clinics, primary healthcare centres, and hospitals located within and around the community. Malaria remains the most prevalent health challenge, followed by respiratory illnesses and diarrhoeal diseases. Although healthcare services are available to many residents, some households experience accessibility challenges due to distance and limited healthcare infrastructure.

The findings suggest that future community development initiatives associated with the proposed CNG Mother Station Project should support improvements in healthcare services, educational infrastructure, public health awareness, and capacity-building programmes to enhance overall community wellbeing.

4.6 Housing and Infrastructure

This section presents the housing characteristics and available infrastructure within the study area. Housing and infrastructure are important indicators of the living conditions and quality of life of residents. The assessment examined housing types, land ownership patterns, water supply sources, electricity access, transportation systems, sanitation facilities, and waste management practices within Izom Community.

The findings are based on responses obtained from the 130 household questionnaires, field observations, and stakeholder consultations conducted during the ESIA study.

4.6.1 Housing Types and Materials

Housing conditions provide useful information on the socioeconomic status of households and the level of community development. The survey assessed the predominant wall materials used for residential buildings within the study area.

Field observations and household survey results indicate that housing in Izom Community consists mainly of cement block and mud-walled structures. The use of cement block materials was observed to be more common, reflecting gradual improvements in housing conditions and increasing adoption of permanent building materials.

Plate 4.6: Concrete-built shops within the host community

However, a significant proportion of households still reside in mud-walled houses, particularly in the older sections of the community. Most residential buildings are single-storey structures with corrugated iron sheet roofing.

Table 4.24: Housing Types and Wall Materials

House Wall Material	Frequency	Percentage (%)
Mud	102	34.0
Cement Block	198	66.0
Total	300	100.0

The predominance of cement block structures suggests a moderate level of housing development within the community.

4.6.2 Land Tenure

Land ownership and tenure arrangements are important considerations in project planning because they influence access to land, compensation matters, and community relations.

The survey revealed that family and community ownership remains the dominant form of land tenure in Izom Community, accounting for 54.0% of respondents. Self-owned land accounts for 40.0%, while only 6.0% reported ownership through government or institutional arrangements.

Table 4.23: Land Ownership Pattern

Land Ownership Category	Frequency	Percentage (%)
Government/Company	18	6.0
Family/Community	162	54.0
Self	120	40.0
Total	300	100.0

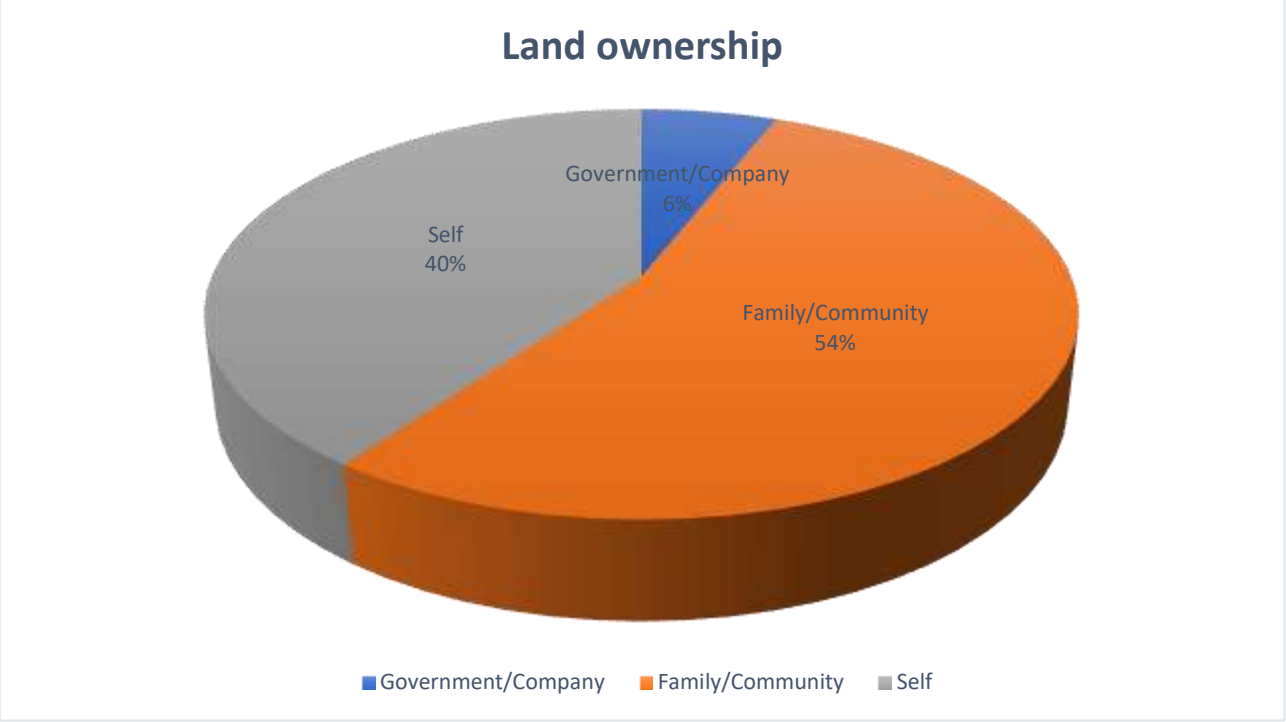

Figure 4.12: Land Ownership Pattern

The findings indicate that customary land ownership practices remain prevalent within the community. Therefore, continuous engagement with traditional authorities and landholding families is essential during project implementation.

4.6.3 Water Supply

Access to safe and reliable water supply is essential for public health and community wellbeing.

The survey findings show that boreholes constitute the primary source of water for most households, accounting for 59.0% of respondents. Wells serve as the main source of water for 29.0% of respondents, while 12.0% depend on river water and rainwater harvesting.

Plate 4.7: A Hand Pump Borehole within the community

Field investigations revealed that the community has approximately 12 to 15 boreholes. However, these facilities are inadequate to meet the growing demand of the expanding population. Residents in newly developed areas often experience difficulties accessing reliable water supplies.

Table 4.24: Main Sources of Water Supply

Water Source	Frequency	Percentage (%)
Borehole	177	59.0
Well	87	29.0
River/Rainwater	36	12.0
Total	300	100.0

The findings indicate that while boreholes remain the dominant source of water, there is a need for additional water infrastructure to support the increasing population.

4.6.4 Electricity Access

Electricity supply within the study area remains limited and irregular. Information obtained during field observations and stakeholder consultations indicates that many households experience inadequate power supply, which affects domestic activities and economic productivity.

Although electricity distribution infrastructure and household connections exist within the community, residents reported that public power supply has been unavailable for more than seven years. As a result, households and businesses rely on alternative energy sources such as generators, rechargeable lamps, solar devices, and battery-powered equipment.

The prolonged absence of electricity has negatively affected economic activities, educational development, household welfare, and small-scale enterprises.

Results from the open-ended survey responses identified lack of electricity as the most pressing community problem.

Table 4.25: Major Community Problems Identified

Community Problem	Frequency	Percentage (%)
Lack of Electricity Supply	123	41.0
Youth Unemployment	75	25.0
Inadequate Water Supply	42	14.0
Poor Road Condition	27	9.0
Poor Healthcare Services	18	6.0
Inadequate Educational Facilities	15	5.0
Total	300	100.0

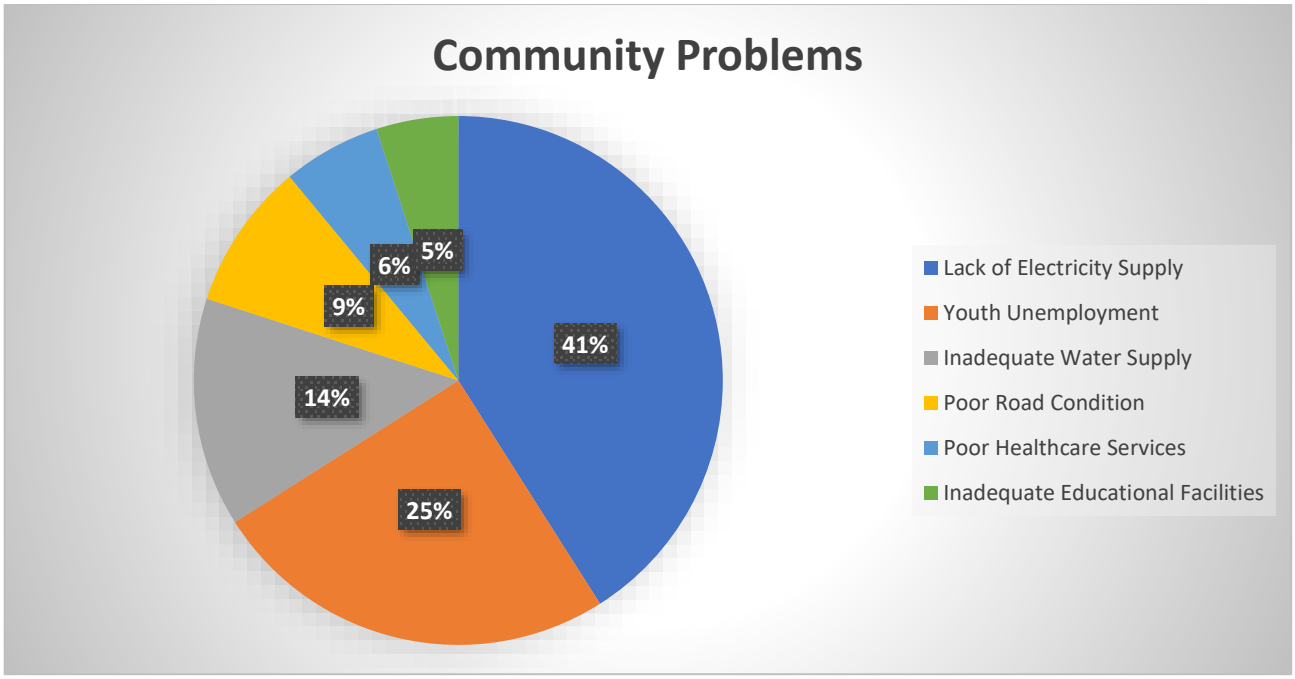

Figure 4.13: Major Community Problems Identified

The restoration of stable electricity supply remains one of the highest development priorities identified by community members. Electricity remains the most critical infrastructure challenge, with residents reporting more than seven years without public power supply despite the existence of electricity distribution infrastructure.

4.6.5 Transportation

Transportation facilities play a vital role in improving access to markets, healthcare services, educational institutions, and employment opportunities. Transportation within Izom Community is facilitated through a network of local roads linking the settlement to neighbouring communities and major transport corridors.

The survey indicates that motorcycles are the most commonly used means of transportation, accounting for 56.0% of respondents. Cars and buses account for 32.0%, while 12.0% of respondents primarily move on foot.

Table 4.26: Main Means of Transportation

Means of Transportation	Frequency	Percentage (%)
Motorcycle	168	56.0
Car/Bus	96	32.0
Walking	36	12.0
Total	300	100.0

The dominance of motorcycles reflects their affordability, flexibility, and suitability for rural transportation. However, stakeholders noted that some internal roads require improvement, especially during the rainy season.

4.6.6 Sanitation and Waste Management

Sanitation facilities and waste management practices are important indicators of environmental health conditions within a community.

Toilet Facilities

The survey revealed that pit latrines are the most common sanitation facility within the community, accounting for 67.0% of households. Flush toilets account for 19.0%, while 14.0% of respondents still practice open defecation.

Table 4.27: Types of Toilet Facilities

Toilet Type	Frequency	Percentage (%)
Flush Toilet	57	19.0
Pit Latrine	201	67.0
Open Defecation	42	14.0
Total	300	100.0

The findings indicate the need for continued sanitation awareness and improved household sanitation facilities. The relatively high level of open defecation indicates the need for improved sanitation infrastructure and hygiene awareness programmes within the community.

Waste Disposal Practices

The survey revealed that 61.0% of respondents dispose of their household waste through private waste collectors operating within the community, while 39.0% rely on open dumping and burning. During consultations, community members reported that private waste vendors regularly collect waste from households for a fee. However, most residents were unable to identify the final disposal locations used by these vendors.

Table 4.28: Waste Disposal Methods

Waste Disposal Method	Frequency	Percentage (%)
Collected by Vendors	183	61.0
Open Dumping/Burning	117	39.0
Total	300	100.0

The relatively high use of waste collection services is a positive development. Nevertheless, improved monitoring of waste disposal practices and environmental sanitation programmes would further enhance environmental quality within the community.

In Summary on housing and infrastructure, the housing and infrastructure assessment shows that Izom Community has a mix of traditional and modern housing structures, with cement block buildings being the dominant housing type. Land ownership is largely based on family and community tenure systems. Boreholes constitute the principal source of domestic water supply, although existing facilities are insufficient for the growing population.
Waste management is undertaken largely by private waste vendors, although concerns remain regarding the final disposal of collected waste. Overall, improvements in electricity supply, water infrastructure, sanitation facilities, and road networks would significantly enhance living conditions and support sustainable community development within Izom Community.

4.7 Stakeholder Engagement and Perception

Stakeholder engagement is a critical component of the Environmental and Social Impact Assessment (ESIA) process. It provides an opportunity for affected communities, government institutions, traditional authorities, and other interested parties to express their views, concerns, expectations, and recommendations regarding the proposed project.

As part of the ESIA for the proposed installation of a Compressed Natural Gas (CNG) Mother Station Project along the AKK Pipeline at Izom Community, consultations were conducted with relevant stakeholders to obtain information on existing socioeconomic conditions and gather community perceptions regarding the proposed development.

The consultation process was carried out in accordance with the requirements of the Federal Ministry of Environment and relevant environmental regulations guiding stakeholder participation in project development.

4.7.1 Stakeholders Identified

Stakeholder engagement was undertaken to obtain the views, expectations, concerns, and recommendations of persons and groups that may be affected by or have an interest in the proposed CNG Mother Station Project at Izom Community. The consultation process covered community leaders, women groups, youth representatives, farmers, traders, transport operators, government representatives, and vulnerable groups.

Plate 4.8: Evidence of Stakeholders Engagement

The stakeholders consulted during the ESIA study are presented in Table 4.29.

Table 4.29: Stakeholders Consulted During the ESIA Study

S/N	Stakeholder Category	Representation
1	Traditional Leaders	Community welfare, land matters, peace and security
2	Village Heads and Elders	Community development and social cohesion
3	Youth Groups	Employment opportunities and skills acquisition
4	Women Groups	Livelihood support and social welfare
5	Farmers	Protection of farmlands and agricultural activities
6	Traders and Business Owners	Business opportunities and local economic growth
7	Transport Operators	Improved access and economic benefits
8	Religious Leaders	Community harmony and social stability
9	Vulnerable Persons	Inclusion and protection from adverse impacts
10	Government Representatives	Regulatory compliance and development objectives
11	Project Proponent	Successful project implementation and sustainability
12	Local Contractors and Service Providers	Contracting and business opportunities

The consultation process ensured that all relevant stakeholder groups were adequately represented during discussions relating to the proposed project.

4.7.2 Community Consultation Process

Community consultation was undertaken through stakeholder meetings, interviews, field observations, and administration of household questionnaires. Stakeholder consultations were conducted as part of the ESIA process to ensure that community members and other interested parties were adequately informed about the proposed project and provided the opportunity to express their views.

The consultation process involved:

- Community entry meetings with traditional leaders.
- Key Informant Interviews (KIIs).
- Household questionnaire administration.
- Focus Group Discussions (FGDs) with women and youth groups.
- Field observations.
- Interactive question-and-answer sessions.

Issues discussed during the consultations included:

- Project objectives and activities.
- Expected environmental and social impacts.
- Employment opportunities.
- Community development expectations.
- Safety and emergency preparedness.
- Grievance management mechanisms.
- Environmental protection measures.

Plate 4.10: Consulting with the Community Youth Leader

Table 4.30: Summary of Community Consultation Process

Activity	Description
Community	Izom Community
Area Council	Gwagwalada Area Council
FCT	Abuja
Consultation Method	Community Meetings, KIIs, FGDs and Questionnaire Survey
Number of Respondents Surveyed	300
Stakeholders Engaged	Traditional leaders, women, youths, farmers, traders and residents
Purpose	To obtain stakeholder views and concerns regarding the proposed project

The consultation process provided valuable information regarding community needs, concerns, and expectations.

4.7.3 Community Support Level

The survey results indicate a high level of support for the proposed project. Out of the 300 respondents surveyed, 95 percent expressed support for the project either fully or subject to certain conditions being met.

Table 4.31: Community Support for the Proposed Project

Level of Support	Frequency	Percentage (%)
Yes Fully	147	49.0
Yes with Conditions	138	46.0
No	15	5.0
Total	300	100

The findings indicate that the community generally welcomes the proposed project because of its anticipated economic and development benefits. However, respondents emphasized the need for continuous engagement and fulfilment of community expectations.

The high level of support demonstrates the willingness of the host community to accommodate the project, particularly where community benefits and employment opportunities are assured.

4.7.4 Perceived Benefits

Respondents identified several potential benefits associated with the proposed CNG Mother Station Project. Employment generation emerged as the most anticipated benefit.

Table 4.32: Expected Benefits of the Proposed Project

Expected Benefit	Frequency	Percentage (%)
Employment Opportunities	156	52.0
Business Opportunities	72	24.0
Better Roads and CSR Projects	42	14.0
Cleaner Energy Supply	30	10.0
Total	300	100

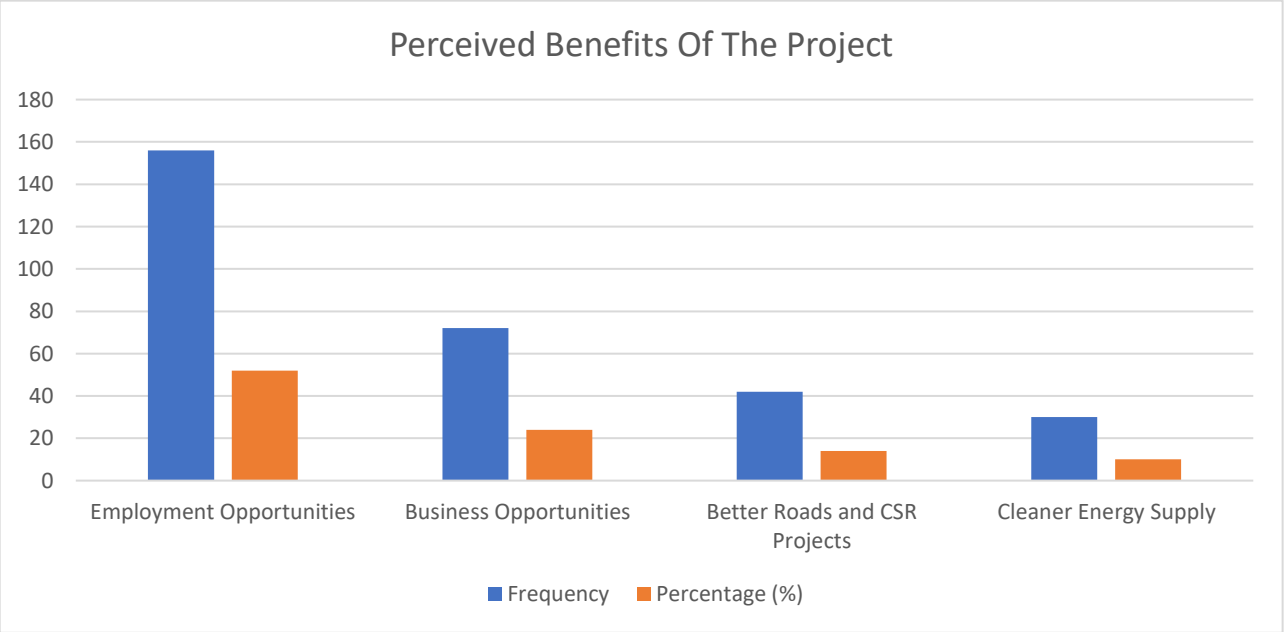

Figure 4.14: Perceived Benefit of the Project

The results show that community members expect the project to improve livelihoods through direct and indirect employment opportunities, increased commercial activities, and community development initiatives.

4.7.5 Concerns and Fears

Although support for the project was generally high, respondents also identified concerns regarding potential environmental and social impacts.

Table 4.33: Community Concerns Regarding the Proposed Project

Concern	Frequency	Percentage (%)
Pollution and Health Effects	117	39.0
Accidents and Safety Risks	78	26.0
Increase in Cost of Living	69	23.0
No Fear	36	12.0
Total	300	100

The major concern identified was environmental pollution and possible health effects. Respondents also expressed concerns regarding accidents, fire outbreaks, and increased cost of living that may arise from project-induced economic activities.

These concerns highlight the need for effective environmental management measures, occupational safety programmes, and continuous stakeholder engagement throughout project implementation.

4.7.6 Community Demands and Expectations

During consultations and questionnaire administration, respondents identified several key expectations and community development priorities.

The most important expectation is the employment of local indigenes, followed by the establishment of a tertiary institution and implementation of formal community development agreements.

Table 4.34: Community Expectations from the Project

Community Expectation	Frequency	Percentage (%)
Employ Local People	171	57.0
Build School and Clinic	57	19.0
Sign Community MoU	54	18.0
Monthly Stipends	18	6.0
Total	300	100

The survey further revealed that local content participation is highly important to community members.

Table 4.35: Preference for Local Contractor Participation

Response	Frequency	Percentage (%)
Yes	204	68.0
Only if Qualified	87	29.0
No	9	3.0
Total	300	100

The results indicate that 68% of respondents support giving priority to local contractors, while 29% support local participation provided the contractors possess the required qualifications and capacity.

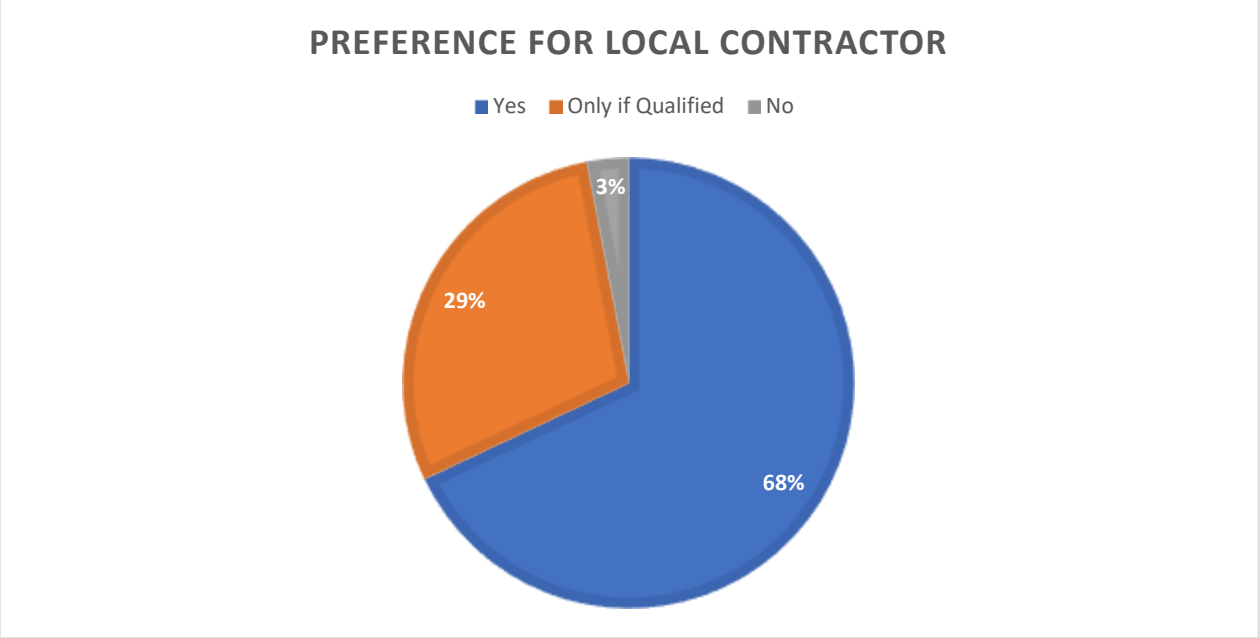

Figure 4.15: Preference for Local Contractor Participation

The findings indicate that the community expects the project proponent to prioritize qualified local labour and contractors during project implementation. Stakeholders also requested the establishment of a formal Memorandum of Understanding (MoU) to guide community-company relations and ensure transparent implementation of Corporate Social Responsibility (CSR) programmes.

The stakeholder engagement exercise demonstrates strong community acceptance of the proposed CNG Mother Station Project in Izom Community.

Support for the project is primarily linked to expectations of employment creation, business opportunities, and community development. Nevertheless, concerns relating to environmental pollution, safety risks, and rising living costs were identified and should be addressed through appropriate mitigation measures, regular stakeholder engagement, local content implementation, and an effective grievance redress mechanism. The establishment of a mutually agreed MoU between the project proponent and the host community is recommended to promote sustainable community relations throughout the project lifecycle.

CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS

5.0 Overview

The Impact Assessment aims at assessing the effects the project will have on the biophysical, social and health components of the project environment. Precise prediction and assessment of impacts is imperative as it ensures that adequate mitigation measures are proffered for the anticipated negative impacts in addition to putting measures in place for enhancing the positive (beneficial) effects.

As a result, the envisaged impact has been identified through interactions between the project activities and environmental sensitivities, and evaluated on the strengths of the likelihood of occurrence as well as the rating of their magnitude and significance. The impact prediction methodology used in this study is described and explained in subsequent sections.

Overall, the project will have in-depth positive impact by providing solutions to waste management challenges of the oil and gas sector and boast the socio-economic needs of the host community.

5.1 Methodology for Impact Prediction

Potential impact evaluation was carried out using a modified method of Leopold Interaction Matrix (Leopold *et al*; 1971). In this system, project activities are in columns while environmental components are in rows (Table 5.1).

Impact Indicators

To further guide the identification and screening of impacts using potential impact screening matrix, established environmental impact indicators or indices are developed for each of the environmental interaction categories. Impact indicators are the observable or measurable parameters of each environmental component that can be directly or indirectly linked to changes in environmental conditions.

Table 5.1. Environmental Components and their Impact Indicators

Environmental Components/Receptors	Potential Impact Indicators
Biophysical	
Soil	Changes to physical and chemical properties and soil ecology
	Changes to geology, geomorphology, topography
Flora	Changes to vegetation population, health, species abundance and diversity and impact on endangered and economic species
Wildlife	Changesto wildlife assemblages, threat to endangered/endemic/ medicinal/economic species, food chain effects
Groundwater	Contamination of shallow or deep groundwater resources,

	depletion of ground water resources.
Air	NOx, NOx, SPM, CO, VOC, Greenhouse Gases (GHG), Ozone
	Measured increases in noise or vibration levels
Socio-Economics	
Communities/Host Population	Changes in population indices – Total population, gender ratio, age distribution
	Infrastructure: Improvement or pressure on existing urban/rural infrastructure including water supply and waste handling facilities Aesthetics: Physical deterioration, landscape, etc
	Social and Cultural structure: Impact on local authority and governance structure, increase in negative social vices (prostitution, crime), intra and interethnic clashes
	Cultural and archaeological resources: Impact on shrines, burial grounds; loss of archaeological resources
	Transportation: Effects of increase or decrease in different types of transportation
	Macro and micro economy: Improvement or negative impact on macro and micro economy, employment, standard of living, occupation changes.
Health Determinants	
	Pollution related health problems/diseases: Increase in concentration of air pollutants of concern (NO_x, SO_x, VOC, CO, PM, Greenhouse gases) beyond regulatory limits. Contamination of surface waters and potable ground water, increased vibration and noise beyond regulatory limits, increased night time light beyond acceptable limits.
	Communicable and non-communicable diseases inventory: Increase in communicable and non-communicable diseases or disease-causing factors.
	Nutritional status: Changes to nutritional status, malnutrition starvation and high fat diets
	Health/Recreational facilities: Changes in availability of and access to health care and recreational facilities
	Psychosocial factors: Drug use/abuse, communal violence, crime, suicide, depression and prostitution
	Fertility: Changes to fertility levels, changes in birth rates
	Morbidity and Mortality: Improvement or impairment of health of workers and of general public, increased security risk.
	Accidents/fires/Explosions: Changes to rate of occurrence and severity of accidents/fire/explosions.

5.2 Preliminary Impact Identification and Screening

The rationale for assessing the likely impacts of the proposed project is based on the following considerations.

i. Knowledge of the project activities, equipment types, construction

methods and operational procedures.

ii. Results of literature search on the baseline condition of the project area
iii. Findings of other EIA studies conducted around the project area
iv. Reference to FMEnv/NMDPRA/UNEP/WHO/WB guidelines and standards
v. Experts group discussions and presentations
vi. Previous experience on other projects

Impact identification is based on the definition of an impact as "having both spatial and temporal components and can be described as the change in an environmental parameter over a specified period within a defined area, resulting from a particular activity compared with the situation which would have occurred had the activity not been initiated".

5.3 Impact Qualification and Categorization

The identified impacts were qualified and quantified. The Impact qualification classified the impacts as direct (D) or indirect (ID), adverse (-) or beneficial (+), local (Lo) or widespread (W), short term (S) or long term (L), reversible (R) or irreversible (I).

- Adverse impacts are those, which impact negatively on the environment.
- Beneficial impacts are those, which enhance the quality of the biophysical, health and social environments.
- Local impacts are limited to the immediate surroundings while the widespread impacts go far beyond the immediate area the impact is occurring.
- Short term means a period of time less than three months while any period greater than three months is considered long term.
- Reversible/irreversible is meant whether the impact can either be reverted to previous conditions or remains permanent once the activity causing the impact is terminated.

The criteria and weighting scale used in evaluating significant impacts are as follows adopted from The International Organization for Standardization ISO 14001. The risk factor and frequency of occurrence of impact are based on the Risk Assessment Matrix, RAM

i. Legal/regulatory (L)
ii. Risk factor (R)
iii. Frequency of occurrence of impact (F)
iv. Importance of impact on an affected environmental component (1) and
v. Public perception/interest (P).

These criteria and ratings are as follows:

a. **Legal/Regulatory Requirements (L)** – Is there a legal/regulatory requirement or a permit required?

0 = There is no legal/regulatory requirement

3 = There is legal/regulatory requirement
5 = There is a legal/regulatory requirement and permit required

b. **Risk Factor (R)** – What is the risk/hazard rating based on the Risk Assessment Matrix?
   1 = Low risk
   3 = Intermediate risk
   5 = High risk

c. **Frequency of Impact (F)** – What is the frequency rating of impact based on the Risk Assessment Matrix?
   1 = Low frequency (rare)
   3 = Intermediate frequency (likely)
   5 = High frequency (very likely)

d. **Importance of affected environmental components and impacts (I)** – What is the rating of importance based on consensus of opinions?
   1 = Low importance
   3 = Medium/intermediate importance
   5 = High importance

e. **Public interest/perception (P)** – What is the rating of public perception and interest in the proposed project and impacts based on consultation with stakeholders?
   1 = Low interest/perception
   3 = Intermediate interest/perception
   5 = High interest/perception

This approach was adopted considering its interactive and descriptive analysis of the relationship between the proposed project activities and the ecosystem components. It combines the following factors in assessing the overall impact rating of the project on the environment:

- The sensitivity/vulnerability of the ecosystem components;
- The productivity evaluation/rating of the ecosystem components;
- Knowledge of the possible interactions between the proposed project and the environment;
- Envisaged sustainability of the project environment;
- The economic value of the proposed project; and
- Projected duration of the impact of each project activity on various environmental components.

The nature and level of health, safety and environmental risks associated with each impact were determined using the Risk Assessment Matrix (Table 5.3) in conjunction with the evaluation of impact significance presented above. The importance of

affected environmental component was determined through consultation and consensus of opinions. The manner in which the host communities and the general public would perceive each potential impact and its effects were again determined through consultation with the host communities and consensus of opinions of environmental professionals and stakeholders.

For this study, the Frequency (F), the Importance (I) and Public (P) perception were judged to be superior indicators of the impacts hence the significant impacts were based on the sum of F+I+P. The maximum possible point from this sum is 15. Impacts whose sum of F+I+P was less than or equal to 5 were rated as low. These impacts were judged not to require mitigation.

Those whose sum of F+I+P was between >5 and <10 was rated as having medium significance while those whose sum of F+I+P was >10 were rated as having high significance (Table 5.2). For this study, medium and high significant impacts were judged to require mitigation, while low impacts would be mitigated through standard practice i.e. Risk Assessment Matrix. The positive impacts of the proposed project on all valued environmental components shall be rated as beneficial; hence amelioration measures shall not be applicable.

Table 5.2: Environmental Impact Significance Rankings

Ranking (F+I+P)	Significance
≤5	Low
6 -≤10	Medium
>10	High

Table 5.3: Risk Assessment Matrix for Environmental Consequences

CONSEQUENCES					INCREASING LIKELIHOOD				
					A (1)	**B (2)**	**C (3)**	**D (4)**	**E (5)**
Severity	People	Assets	Environment	Reputation	Never heard of in the industry	Heard of in the industry	Has happened in the Organisation or more than once per year in the industry	Has happened at the location or more than once per year in the Organisation	Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact					
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact		Low Risk			
2	Minor Injury or health effect	Minor damage	Minor effect	Minor Impact					
3	Major Injury or health effect	Moderate damage	Moderate effect	Moderate impact			Medium Risk		
4	PTD or up to 3 fatalities	Major damage	Major effect	Major Impact				High Risk	
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact					

Table 5.4: Evaluation of Associated and Potential Impacts of the Proposed CNG Mother/Daughter Station

	Activities	Receptors	Potential Impact: Negative/Positive	Impact quantification	Significance			Overall Significance
					F	I	P	
Pre-Construction	Site selection and land acquisition	Community and youth concern	Land-use change and possible displacement (-); Agitation	D; (-); Local; S/L; R	1	5	3	9
	Environmental and engineering surveys	Soil, vegetation, community	Minor disturbance from survey activities (-)	D, -, Lo, S, R	1	1	1	3
	Stakeholder engagement and permitting	Local communities	Improved stakeholder participation and project acceptance (+)	ID, +, Lo, L, R	2	2	2	6
	Material and equipment supply	Air quality	Vehicular emission from vehicles used in conveying construction equipment (pollutants and greenhouse gases with possible health hazards)	D; (-); Local; S; R	5	1	1	7
		Noise	Noise generated from vehicles conveying construction equipment	D; (-); Local; S; R	3	3	1	7
Construction	Mobilization of workforce	Population in the vicinity of activity	Social and cultural interaction issues; Health and security issues; Noise and dust.	D; (-); Local; S; R	3	3	3	9
		Community infrastructure and utilities	Increase demands on services in local communities	D; (-); Local; S; R	3	3	3	9
		Community and youth concern	How to be gainfully employed	D; (+); Local; S; R	5	3	5	13
		Transport	Increase in the demand of public transport	D; (-); Local; S; R	3	3	3	9
		Vector related	Vector such as bed bug etc. can be an issue	D; (-); Local; S; R	1	3	3	7

	Activities	Receptors	Potential Impact: Negative/Positive	Impact quantification	Significance			Overall Significance
					F	I	P	
		Sexually transmitted infection HIV/AIDS	Sexual relationship	D; (-); Local/Wide; S/L; R/I	3	5	3	11
		Nuisance exposure	Noise and dust exposure	D; (-); Local; S; R	3	3	1	7
	Base camp construction, ground clearance and grading	Air quality	Reduction in air quality due to an increase in airborne particulate matter	D; (-); Local; S; R	5	1	3	9
		Noise	Noise generated from activities	D; (-); Local; S; R	5	1	3	9
		Soil quality	Disruption of the topography of the soil	D; (-); Local; S; R	5	1	3	9
		Nuisance exposure	Noise and dust exposure	D; (-); Local; S; R	3	3	1	7
	Excavation and construction of site facilities	Air quality	Reduction in air quality due to dust and emissions from equipment	D; (-); Local; S; R	5	1	3	9
		Noise level	Increase in ambient noise level due to operation of equipment and machinery	D; (-); Local; S; R	5	1	3	9
		Groundwater quality	Contamination of groundwater aquifers	D; (-); Local; S; R	1	1	5	7
	Construction traffic	Road users	Traffic congestion and accident risk (-)	D, -, Local, S, R	2	2	2	6
	Construction activities	Local economy	Employment and business opportunities (+)	ID, +, Local, S, R	2	5	2	9
	Fuel/lubricant storage	Soil and groundwater	Spill-related contamination (-)	D, -, Local, L, R	2	5	2	9
	Equipment installation and commissioning	Workers	Occupational health and safety risks (-)	D, -, Local, S, R	2	5	2	9

	Activities	Receptors	Potential Impact: Negative/Positive	Impact quantification	Significance			Overall Significance
					F	I	P	
Operation Phase	Natural gas compression	Ambient air	Methane leaks and greenhouse gas emissions (-)	D, -, Local, L, R	2	5	2	9
	Compressor operation	Local community	Continuous operational noise (-)	D, -, Local, L, R	2	2	2	6
	CNG dispensing operations	Vehicle owners	Access to cleaner transportation fuel (+)	D, +, Local, L, R	5	5	5	15
	CNG use replacing conventional fuels	Air quality	Reduced particulate matter and NOx emissions (+)	ID, +, W, L, R	5	5	5	15
	CNG station operations	Economy	Reduced fuel costs and increased energy availability (+)	ID, +, W, L, R	5	5	2	12
	High-pressure gas storage	Workers and public	Fire and explosion hazards (-)	D, -, Local, S, I	1	5	5	11
	Mother station trailer loading	Workers	High-pressure gas handling hazards (-)	D, -, Local, S, I	2	5	5	12
	Transportation of CNG trailers	Communities, road users	Road accidents and gas release incidents (-)	ID, -, W, S, I	2	5	5	12
	Daughter station unloading	Workers	Gas leakage during unloading operations (-)	D, -, Local, S, I	2	5	5	12
	Routine maintenance	Workers	Exposure to operational hazards (-)	D, -, Local, S, R	2	5	2	9
	Operations and maintenance	Workforce	Long-term employment generation (+)	ID, +, Local, L, R	5	2	2	9
	National gas utilization	Energy sector	Enhanced energy security and domestic gas utilization (+)	ID, +, W, L, R	5	5	2	12
	Emergency situations: fire/explosion	Workers, public, infrastructure	Injury, fatality and asset damage (-)	D, -, Local, S, I	1	5	5	11

	Activities	Receptors	Potential Impact: Negative/Positive	Impact quantification	Significance			Overall Significance
					F	I	P	
Accidental Events	Work related injuries	Accidents and injuries	Can be as severe as loss of live	D; (-); Local; S/L; R/I	1	5	5	11
		Health services infrastructure and capacity	Additional stress on the available healthcare infrastructure and manpower	D; (-); Local; S; R	1	3	5	9
	Facility operation and utility	Air quality	Reduction in air quality due to emissions from the machines and equipment exhaust	D; (-); Local; L; R	5	1	3	9
		Soil quality	Waste generation and discharge on land	D; (-); Local; L; R	3	3	3	9
		Population in the vicinity of activity	Social and cultural interaction issues; health and security issues.	D; (-); Local; L; R	3	3	5	11
		Community and youth concern	Business and employment opportunity	D; (+); Local; L; R	3	5	5	13
		Transport	Increase in the use of access route	D; (-); Local; L; R	3	1	3	7
		Sexually transmitted	Sexual relationship	D; (-); Local/Wide; S/L; R/I	3	5	5	13
Decommission and Abandonment	Facility Decommission	Employees	Loss of employment opportunities (-)	ID, -, Lo, L, R	2	2	2	6
		Air quality	Dust/pollutants generated from equipment removal/building remodeling	D; (-); Local; S; R	5	1	3	9
		Noise level	Noise generated from activities	D; (-); Local; S; R	5	1	3	9
		STDs/Infections; HIV/AIDS	Sexual relationship	D; (-); Local; S; R	3	5	5	13
		Community and youth concern	Agitation	D; (-); Local; S; R	1	5	5	11
		Accidents and injuries	Resultant injuries from work activities. Can be as severe as loss of life	D; (-); Local; S/L; R/I	1	5	5	11
		Environment/Aesthetics	Change in aesthetic value of the area	D; (-); Local; S/L; R/I	1	3	3	7
		Community	Increased opportunity for business	D; (+); Local; S/L; R/I	1	3	1	5

	Activities	Receptors	Potential Impact: Negative/Positive	Impact quantification	Significance			Overall Significance
					F	I	P	
	Work-related injuries	Health services infrastructure and capacity	Additional stress on the available healthcare infrastructure and manpower	D; (-); Local; S; R	1	3	5	9

5.4 Description of Qualitative Impacts

5.4.1 Preliminaries

- **Land Acquisition:** GVLNG has acquired portions of land in Izom Community, Gwagwalada Area Council, Abuja-FCT and has made all the requisite payments as agreed on an MoU. The activity has increased awareness of the project.

- **Survey Line Cutting:** Survey line cutting consists primarily of very little vegetation clearing, as the area is already built-up, for survey activities on a temporary land area. The potential impacts of this activity are direct, negative, short-term, local and rated minor. This activity also has socio-economic benefits as it is income and employment generating and shall impact positively on community relations.

- **Permitting:** Permitting is the process of obtaining permission of relevant government agencies and other stakeholders on issues related to the project. All required permits are being processed, at both the local, state and federal levels; this EIA Studies is one of such permits. Prior to commencement of the project, extensive stakeholder consultations have been carried out with host community, State and Local Government agencies and other interest groups to enlist their support, cooperation and participation in the project. The occurrence of this is rated as high and the impact is positive.

5.4.2 Site Preparation and Pre-Construction Phase

The site preparation activity for the project shall consist primarily of mobilization of personnel, heavy machinery, equipment and materials to the project camp-site. The activities shall include; clearing to remove vegetation at the site with the use of bulldozers and hydraulic excavator and soil spoils disposal and levelling of cleared area; this requires motor scrappers and grader. The potential impacts of these procedures are;

- **Contracts/Tenders Award**

Contracts shall be awarded at this phase of the project site preparation. This shall have a positive/beneficial impact on the socio-economic environment only as it leads to employment and income generation for many people and higher output or productivity. The impact shall be direct, positive, short-term, local and rated major.

- **Vegetation Clearing**

This impact is direct, negative, short-term, local, reversible and rated minor.

Secondary impacts include increase in ambient noise, prevalence of particulate

matter suspension in the atmosphere. These might further put any wildlife in the immediate vicinity of the plot migrate.

- **Soil Testing**

Before construction phase begins the soils in the site shall be tested by soil civil engineers to enable determination of type of foundation to be made for the different categories of buildings to be constructed and equipment to be installed. Soil profiles to depths of more than 10m shall be determined. Soil testing involves soil samples collection at regular depths per site and laboratory tests, for certain soil properties. It is income and employment generating, the impact shall be direct, positive, short term, limited to project site and rated moderate.

- **Bulldozing, Grading and Compaction of Soil**

Assemblage and use of heavy equipment and machines such as bulldozers, graders and rollers into the cleared site temporarily cause noise. People will be employed and receive income. Bulldozers shall remove weeds and stumps of trees. The soil surface shall be leveled and compacted with the aid of graders and rollers. Evaporation from bare exposed soil shall be high, affecting local climate. These activities shall generate minor increase in air-borne particulates. This impact shall be direct, negative, short term, local and minor in magnitude.

- **Excavated Soil Spoils and their Disposal**

Soil spoils shall have to be adequately disposed of so as not to pose solid waste problem on the project area. Heaps of soil spoils shall become substrate for many unwanted organisms and obstruct flow of stormwater runoff. The soil spoils can be used in the facility and road grading. These impacts shall be direct, negative, short term, local and rated low to moderate in magnitude, and shall be limited to project site.

5.4.3 Activities at Construction Phase

a. Camp Site Establishment

A camp site for the construction workers shall be within the project site. A moderate quantity of solid waste, refuse and sanitary waste shall be generated during the period of construction activities. These shall have to be adequately disposed of. There are possibilities of relationship between the male and female workers on- and off-site. Therefore, there are likelihood of HIV/AIDS and other sexually transmitted diseases (STDs) with their adverse impacts. The solid wastes/refuse are likely to blight the landscape and dirty the environment and water-and air-borne diseases may emanate from sanitary wastes and sold unhygienic food.

b. Building/Civil Works (*Increase in Vehicular Traffic)*

The construction phase of the project will lead to the vehicular transport volume increase around the project vicinity. This impact is described as direct, negative,

short-term, local, reversible and is rated moderate.

Air Quality

Construction activities shall result in localised high levels of dust/particulate matter, noise and vehicular emissions. The dust rising from earthwork and vehicular movement could be significant, particularly during dry season and can cause disturbances to the nearby communities. Potential impacts from dust emissions on site shall be significantly reduced by careful management and the implementation of mitigation measures to reduce dust generation.
Other sources of air pollutants include:

- Internal combustion engines of construction machinery;
- Welding and drying equipment on construction site;
- Unloading and storage of inert materials (crushed stoned, sand).
- Dust from the ground surface disturbed by earthmoving operations during dry season. Emissions from welding activity and construction machinery/vehicular exhaust shall consist of numerous gaseous components divided into several groups based on similar impact on the environment and human health. These include:
- Carbon monoxide, the presence of which in large amounts (up to 12%) is characteristic of exhaust gas from internal combustion engines using gasoline;
- Nitrogen oxides;
- Hydrocarbons, aromatic compounds including carcinogens;
- Non-toxic substances such as nitrogen, hydrogen, carbon dioxide and water vapour,
- Spent gas components.

The emissions are short-term and localised to the immediate project site area; though the likelihood of occurrence is high, the consequence is rated a negligible negative. Thus, the overall impact risk level is expected to be low.

Noise

The heavy equipment used in site excavation and construction works, diesel powered generators used for on-site power generation, vehicular movement on-site for shuttling of material and men shall have an adverse impact on ambient noise levels.

With respect to the ambient noise levels, since noise is attenuated by distance (typically noise levels drop by about 40dBA at 100m distance from source) the activities on-site are unlikely to adversely affect receptors at a significant distance. However, during the night-time when the ambient noise levels are low, the level of perception to noise by communities may be more acute. Noise from transport

vehicles shall be only transient for a given location and can be considered as a nuisance during night-time.

The permissible noise level of 90 dBA for an 8-hour exposure is not envisaged to be exceeded. Hearing impairment could occur from prolonged exposure to high noise level. However, it is envisaged that the site shall be demarcated and an exclusion zone created. Thus, it is unlikely that villagers will be exposed to harmful noise level. The noise impact is rated short-termed and localized to the immediate site area; with a high likelihood of occurrence, the overall impact is low, reversible and rated minor.

Behavioural Modifications from Wildlife

The noise and physical presence of equipment and personnel being conveyed to the site will lead to behavioural modifications from wildlife around the site. The forms of behavioural modifications will vary but may include interrupted breeding and feeding patterns; unusual burrowing patterns; mother-calf separation; movement away from the area; obstruction of normal movement patterns; amongst others. This impact is described as direct, negative, short term, local, reversible and is rated moderate.

Hydrogeology

Groundwater flow in the area is not expected to be disturbed as a consequence of the construction/civil works of the facility, as only the topmost layer of earth materials would be involved during the construction. The only possibility of impact on the groundwater is expected to occur in the remote case of percolation of construction materials and wastes if not properly stored. This possibility is remote considering the management plan that shall be put in place. Thus, impact is considered negligible negative with negligible likelihood. Thus, overall rating is low risk.

Geology

Only minimal geological impacts are expected in the construction phase of the project, as there shall not be significant topographic or geological changes due to the construction of the facility. Soil erosion, which could be another potential impact to geology of the area, is not envisaged as adequate erosion control measures shall be put in place. Impact consequence from the construction activities is rated a negligible negative, while the likelihood of its occurrence is low, thus, the overall risk is low i.e. of a low priority.

Labour Requirement/Recruitment of Workforce:

During the construction/civil works the project could offer employment for the indigenes at various stages. This could improve income. The impact was described as direct, long term, local/widespread and reversible. It was rated positive

Migrant labour could be attracted to the project area. This increase in population of the area could put pressure on the already deficient infrastructure. This could lead to overcrowding with potential for increase in communicable diseases like malaria, respiratory tract infections and skin diseases. The impact was direct, negative, short term, local and reversible. It was rated moderate.

The increase in financial flow could lead to social vices such as violence, alcoholism, attraction of commercial sex workers (CSW), substances abuse, and teenage pregnancies. This could lead to increase in sexually transmissible diseases (HIV/AIDS, syphilis among others), injuries, and loss of life or properties. This impact is rated as direct, negative, short term, local, reversible and major.

Conflicts/ Third party agitations over employment issues

Labour issues are always a source of friction between companies and communities and among community members, this is the current situation particularly, in oil bearing zones of the country. The agitation could be either due to requests for a certain number of labour that could not be met or sharing the labour slots in the community. However, such conflicts/agitations are most unlikely to occur, due to the existing understanding between the project proponent and the host community. The impact was described as direct, negative, short term, local and reversible. It was rated minor.

Health Issues: Increased level of disease vectors (mosquitoes, flies, etc.)

Improper disposal of wastes generated from construction activities can be a breeding site for disease vectors such as mosquitoes, rats, cockroaches, flies, etc. The impact is direct, negative, short term, local and reversible with a moderate rating.

Consequent on disposal of wastes without proper adherence to sanitary guidelines, discharge of sewage on-land, will attract the preponderance of disease vectors leading to widespread increase in diarrhea diseases. The impact was direct, negative, short term, local and reversible. The rating is moderate.

Burns/ Injuries from Welding Sparks

The sparks generated during welding activities could result in fires or injuries on soft tissues of the body. Adherence to the project management plan will forestall such occurrences. This impact is described as direct, negative, short term, local, reversible and is rated moderate.

Waste Generation/Handling:

Wastes are envisaged to be generated during the construction/civil works. All wastes generated shall be properly handled and disposed of. The impact was direct, negative, short term, local and reversible. The rating is moderate.

5.4.4 Operation and Maintenance Phase Activities

The operational activities of the proposed project are envisaged to impact on the ambient air, noise, hydrogeology, geology, and soil quality. These are discussed thus:

Increase in Vehicular Traffic

The operation of project will make for an increase the vehicular transport volume to the project area. Vehicles conveying the staff, customers to and from the project area. This will lead to increase of noise, gaseous and particulate load of the ambient environment. This impact is described as direct, negative, long-term, local, reversible and is rated moderate.

Air Quality:

The facility shall have gaseous emissions from the operational machinery. The envisaged gaseous emissions include heat, particulates, CO, SO_x, NO_x, NH_3, sulphides and mercaptans. Some of which may contribute to global warming, respiratory problems, scorching of vegetation. The impact is high risk, of long-term duration and very significant.

Noise

Noise shall arise from the continuously and intermittently operating sources such as machines, generators, mobile equipment, trucks etc. The estimated maximum sound level shall be 65.5dB (A). Noise emissions shall also occur due to equipment faults, inappropriate operation, and damage to equipment supports and fixtures, etc.

The design considerations and installation of muffs, are expected to reduce noise level to generally low values, within regulatory limit. The likelihood of occurrence is high, the effect of the noise shall be local, the noise level reduces with distance and the impact is expected to be moderate.

Soil

The potential causes for land contamination are the discharge of liquid effluents (wastewater), disposal of solid and hazardous wastes on land and accidental spillages of hazardous material. The likelihood is low and significance of the impact is high.

The comprehensive environmental procedures prepared for the project shall ensure that any potential impact(s) are adequately mitigated. Thus, impact level is minor negative consequence, with low likelihood of occurrence; overall risk level is low and acceptable.

Geology

The study area lies in a very geologically (tectonic and seismic) stable zone with no recorded cases of earthquakes or tremors. Furthermore, no major or minor faults are known to transverse the area. Therefore, the possibility of any geo-hazards occurring in the area is negligible. Overall impact risk is low.

Hydrogeology

During operational phase, groundwater resources could be negatively impacted through leaked chemicals, oil or accidental spills that could infiltrate resources. The management plan that shall be in place shall make this a very rare occurrence. Hence the overall rating of impact is seen as low with low likelihood of occurrence and medium negative impact.

Wastes Disposal

A number of waste types shall be produced during the operational phase of the project. These include wastewater, lubricant filters, office waste. Improper waste disposal would lead to a loss of aesthetics, risk of contamination of soil, groundwater through seepage and water bodies (through run-offs). The effects of improper waste disposal can be reversed and are of long-term.

However, waste handling could create opportunities for employment and services by waste management vendors associated with project operations resulting in increased income levels. This impact is described as direct, short/ long term, local, reversible and is rated positive.

Sanitary Waste Discharges and stormwater Run-offs

Sanitary wastes shall be properly handled. Consequent on disposal of wastes without proper adherence to sanitary guidelines, could lead to widespread health challenges. The impact is considered direct, negative, short-term, local and reversible. The rating is moderate.

Water Demand and Use

Water intake shall be from borehole dogged within the facility. Water abstraction shall be low, as the wastewater shall be treated and re-used. The water demand shall have minimal impact on water quantity of the project area. The impact is considered direct, long-term, local and reversible. The rating is low.

Product Spill Incidents

Operational accidents can result in product spills due to equipment failure and human errors. The spilled product could contaminate soil, groundwater and any nearby surface water bodies within the project vicinity. The product spills will have a devastating impact on the flora and fauna in the area if not contained. This impact is described as direct, negative, short/long term, Local/widespread, reversible/ irreversible and is rated major.

Fire Outbreaks during Operations

Fire outbreaks can occur during the project operations; and as the product being handled is flammable. A worst-case scenario will involve a fire outbreak accompanying a spillage/leakage leading to loss of assets, properties and life; including that of the third parties. This impact is described as direct, negative, long term, local/ widespread, irreversible and is rated major.

5.4.5 Decommissioning and Abandonment Phase Activities

The potential impacts from the decommissioning and abandonment phase include the following:

Job/Services Opportunity and Income

The decommissioning phase of the project could offer assets and temporal job opportunities for the indigenes and this would improve income for a final time. Contract services will also be given to specialized companies to handle special components of the decommissioning program. The impact is described as direct, short term, local, reversible and is rated positive.

Air Quality Impairment and Noise

During decommissioning, pollutants from heavy machinery and diesel generators will impair the air quality with noxious gases such as VOC's, CO, NOx SOx as well as other pollutants into the ambient air in addition to generation of noise. This impact is described as direct, negative, short term, local, reversible and is rated moderate.

Community Agitation over Environmental Damage and Loss of Benefits

Any form of environmental damage that occurred in the host communities over the lifespan of the proposed plant can lead to conflicts during the decommissioning phase as the community could make demands which may not be met by the operators of the project. In addition, the loss of benefits that the host community regularly enjoyed can lead to community agitations as they could possibly make some final demands before facility closure. The impact is described as direct, short-term, local, reversible and is rated moderate.

5.4.6 Significant Positive Impacts of the Project

The proposed project will result in a number of positive impacts for the community. Most of the positive impacts will be in the area of macro-economics. The envisaged positive impacts of the project are further discussed below.

Income from site clearing and other site preparation activities

During the early stages of the project there will be need to clear the land. The communities surrounding the project site will benefit financially from contracts and employment opportunities relating to land clearing and site preparation.

Income during construction and operation of the proposed project

Direct employment opportunities shall be created for the local populace because of the personnel requirement for the construction and operation of the project. Indirect employment opportunities will be created from support services and retail sales given that some construction materials and personnel needs would be locally sourced; this would increase financial flow in the local economy. During the construction phase, local spending will increase, economically benefiting the area.

Increase in income from transportation

During all the project phases, there will be transportation of workers, equipment and supplies to and from the project site. Some contractors involved in this project will hire vehicle owners who may live in the communities around the proposed project area.

Income from involvement in waste handling activities

Solid wastes will be generated at each phase of the project, but will peak during the construction and decommissioning phases. Most of the wastes associated with this project will be handled by, accredited waste handling and disposal companies; and this will generate income for the vendors engaged.

Income from dismantling of structures and site restoration

Direct and indirectly related job opportunities would be created for the local populace during the decommissioning phase of the project which will include the dismantling of structures, site remediation/restoration, and demobilization of equipment and men from site. Logistics, transportation, waste management and site restoration activities will create job opportunities that will impact the macroeconomics of the communities positively.

CHAPTER SIX: MITIGATION MEASURES

6.0 Introduction

This chapter proffers mitigation measures for the impacts from the proposed CNG Mother/Daughter Stations identified in **Chapter 5**. Some major negative impacts were identified though impacts mainly fell between moderate and minor. Mitigation measures have been provided for the impacts rated as major and moderate, while recommendations have been made for enhancing the positive impacts. Continuous improvement and standard practices would address minor and negligible impacts as shown in the HEMP process that is contained in the Environmental Management Plan (**Chapter 7**) in this report.

The mitigation measures for the proposed project plays the dual role of reducing the levels of the identified negative impacts to As Low as Reasonably Practical (ALARP) as well as enhancing the positive (beneficial) effects of the different phases of the project (pre-construction, construction, operations and decommissioning). The residual impacts that could arise despite the mitigation measures have also been assessed and information on these residual impacts as well as the plan for monitoring compliance and effectiveness of mitigation measures are provided in the Environmental Management Plan (**Chapter 7**).

In proffering mitigation measures, the primary objectives were:

- ***Prevention or avoidance*** – ensuring that significant and adverse potential impacts and risks do not occur.
- ***Reduction*** – ensuring that the effects or consequences of those significant associated and potential impacts that cannot be prevented are reduced to as low as reasonably practicable. Reasonable practicability was determined in reference to best industry practice and to economic, environmental, technical, health and safety considerations.
- ***Control*** – ensuring that residual associated impacts are reduced to a level as low as reasonably practicable.

The mitigation measures proffered for the predicted environmental impacts from the project took cognizance of:

- Environmental laws in Nigeria, with emphasis on permissible limits for waste streams {FEPA (1991) now FMEnv, EGASPIN (2018)};
- Best Available Technology for sustainable development;
- Feasibility of application of the measures in Nigeria;
- Social well-being, etc.
- Professional Judgement

GVLNG Limited is committed to ensuring the implementation of mitigation

measures for the various phases of the project which are shown in **Table 6.1**.

Table 6.1: Mitigation Measures

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
Pre-Construction	Land acquisition and tenure	Liability/ reputation	Litigation	9	• Ensure that all relevant stakeholders/ issues are identified, discussed and resolved properly prior to mobilization	Low
		Community and youth concern	Agitation	9	• Implement regular consultations with the local community and other stakeholders (Govt., Community, NGOs, CBOs etc.) for effective communication and social license; • Support traditional conflict resolution structures in the project communities	Low
	Environmental and engineering surveys	Soil, vegetation, community	Minor disturbance from survey activities (-)	3	• Restrict survey footprint; restore disturbed areas after surveys	Negligible
	Material and equipment supply	Air quality	Vehicular emission from vehicles conveying workers and construction equipment (pollutant and greenhouse gases with possible health hazards)	9	• Engine to comply with international standards for exhaust gases; • Maintenance of engines and exhaust gas check; • Adoption of engine off policy at construction site. • Regular inspection, servicing and maintenance of plant and equipment will be scheduled and carried out to ensure good performance and reduced emissions.	Medium

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
		Noise	Noise generated from vehicles conveying construction equipment	9	• Adoption of engine off policy at construction site; • When not in use, schedule activities to daytime only; • Use of noise muffs	Low
	Mobilization of workforce	Population in the vicinity of activity	Social and cultural interaction issues; Health and security issues; Noise and dust.	9	• Effective and open complaints procedure; while other impacts are treated in the relevant column	Medium
		Community infrastructure and utilities	Increase demands on services in local communities	9	• Proponent to provide all utilities for the facility; therefore, the community infrastructure and utilities will not be overstressed.	Low
		Community and youth concern	How to be gainfully employed	13	• Company to provide appropriate job opportunities for skilled and unskilled labour for the communities. • Cooperative and open working relations shall be established early with local communities and maintained throughout the life of the project; commitments with respect to local and national content of workforce;	Medium
		Transport	Increase in the demand of public transport	9	• Develop a Transport Management Plan specifying routes, speeds, times of travel and key roads in terms of local services; • Consideration shall be given to avoid reliance on public transport and contractors shall be required to use	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
					private buses/vehicle	
		Vector related	Vector such as bed bug etc. can be an issue	7	• Provide employee induction, awareness and training aimed at building a culture of environmental awareness;	Low
				9	• Provide support to district health vector-related control programs to provide long lasting. • Insecticide at reduced costs.	Low
		Sexually transmitted infection HIV/AIDS	Sexual relationship	13	• HIV/AIDS, and other sexually transmitted diseases (STD) awareness information, including means of preventing contraction of such diseases, shall be included in induction training and toolbox talks of workers. • Workers will be informed of the health risks of illicit sex and that prostitution is illegal and information on the health risks of prostitution will also be provided; • Information on sexually transmitted diseases and the risks of prostitution shall also be provided.	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
	Base camp construction, ground clearance and grading	Air quality	Reduction in air quality due to an increase in airborne particulate matter	9	• Good maintenance of machinery to generate minimal levels of pollutants; • Regular visual monitoring to identify equipment producing excessive visible emissions. • Equipment observed to be creating excessive air quality emissions will be replaced or serviced within 48 hours. • Use of the most suitable site equipment that can carry out the required tasks with the most efficient fuel consumption rates	Medium
Construction		Noise	Noise generated from activities	9	• Use of mufflers on diesel equipment; • Adoption of engine off policy at construction site; • Schedule activities during daytime	Low
		Soil quality	Disruption of the topography of the soil	9	• Best available technology shall be used; • Area of disruption shall be kept as minimal as possible	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
	Excavation and construction of facility	Air quality	Reduction in air quality due to emissions from equipment	9	• Regular visual monitoring to identify areas generating visible dust emissions from the site. Where visible dust emissions from the site are observed, feasible and reasonable dust mitigation measures will be identified and implemented e.g. Implementation of a dust suppression system such as regularly spraying surfaces with water to reduce dust levels; (especially during the Dry Season). • All plant / equipment operators will be appropriately trained and certified • Monitoring of PM 2.5 and PM 10 in line with FMEnv. guidelines for air quality in the Dry Season	Low
		Noise level	Increased noise and vibration level from construction plant and equipment	9	• Mufflers shall be installed on all combustion engine plant, such as generators and compressors, and they will be checked to ensure they produce minimal noise. • Best industry practice will be employed.	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
	Excavation and construction of facility				• All plant/equipment operators will be appropriately trained and certified. • Construction plant, equipment and vehicles will be modern and well maintained in accordance with written procedures that are based upon the manufacturer's guidelines, applicable industry code, or engineering standards to ensure efficient and reliable operation. • Noisy operations will be scheduled at the same time to take account of the fact that combined levels may not be significantly higher than the level if the operations were performed separately. The perceived percentage usage for the noisiest activities will therefore be lower at receptors. • Provide employee induction, awareness and training aimed at building a culture of environmental awareness	
		Groundwater quality	Contamination of groundwater aquifers	7	• Best available technology shall be used; • Avoid digging to the bottom aquifer	Low
		Soil quality	Change in topography	7	• Green areas to be planted with native plants	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
			Loss of terrestrial habitat	7	- Excavation shall be limited to areas clearly marked out for the facility - Limit clearing and earthworks - Vegetation will be replanted as part of the landscaping works - Where practical utilize previously cleared areas	Low
Construction	Construction traffic	Road users, local communities	Increased traffic congestion and accident risk (-)	6	- Implement traffic management plan; - Provide signage; train drivers; - Schedule deliveries appropriately	Low
	Construction activities	Local economy	Increased employment and business opportunities (+)	9	- Maximise local workforce participation and local sourcing	Medium (Positive)
	Fuel and lubricant storage/handling	Soil and groundwater	Contamination from accidental spills and leaks (-)	9	- Store fuels in bunded areas; - Maintain spill kits; - Train personnel; - Implement spill response procedures	Low
	Equipment installation and commissioning	Workers	Occupational injuries and accidents (-)	9	- Enforce HSE procedures; - Provide PPE; - Conduct toolbox talks and - Safety training	Low
Accident al Events	Work-related injuries	Accidents and injuries	Can be as severe as loss of life	11	- Site specific induction and continual safety training for all staff; - Continual drills in emergency procedures; - Ensure that appropriate safety and rescue equipment is available and employees trained in its use	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
		Health services infrastructure and capacity	Additional stress on the available healthcare infrastructure and manpower	9	- Rescue ambulance should be available; - Assist the local hospital/clinic in areas of shortcomings	Low
Operations	Natural gas compression operations	Ambient air	Methane emissions and greenhouse gas releases (-)	9	- Conduct routine leak detection and repair (LDAR); - Install gas monitoring systems; maintain compressors	Low
	Compressor operations	Nearby neighbours/ communities	Noise from compressors and associated equipment (-)	9	- Install acoustic enclosures; - maintain equipment; - establish noise buffer zones	Low
	CNG dispensing operations	Vehicle owners and transport sector	Improved access to cleaner fuel (+)	15	- Ensure reliable supply and safe operation of dispensing systems	High (Positive)
	Substitution of conventional fuels with CNG	Air quality, public health	Reduction in particulate matter, SOx and NOx emissions (+)	15	- Promote adoption of CNG-powered vehicles - Maintain fuel quality standards	High (Positive)
	Operation of CNG station	Consumers and businesses	Reduced fuel costs and improved energy access (+)	12	• Maintain operational efficiency and uninterrupted supply	High (Positive)
	High-pressure gas storage	Workers, public, infrastructure	Fire and explosion hazards (-)	11	- Install emergency shutdown systems; - Gas detection systems; fire protection systems; - Comply with applicable design codes; - Conduct emergency drills	Medium

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
	Tube trailer loading (Mother Station)	Workers	Exposure to high-pressure gas handling risks (-)	12	- Develop loading SOPs; - use pressure relief devices; - conduct competency training; - implement permit-to-work system	Medium
	Transportation of CNG trailers	Communities, road users	Traffic accidents and gas release incidents (-)	12	- Use certified transport vehicles; - implement journey management plans; - Train drivers; perform vehicle inspections	Medium
Operations	Trailer unloading (Daughter Station)	Workers	Gas leakage during unloading operations (-)	12	- Use standardized unloading procedures; - Install emergency isolation valves; - Conduct operator training	Medium
	Routine maintenance activities	Workers	Exposure to operational and maintenance hazards (-)	9	- Implement lockout/tagout procedures; - Provide PPE; - Conduct regular safety audits	Low
	Routine operations and maintenance	Workforce	Long-term employment opportunities (+)	9	- Maintain fair employment - Practices and workforce development programs	Medium (Positive)
	Emergency situations (fire/explosio n)	Workers, communities, infrastructure	Injury, fatality, and property damage ()	11	- Emergency response plan; - Firefighting systems; - Emergency drills; - Mutual aid agreements; - Adequate separation distances	Medium
	National gas utilization	Energy sector	Enhanced energy security and domestic gas utilization (+)	12	- Ensure sustainability of the facility and its operations	High (Positive)

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
Operations	Facility operation and utility	Air quality	Reduction in air quality due to emissions from the machines and equipment	9	- Use of mechanical seals, vapour recovery, sealing glands by oil pressure, and maintenance - Engine to comply with international standards for exhaust gases; - Maintenance of engines and use of gas filters on exhaust to minimize emission; - Adoption of engine off policy at docking premises. - Regular inspection, servicing and maintenance of plant / equipment will be scheduled and carried out to ensure good performance and reduced emissions. - Equipment will be subject to periodic performance reviews - the scope of which includes environmental performance indicators - Where practical machines will be operated at low speed or power and will be switched off when not being used.	Low
		Transport	Interference with public transport	5	- Operational activities shall not interfere with public transport or cause road jams; - However, consult with stakeholders on nature and timing of activities which may likely cause interference	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
		Soil quality	Contamination of soil	7	- Good housekeeping to minimize leaks and spills	Low
			Waste generation	11	- All generated wastes shall be placed in appropriate containers prior to disposal. - Provide consistent, clear direction on waste and resource handling, storage, stockpiling, use and re-use management measures. - Waste collection and storage areas shall be established and maintained. - Waste will be segregated at source, stored and transported to disposal sites by appropriate third-party contactor. - Sludge, and effluent waste shall be placed in sealed containers, before disposal	Low
		Noise	Noise generated from activities	11	- Silencers / mufflers shall be used on equipment where possible - Operations will be conducted such that noise generation will be managed within regulatory requirements - Continuous noise emitting machinery, such as generators, will be housed in a suitable acoustic enclosure	Low
		Health and safety	Exposure of the workforce	11	- Emergency response plan and procedures are in place. - Ensure that an adequate number of trained first aiders are available at work sites.	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
					- Create awareness on handling of electrical appliances amongst the staff.	
	Facility operation and utility				- Ensure that appropriate PPE are provided and correctly used - Job hazard identification and analysis is conducted - Perform regular workplace inspections. Hazards identified must be addressed immediately, or as soon as reasonably possible. - Risk assess activities involving hazardous substances - Safety signage is provided at strategic locations. - Toolbox talks shall be held before any site work commences - Use best practice procedures to ensure safe operations	
		Community infrastructure and utilities	Increase demands on services in local communities	11	- Overstressed utilities can be addressed by community assistance grant, loans, construction of needed facilities, etc.	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
		Community and youth concern	Community health and employment	13	- Give concessions to indigenes in employment, award of contracts, scholarships and training schemes. - Cooperative and open working relations shall be established early with local communities and maintained throughout the life of the project; - Show commitments with respect to local and national content of workforce and - Provide job opportunities for local skilled and unskilled labour;	Low
	Facility operation and utility				• Encourage communities to identify impacts that may be of particular concern to them and have a voice in appropriate mitigation measures.	

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
		Sexually transmitted infection HIV/AIDS	Sexual relationship	13	- HIV/AIDS, and other sexually transmitted disease (STD) awareness information, including means of preventing contraction of such diseases, shall be included in induction training and toolbox talks of workers. - Induction for workers on health risks of illicit sex and communicable diseases. - Workers will be informed that prostitution is illegal and information on the health risks of prostitution will also be provided; - Information on sexually transmitted diseases and the risks of prostitution shall also be provided.	Medium
Operation	Power generation	Air quality	SPM and other gaseous pollutants from power generating plant	9	- The open end of the exhaust of generator should be at least 2.5meters above the ground level. It should also be pointing skywards. - This will minimize pollutant gases concentration at level close to workers. - This also enhances wind dispersion effect on the pollutant gases; - Systematic inspection and maintenance of generators to minimize air emission	Low
		Noise	Noise from power generator	9	- Mufflers on power generators;	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
					Systematic inspection and maintenance of generators to minimize noise emission	
		Soil quality	Contamination of soil from generator fuel	7	- Good housekeeping to minimize leaks and spills	Low
		Population in the vicinity of activity	Health issues.	11	Effective and open complaints procedure; while other impacts are treated in the relevant column	Medium
Accidental Events/ Non-Routine Activities	Fire/explosion	Air quality	Resultant air emission from fire/explosion	11	- Ensure and enforce the implementation of fire prevention & protection devices are incorporated into the daily operations; - Ensure the implementation of emergency response plan for the location; - Firefighting material should be available on location at all times; - Material safety data sheets (MSDS) should be available for all chemicals and hazardous substances to be used on location; - Staff handling hazardous substances/materials must be aware of their potential impact and take appropriate safety measures; - Carry out HAZID/HAZOP of the facility; Permit	Medium
		Soil quality	Resultant contamination of soil from fire/explosion	11		Medium
		Vegetation	Resultant vegetation destruction from fire/explosion	11		Medium
		Wildlife	Habitat destruction and wildlife kill from fire/explosion	11		Medium

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
					to work system (PTW) should be enforced; restoration of biophysical environment	
		Population in the vicinity of activity	Health issues	11	- Effective and open complaints procedure; - Emergency preparedness and management procedure is in place	Medium
		Community infrastructure and utilities	In case of fire outbreak, localized infrastructure and utilities shall be damaged	9	- Reduction of activities leading to explosion and fire outbreak - Good housekeeping	Low
		Community and youth concern	Avoidance of such catastrophe	11	- Encourage communities to have a voice in appropriate mitigation measures	Low
		Liability/ reputation	Litigation and damaged reputation	11	- Prompt compensation for damage property and utilities	Low
		Accidents and injuries	Resultant injuries from fire/explosion	11	- Emergency responses should also cover the injured victims	Medium
	Work-related injuries	Accidents and injuries	Can be as severe as loss of life	11	- Periodic training and continual safety drills for all staff; - activation of emergency procedures; - ensure that appropriate safety and rescue equipment is available and employee trained in its use	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
		Health services infrastructure and capacity	Additional stress on the available healthcare infrastructure and manpower	9	- Rescue ambulance should be available; - Assist the local hospital/clinic in areas of shortcomings	Low
Decommissioning	Facility shutdown and decommissioning	Employees	Job losses and reduced economic activity (-)	6	- Develop workforce transition plan; - Provide notice and retraining opportunities	Low
	Equipment dismantling and demolition	Workers	Occupational health and safety risks (-)	9	- Prepare decommissioning HSE plan; - use trained contractors; - enforce PPE requirements	Low
	Demolition activities	Nearby communities	Dust, noise and vibration generation (-)	9	- Water suppression; noise control measures; - Controlled demolition practices	Low
	Removal of pipelines and storage vessels	Soil and groundwater	Residual contamination from hydrocarbons or chemicals (-)	9	- Conduct contamination assessment; - Remove contaminated soils; - Implement remediation measures	Low
	Scrap metal recovery and recycling	Environment	Resource recovery and waste minimization (+)	9	- Maximize recycling and reuse of materials through licensed recyclers	Medium (+)
	Site restoration and revegetation	Soil, biodiversity, landscape	Restoration of ecological and aesthetic value (+)	12	- Implement site rehabilitation plan; - revegetate with native species; - monitor restoration success	High (+)

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
	Decommissioning and Abandonment	Air quality impairment and noise	Resultant air emissions and noise from decommissioning activities.	9	- Protective masks will be worn by personnel in areas having excessive emissions as well as dust-prone areas. - Operators of equipment will be mandated to wear PPE (earplugs, noise mask, coverall etc, - Vehicles and machinery to be used during decommissioning will be fitted with filters and muffs to minimise emissions and noise levels	Low
		Community and youth concern	Community agitations over environmental damage and loss of oil benefits	9	- Identification and resolution with relevant stakeholders' issues will be ensured. - Regular consultation will be made with stakeholders (Govt., Community, NGOs, CBOs etc.) to understand community perceptions, issues and concerns. - Effective liaison/ communication channels with communities (via Community interface coordinators/ community relations officers [CIC/CROs]) will be maintained. - There will be inclusion of decommissioning issues in the Terms of Reference for the MOU.	Low

	Activities	Receptors	Description of Potential Impact: Negative/Positive	Impact Rating	Mitigation	Residual Impact
		Community and youth concern	Creation of business/job opportunity	13	- Indigenous contractors/ personnel and qualified resource persons shall be engaged in the decommissioning activity. - There will be a strict Compliance with GVLNG procedures /criteria for indigenous labour sourcing /employment.	High (+)

CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.0 Overview and Scope

This chapter contains the Environmental and Social Management Plan (ESMP) drawn up for the GVLNG Limited's CNG Mother/Daughter Station at Izom, Gwagwalada Area Council, Abuja-FCT

This Environmental and Social Management Plan (ESMP) will enable GVLNG to realize its Health, Safety and Environment (HSE) regulatory compliance objectives, carry out its institutional responsibilities (Federal Ministry of Environment/NMDPRA regulations and AEPB guidelines), and other associated obligations connected to the development and operation of the Plant. An ESMP for the facility is a major feature of GVLNG's overall Environment Management System (EMS), as it addresses environmental, social, and health performance.

This ESMP has been designed for the following purposes:

1. It lays down the procedures and measures that will be incorporated into the development and operations of the plant to verify and regularly monitor the effectiveness of the mitigation and enhancement measures that GVLNG Limited has chosen to implement during this project.
2. The ESMP will be used to ensure strict compliance with statutory requirements and GVLNG's corporate policies on safety and the environment.
3. This ESMP will establish any relationship between each significant impact (major or moderate significance); the relevant mitigation measures; and the monitoring approach of all significant impacts that have so far been identified in the study.

Also, through this ESMP, significant impacts are referenced to:

- Appropriate regulatory requirements, institutional responsibilities and other obligations;
- Relevant GVLNG Limited operational controls (e.g., management best practices, construction and operation specifications, procedures, and work instructions); and
- Mitigation and regulatory monitoring of institutional roles.

This EMP applies to all sub activities of the operation of the project.

Policies

GVLNG Limited has established an HSE Policy and a sustainability commitment that mutually defines the company's resolve in carrying out operations in a socially responsible and ethical manner, at the same time considering the protection of

health, safety and the environment. GVLNG Limited is fully committed to the implementation of the policy and guidance as presented in **Chapter 1** of this report. Environmental aspects will be embarked upon using the following process identification of environmental sensitivities:

- Identification of potential significant impacts,
- Implementation of design measures or operational procedures that minimize impacts to satisfactory levels,
- Establishment of emergency and contingency plans
- Monitoring the effectiveness of environmental protection, and
- Auditing the success of the overall strategy.

The negative impacts associated with the development and operations at the Stations and measures drawn up to mitigate them have previously been examined. But the long-term process of managing HSE issues relating to development and operations at the Plant requires management of residual impacts, as well as monitoring and follow-up.

The guidelines employed by GVLNG Limited in its operations include:

- Control and minimization of all solid and non-solid wastes,
- Prevention of release of petroleum products to the environment,
- Reducing gaseous emissions and noise in the ambient air.

7.1 Environmental and Social Management Plan

This Environmental and Social Management Plan has been set up to serve as a guide for the regulators, GVLNG Limited's managers and any other suppliers/ contractors that would be involved in the project, as well as other personnel tasked with the implementation of the plan. The EMP integrates features of the larger GVLNG EMS, modelled for all of the Company's operations. The HSE-MS blueprint has been drawn up to identify, plan for, and subsequently minimise potential HSE and socio-economic impacts.

Table 7.1: Environmental and Social Management and Monitoring Plan for GVLNG CNG Mother/Daughter Stations

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
Land Acquisition	Loss of means of Livelihood of land owners who previously use the acquired land for farming.	Moderate	Adequate compensation shall be paid to those whose livelihoods are affected as a result of the project	Minor	Admin/ Community Relations Depts.	Pre-Mobilization	Site inspection Report	Once Prior to site preparation activities	Admin Manager
Site Preparation / Site Clearing	Vegetation removal and loss; to make room for the construction of the proposed Plant.	Moderate	Vegetation clearing shall be limited to the areas within the site needed for the Project. Use of herbicides for clearing shall be avoided	Minor	Project contractor and HSE Dept.	Pre-Mobilization	Site inspection Report	Daily throughout site preparation activities	HSE Manager
			Cleared trees shall be replanted within the project site or elsewhere	Minor	Project contractor and HSE Dept.	Pre-Mobilization	Site inspection Report	Daily throughout site preparation activities	HSE Manager
	Removal of the topsoil in preparation for the project	Moderate	Removal of the topsoil and vegetation shall be restricted to the	Minor	Project contractor and HSE Dept.	Pre-Mobilization	Site inspection Report	Daily throughout site preparati	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	construction.		construction area Measures should be employed to restrict silt removal					on activities	
	Noise and Vibrations from site preparation equipment and machines.	Moderate	Machinery with noise levels within acceptable limits shall be used	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation activities	HSE Manager
			All engines of all heavy equipment and automobiles will be switched off when not in use	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation activities	HSE Manager
			Time management will ensure that the site preparation activities will be done within the shortest possible time	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site Preparation activities	HSE Manager
			Acoustic mufflers shall be provided for heavy engines with noise levels above acceptable	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			limits					activities	
			Noise generating energy equipment shall be enclosed in noise insulators	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation activities	HSE Manager
			Workers with existing hearing impairments shall not be deployed to site.	Minor	HSE Dept.	Pre-Construction	Records of medical checks	Prior to mobilization of personnel	HSE Manager
	Impairment of Air Quality from site clearing and preparation activities.	Moderate	Protective masks will be worn by personnel in areas having excessive emissions as well as dust prone areas	Minor	Project contractor and HSE Dept.	Pre-Construction	SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc.	Weekly throughout site preparation activities	HSE Manager
			All heavy equipment that will be used in the site preparation will be mandated to regularly maintain and service their	Minor	Project contractor and HSE Dept.	Pre-Construction	SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc. and equipment	Weekly throughout site preparation activities	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			vehicles to minimize the emissions levels from their exhausts				servicing records		
	Loss of Wildlife and Habitat due to the site clearing and construction preparation.	Moderate	The site clearing is minimal as such the destruction of habitats of various microfauna and macrofauna species will not be carried out beyond the required project area	Minore	Project Contractor	Pre-Construction	Site Inspection Reports	Weekly	HSE Manager
			The use of herbicides will be avoided	Moderate	Project Contractor	Pre-Construction	Project Progress Reports	Weekly	HSE Manager
	Social Management Plan								
	Exposure of workers to poisonous animals and plants as a result of site clearing and preparation.	Moderate	Workers shall be provided with PPE (coveralls, jungle boots, hard hat and gloves) and their usage enforced	Minor	Project Contractor	Pre-Construction	Site inspection Report	Weekly throughout Site preparation activities	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			Awareness shall be created among personnel on the likelihood of exposure to poisonous wildlife and plants and the immediate measures to be taken if it occurs	Minor	HSE Dept	Pre-Construction	Minutes of Project Kick off meetings	Prior to site preparation activities	HSE Manager
			First aid measures and Medevac procedures shall be put in place in the event of an incident.	Minor	Project Contractor and HSE Dept	Pre-Construction	Site inspection Report	Weekly throughout site preparation activities	HSE Manager
			Anti-venom injections shall be provided on site.	Minor	Project Contractor	Pre-Construction	Site inspection Report	Weekly throughout site preparation activities	HSE Manager
	Opportunities for employment	Positive	Indigenous contractors and qualified resource persons shall be employed.	Positive	Project Contractor	Pre-Construction	Interview Records and Personnel CV's	Once prior to confirmation of employment	Human Resources (HR) Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			GVLNG shall develop procedures/criteria for indigenous labour sourcing/ employment.	Positive	HR Dept and Community Relations Department	Pre-Construction	Contract documents	Prior to site preparation activities	Human Resources Manager
	Injuries resulting from clearing of vegetation.	Moderate	Workers shall be provided with PPE (coveralls, jungle boots, hard hat and gloves) and their usage will be thoroughly enforced	Minor	Project Contractor	Prior to all Construction activities	Project safety reports	Weekly throughout site preparation activities	HSE Manager.
			Toolbox meetings will be conducted before commencing site clearing activities.	Minor	Project Contractor	Prior to the start of Construction activities	Minutes of Toolbox meetings	Daily throughout site preparation activities	HSE Manager.
			First aid /medical facilities shall be provided on site, with critical cases transferred to GVLNG approved or other	Minor	Project contractor and HSE Dept	Throughout Pre-Construction	Project safety reports Incident Reports	Weekly throughout site preparation activities	HSE Manager.

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			appropriate health facilities (Medevac).						
Recruitment of Workers	Increased employment/ services opportunities for the host community, and potential increase in income and better livelihoods.	Positive	Engagement of indigenous contractors and qualified resource persons	Positive	HR Dept	All Project Phases	Contractor Portfolio, Interview Records and Personnel CV's	Once prior to signing contract/ confirmation of employment	Human Resources (HR) Manager
			Application of existing GVLNG procedures/ criteria for indigenous labour sourcing and employment.	Moderate	HR Dept and Community Relations Department	All Project Phases	Contract Documents and Employment Letters	Prior to site preparation activities	Human Resources Manager
	Increase in social vices (violence, drug/alcohol abuse, Teenage pregnancies, prostitution etc)	Moderate	Awareness campaigns shall be carried out to enlighten the communities/ workers on the implications of drug and alcohol abuse, unprotected sex, prostitution and the	Moderate	HSE and Community Relations Depts.	Pre-Construction	Consultation Sessions Records	Prior to site preparation activities	HSE and Community Relations Managers.

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			need to sustain cultural values.						
			Condom use shall be encouraged	Moderate	HSE Dept.	Pre-Construction	Consultation Sessions Records	Prior to site preparation activities	HSE Manager.
			Alcohol and drug sales will be prohibited around the Plant at all project phases	Moderate	HSE Dept.	All Project Phases	Site Inspection Reports	Weekly	HSE Manager.
			Alcohol consumption and drug use shall be prohibited on the facility in line with GVLNG's Drug and Alcohol policy.	Moderate	HSE Dept.	All Project Phases	Incident Reports	Weekly	HSE Manager.

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			Efforts will be made to enlighten the host communities to existing government control programs for HIV/AIDS	Moderate	HSE Dept.	Pre-Construction	Consultation Sessions Records	Prior to site preparation activities	HSE Manager.
	Third party agitation (over employment issues)	Moderate	Identification and resolution of relevant stakeholders' issues will be ensured	Minor	Community Relations Dept	Prior to Construction	Project Registration Documents, Consultation Records and MOU with the host community	Prior to site preparation activities	Community Relations Manager
			Regular consultation will be made with stakeholders (Govt., Community, NGOs, CBOs etc.) to understand community perceptions, issues and concerns.	Minor	Community Relations Dept	Prior to Construction	Consultation Sessions Records	Weekly	Community Relations Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			Effective liaison/communication channels with communities (via Community interface coordinators/ community relations officers [CIC/CROs]) will be maintained	Minor	Community Relations Dept	Prior to Construction	MOU with the host community	Prior to site preparation activities	Community Relations Manager
			There will be inclusion of community employment issues in the Terms of Reference for the MOU	Minor	Community Relations Dept	Prior to Construction	MOU with the host community	Prior to site preparation activities	Community Relations Manager
Mobilization	**Environmental Management Plan**								
Transportation of Personnel and Equipment	Noise and Vibration	Moderate	Personnel will be car pooled as much as possible to reduce the number of vehicles that will be used to convey personnel to site thus reducing	Minor	Project contractor and HSE Dept.	Pre-Construction	Contractors Work Execution Plan and Noise level monitoring	Weekly throughout site preparation activities	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			cumulative noise						
			Machinery with noise levels within acceptable limits shall be used	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation activities	HSE Manager
			All engines of all heavy equipment and automobiles will be switched off when not in use	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation activities	HSE Manager
			Time management will ensure that the movement and transportation of personnel shall be done within the shortest possible time	Minor	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation activities	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	Emissions and dust from vehicles	Moderate	Protective masks will be worn by personnel in areas having excessive emissions as well as dust prone areas.	Minor	Project contractor and HSE Dept.	Pre-Construction	SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc.	Weekly throughout site preparation activities	HSE Manager
			All heavy equipment that will be deployed to site will be mandated to regularly maintain and service their vehicles to minimize the emission levels from their exhausts	Minor	Project contractor and HSE Dept.	Pre-Construction	SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc. and equipment servicing records	Weekly throughout site preparation activities	HSE Manager
	Social Management Plan								
	Injuries and accidents to workers during loading and off loading construction materials.	Moderate	Adequate PPE shall be provided especially gloves, safety shoes, and hard hats to workers shall be ensured. It is mandatory that all employees on site shall wear the appropriate PPE whilst performing	Minor	Project contractor and HSE Dept	Pre-Construction	Work Execution Plan	Weekly throughout site preparation activities	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			their duties.						
	Increased vehicular movement and traffic and possibilities for road accident	Moderate	A journey management plan shall be developed and workers shall be pooled. Use of signages	Minor	Project contractor and HSE Dept	Pre-Construction	Work Execution Plan Journey Management Plan	Weekly throughout site preparation activities	HSE Manager
	Behavioural modifications from wildlife	Moderate	Personnel will be car-pooled as much as possible to reduce the number of vehicles that will be used to convey personnel to site thus reducing cumulative noise and behavioural modifications by wildlife	Moderate	Project contractor and HSE Dept.	Pre-Construction	Contractors Work Execution Plan and Noise level monitoring	Weekly throughout site preparation activities	HSE Manager
			All engines of all heavy equipment and automobiles	Minor	Project contractor and HSE	Pre-Construction	Monitoring of noise levels	Weekly throughout site	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			will be switched off when not in use		Dept.			preparation activities	
			Time management will ensure that the movement and transportation of personnel shall be done within the shortest possible time	Moderate	Project contractor and HSE Dept.	Pre-Construction	Monitoring of noise levels	Weekly throughout site preparation activities	HSE Manager
Construction	**Environmental Management Plan**								
Construction of the Plant and Ancillary Facilities	Noise/ Vibration	Moderate	Engines of any equipment not in use shall be switched off	Minor	Project contractor	During Construction	Monitoring of noise levels	Weekly During Construction	HSE Manager
			Time management will ensure that the construction of the Plant shall be executed within the shortest possible time	Minor	Project contractor	During Construction	Monitoring of noise levels	Weekly During Construction	HSE Manager
			Acoustic mufflers shall be provided for equipment if	Minor	Project contractor	During Construction	Monitoring of noise levels	Weekly During Constructi	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			noise levels are above acceptable limits					on	
			GVLNG HSE policy of wearing ear muffs/ plugs shall be applied in areas of high noise pressures	Minor	Project contractor	During Construction	Site Safety Reports	Weekly During Construction	HSE Manager
			Sufficient separation distances shall be provided for sources of high energy sound to reduce noise levels	Minor	Project contractor	During Construction	Monitoring of noise levels	Weekly During Construction	HSE Manager
			Warning signs shall be provided at noise prone areas and will be designated "Ear Muff Area".	Minor	Project contractor	During Construction	Site Safety Reports	Weekly During Construction	HSE Manager
			Workers with existing hearing impairments shall not be deployed to site.	Minor	Project Contractor and HSE Dept.	Pre-Construction	Records of medical checks	Prior to Construction	HR Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	Impairment of Air Quality	Moderate	Protective masks will be worn by personnel in areas having excessive emissions as well as dust prone areas.	Minor	Project contractor	During Construction	SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc.	Weekly	HSE Manager
			Operators of emission generating equipment/ vehicles that will be used in construction will be mandated to regularly maintain and service their engines to minimize the emission levels generated	Minor	Project contractor	During Construction	SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc. and Equipment Service Records	Weekly	HSE Manager
			Operators of power generators will regularly maintain them	Minor	Project contractor	During Construction	SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc. and Equipment Service	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
							Records		
	Increase in vehicular traffic	Moderate	Movement of any supply vehicles will be limited to off-peak times to reduce traffic congestion	Moderate	Project contractor	During Construction	Traffic Management Plan and Traffic Density	Monthly	HSE Manager
			Journey Management Plans that reduce pressure on the existing road networks shall be implemented	Moderate	Project contractor	During Construction	Traffic Count and Traffic Density	Monthly	HSE Manager
			There will be a strict adherence to the Construction Traffic Management Plan	Moderate	HSE Dept.	During Construction	Traffic Count and Traffic Density	Monthly	HSE Manager
			Contractors will be encouraged to use buses to convey personnel to reduce traffic congestion	Moderate	Project contractor	During Construction	Traffic Count and Traffic Density	Monthly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	Interruption of drainage pattern	Moderate	Health awareness training shall be conducted prior to work commet.	Minor	Project Contractor and HSE Dept.	During Construction	Minutes of toolbox. Toolbox meetings/ safety briefings.	Weekly	HSE Manager
			Engineered drainage channels will be constructed taking into cognizance the topography and natural drainage of the area	Minor	Project Contractor	During Construction	Project Progress Reports	Monthly	HSE Manager
			The engineered drainage system will be designed in such a way as to prevent soil erosion in surrounding areas with vegetative cover being one of the key components of the altered drainage channels	Minor	Project Contractor	During Construction	Project Progress Reports and Site Inspection Reports	Monthly	HSE Manager
	Social Management Plan								

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	Burns/ injuries from welding sparks and other construction activities	Moderate	Awareness sessions on health risks and safety precautions of welding operations shall be carried out for workers.	Minor	Project contractor	During Construction	Minutes of toolbox meetings/ safety briefings.	Weekly	HSE Manager
			Pre-employment medical certification shall be carried out for the welders.	Minor	Project contractor	During Construction	Records of medical checks	Once, Prior to start of construction	HSE Manager
			GVLNG shall enforce the use of welder's mask, goggles, earmuffs, jacket, gloves, boots and coveralls, by welders during welding.	Minor	Project contractor and HSE Dept	During Construction	Safety Reports	Weekly	HSE Manager
			A medical facility/ first aid delivery service Plant shall be arranged for personnel use	Minor	Project contractor	During Construction	Incident Reports	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	Exposure to radioactive emission during radiography.	Moderate	Health awareness training shall be conducted prior to commencement of activities.	Minor	Project Contractor and HSE Dept.	During Construction	Minutes of toolbox meetings/ safety briefings.	Weekly	HSE Manager
			Staff shall undergo routine medical check-ups for radiation exposure.	Minor	Project Contractor and HSE Dept.	During Construction	Records of medical checks and Results of radiation tag monitoring	Weekly	HSE Manager
			Radiation monitors shall be provided to monitor radiation levels above threshold.	Minor	Project Contractor and HSE Dept.	During Construction	Radiation levels	Daily	HSE Manager
			The use of radiography aprons to protect the body from radiation shall be enforced.	Minor	Project Contractor	During Construction	Radiation levels	Weekly	HSE Manager
			Warning signs shall be provided during actual activities.	Minor	Project Contractor	During Construction	Site Inspection Report	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			The activity shall be carried out in accordance with standard specifications	Minor	Project Contractor and HSE Dept.	During Construction	Safety Reports	Weekly	HSE Manager
	GBV (sexual harassment, intimate partner violence, poor working conditions)	Moderate	The EEP GBV Action Plan shall be implemented for the Project	Minor	Project Contractor and HSE Dept	During Construction	Health and Safety Report	Weekly	HSE Manager
	Sexual transmitted diseases with influx of people.	Moderate	Labour management plan shall be developed. Sensitization programme shall be conducted for the construction workers as well as a Code of Conduct.	Minor	Project Contractor and HSE Dept	During Construction	Health and Safety Report	Weekly	HSE Manager
	Employment opportunities	Positive	Engagement of indigenous contractors and qualified resource persons will be done	Positive	Project Contractor	Prior to Construction	Employment Records and Personnel CV's	Once, Prior to construction	HR Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			Application of existing GVLNG procedures/ criteria for indigenous labour sourcing and employment.	Positive	Project Contractor and HR Dept	Prior to Construction	Contract documents	Once, Prior to Construction	HR Manager
Operations	**Environmental Management Plan**								
Operations and Maintenance	Noise and vibration	Moderate	Acoustic treatment by enclosure of equipment or soundproofing buildings that hold loud equipment and/ or units that operate at significant noise levels	Minor	HSE Dept	During Operations	Noise level monitoring	Weekly	HSE Manager
			Machinery with noise levels within acceptable limits shall be used	Minor	HSE Dept	During Operations	Noise level monitoring	Weekly	HSE Manager
			Noise generating equipment/ machinery/ generators shall be switched off if not in	Minor	HSE Dept	During Operations	Noise level monitoring	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			use						
			Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits	Minor	HSE Dept	During Operations	Noise level monitoring	Weekly	HSE Manager
			Noise generating energy equipment shall be enclosed in noise insulators in line with GVLNG's policy	Minor	HSE Dept	During Operations	Noise level monitoring	Weekly	HSE Manager
			GVLNG HSE policy of wearing ear muffs/plugs shall be applied in areas of excessive noise pressures	Minor	HSE Dept	During Operations	Noise level monitoring	Weekly	HSE Manager
			Sufficient separation distances shall be provided for sources of high energy sound to reduce cumulative noise levels	Minor	HSE Dept	During Operations	Site Inspection Reports	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			Workers with existing hearing impairments shall not be deployed to site	Minor	HSE Dept	During Operations	Medical checks	Annually	HSE Manager
	Impairment of Air Quality	Moderate	Protective masks will be worn by personnel in areas having excessive emissions as well as dust prone areas.	Minor	HSE Dept	During Operations	Safety Reports	Weekly	HSE Manager
			All tanker vessels, generators and vehicles will be regularly maintained and serviced to minimize emission levels	Minor	HSE Dept	During Operations	Equipment Service Records	Quarterly	HSE Manager
			Monitoring of indicator air quality parameters like NOx, CO, SPM, SOx and VOCs, will be undertaken regularly	Minor	HSE Dept	During Operations	Radiation, SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc.	Weekly	HSE Manager
			Power generators will be maintained/	Minor	HSE Dept	During Operation	Generator Service	Quarterly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			serviced regularly			s	Records		
			Generators, road tankers and road vehicles must be switched off when not in use	Minor	HSE Dept	During Operations	Site Inspection Reports	Weekly	HSE Manager
	Changes in Soil and Groundwater Quality	Major	The soil and groundwater quality in the vicinity of the terminal shall be periodically monitored in line with regulatory requirements.	Moderate	HSE Dept	During Operations	pH, THC, PAH, TOC, BOD, COD, Conductivity, heavy metals, phenols, etc	Monthly	HSE Manager
			Any spill that is noticed will be promptly cleaned up to prevent pollution of soil and groundwater.	Moderate	HSE Dept	During Operations	pH, THC, PAH, TOC, BOD, COD, Conductivity, heavy metals, phenols, etc	Monthly	HSE Manager
	Oil spill incidents	Major	GVLNG will have a full functional Oil Spill Contingency Plan in place to	Moderate	HSE Dept	During Operations	Oil Spill Contingency Plan	Annually	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			control and recover oil from incidents						
			ESI maps will be used to minimize environmental impacts in the event of a spill.	Moderate	HSE Dept	During Operations	Oil Spill Contingency Plan	Annually	HSE Manager
			Majority of chemicals will be controlled in accordance with the OSPAR HOCNS and the CHARM model, which ensure that all chemicals are not toxic to the environment at the quantities released.	Moderate	HSE Dept	During Operations	Chemicals MSDS	Monthly	HSE Manager
			Oil spill cleanup materials (e.g. absorbent pads, booms, skimmers etc) will be	Moderate	HSE Dept	During Operations	Materials Inventory, OSCP	Monthly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			stockpiled to contain and collect spills.						
			GVLNG personnel will be trained in use of such materials and contingency measures will be implemented for even the smallest of spills.						
	Fire Outbreaks during operations	Major	Fire protection facilities (detection, fighting and control) shall be provided at the Plant and will be regularly inspected with regular drills carried out.	Moderate	HSE Dept	During Operations	Site Inspection Report and Emergency Response Plan	Monthly	HSE Dept
			GVLNG's Emergency Response Procedures shall be implemented,	Moderate	HSE Dept	During Operations	Emergency Response Plan	Monthly	HSE Dept

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			including measures to quickly seek third-party assistance when necessary.						
			Adequate compensation shall be paid to affected parties in the event of third-party damage to lives and property.	Moderate	HSE Dept	During Operations	Incident Reports and GVLNG's Compensation Records	After every event	HSE Dept
	Electric shock, injuries to personnel during maintenance	Moderate	Ensure that workers wear appropriate PPE at work. Strict compliance with the SOP	Minor	HSE Dept	During Operations	Inspection Report	Monthly	HSE Dept
	Social Management Plan								
	Pressure on Existing Infrastructure	Moderate	Proper waste management procedures will be followed to reduce pressure on existing waste management facilities with the	Moderate	HSE Dept	During Operations	Waste Consignment Notes	Weekly	HSE Dept

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			key focus being placed mainly on reduction and recycling						
			GVLNG shall liaise with other companies on the need to jointly use/ develop key infrastructure to avoid pressures on the existing infrastructure thatthe public utilizes.	Minor	Admin Dept	During Operations	Minutes of Meetings and General Correspondence	Quarterly	Admin Manager
	Increase in vehicular traffic	Moderate	The movement of supply vehicles shall be limited to off-peak times to reduce traffic congestion	Minor	Admin Dept	During Operations	Traffic Management Plan and Traffic Density	Monthly	HSE Manager
			All personnel will be encouraged to adapt to Journey Management Plans to reduce pressure on the existing road	Minor	HSE Dept.	During Operations	Traffic Count and Traffic Density	Monthly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			networks						
			There will be strict adherence to the facilities Traffic Management Plan	Minor	HSE Dept.	During Operations	Traffic Count and Traffic Density	Monthly	HSE Manager
			Road tankers will be mandated to use designated parking areas to prevent traffic congestion on the major roads	Minor	HSE Dept.	During Operations	Traffic Count and Traffic Density	Monthly	HSE Manager
	Increase in local Population	Moderate	Any arbitrary micro-economic developments springing up as a result of the Plant's operations will be located as far away as possible from the facility.	Moderate	Admin Dept	During Operations	Site Inspection Reports	Weekly	Admin Manager
	GBV (sexual harassment, intimate partner violence, poor working	Moderate	The EEP GBV Action Plan shall be implemented for the Project	Minor	Project Contractor and HSE Dept	During Construction	Health and Safety Report	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	conditions)								
	Susceptibility to Pollution Related Diseases	Moderate	Monitoring of indicator air quality parameters like NOx, CO, SPM, SOx and VOCs will be carried out regularly to ensure that they are within recommended levels	Minor	HSE Dept	During Operations	Radiation, SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc.	Weekly	HSE Manager
			There will regular monitoring of groundwater quality for pollution to ensure that the groundwater complies to drinking water standards	Minor	HSE Dept	During Operations	pH, THC, PAH, BOD, COD, DO, Turbidity, TSS, heavy metals, phenols, etc	Monthly	HSE Manager
	Increased opportunities for employment and business	Positive	GVLNG will engage indigenous contractors/ personnel and qualified resource persons	Positive	HR Dept	Prior to Operations	Employment Records and Personnel CV's	Once, Prior to Operations	HR Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			There will be a strict Compliance with GVLNGs procedures /criteria for indigenous labour sourcing /employment.	Positive	HR Dept	Prior to Operations	Contract documents	Once, Prior to Operations	HR Manager
	Conflicts arising from Project Operations	Moderate	Identification and resolution of relevant stakeholders' issues will be ensured.	Minor	Community Relations Dept	During Operations	Project Registration Documents, Consultation Records and MOU with the host community	Continuously	Community Relations Manager
			Regular consultation will be made with stakeholders (Govt., Community, NGOs, CBOs etc.) to understand community perceptions, issues and concerns.	Minor	Community Relations Dept	During Operations	Consultation Sessions Records	Quarterly	Community Relations Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			Effective liaison/communication channels with communities via Community interface coordinators/ community relations officers [CIC/CROs]) will be maintained	Minor	Community Relations Dept	During Operations	MOU with the host community	Continuously	Community Relations Manager
			There will be an inclusion of community employment issues in the Terms of Reference for the MOU with the community	Minor	Community Relations Dept	During Operations	MOU with the host community	Once Prior to Start of operations	Community Relations Manager
Waste Generation (solids/liquid / gaseous)	Contamination of soil, surface water and ground water	Moderate	Solid wastes that cannot be recycled must be treated appropriately before final disposal	Minor	Waste Contractors and HSE Dept	During all project phases	Waste Inventory	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			For waste that are to be treated at third party facilities, appropriate storage areas will be designated on site	Minor	Waste Contractors and HSE Dept	During all project phases	Waste Management Plan	Quarterly	HSE Manager
			The choice of appropriate treatment of wastes will comply with the waste classification schemes from FMEnv, NMDPRA	Minor	Waste Contractors and HSE Dept	During all project phases	Waste Management Procedural Document	Continuously	HSE Manager
	E-waste generation and Disposal	Moderate	Training of workers on the handling of generated e-waste	Minor	Waste Contractors and HSE	During all project phases	Training/ Waste Management	Continuously	HSE Manager
	Social Management Plan								
	Increased opportunities for employment and business	Positive	GVLNG will engage indigenous contractors/ personnel and qualified resource persons	Positive	HR Dept	During all project phases	Employment Records and Personnel CV's	Continuously	HR Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			There will be strict Compliance with GVLNG's procedures/criteria for indigenous labour sourcing /employment.	Positive	HR Dept	During all project phases	Contract documents	Continuously	HR Manager
D&A	**Environmental Management Plan**								
Decommissioning and Abandonment.	Air Quality Impairment and noise	Moderate	Protective masks will be worn by personnel in areas having excessive emissions as well as dust prone areas.	Minor	HSE Dept	During Decommissioning	Safety Reports	Weekly	HSE Manager
			Operators of equipment, vehicles and machinery that will be involved during decommissioning, will be mandated to regularly maintain and service them to minimize emissions levels	Minor	HSE Dept	During Decommissioning	Equipment Service Records	Quarterly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			Monitoring of indicator air quality parameters like NOx, CO, SPM, SOx and VOCs, will be undertaken during and after decommissioning	Minor	HSE Dept	During Decommissioning	Radiation, SPM, NOx, VOC, O3, CO, H2S, CH4, dust levels etc.	Weekly	HSE Manager
			Machinery with noise levels within acceptable limits shall be used	Minor	HSE Dept	During Decommissioning	Noise level monitoring	Weekly	HSE Manager
			Noise generating equipment/machinery/ generators shall be switched off if not in use	Minor	HSE Dept	During Decommissioning	Noise level monitoring	Weekly	HSE Manager
			Acoustic mufflers shall be provided for machines/ engines with noise levels above acceptable limits	Minor	HSE Dept	During Decommissioning	Noise level monitoring	Weekly	HSE Manager
			GVLNG HSE policy of wearing ear muffs/plugs shall be	Minor	HSE Dept	During Decommissioning	Noise level monitoring	Weekly	HSE Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			applied in areas of excessive noise pressures						
			Workers with existing hearing impairments shall not be deployed to site.	Minor	HSE Dept	During Decommissioning	Medical checks	Annually	HSE Manager
	Social Management Plan								
	Increased opportunity for business and employment	Positive	GVLNG will engage indigenous contractors/ personnel and qualified resource persons	Positive	HR Dept	During Decommissioning	Employment Records and Personnel CV's	Continuously	HR Manager
			There will be a strict Compliance with GVLNG's procedures /criteria for indigenous labour sourcing /employment.	Positive	HR Dept	During Decommissioning	Contract documents	Continuously	HR Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
	Community agitations over environmental damage and loss of oil benefits	Major	Identification and resolution of relevant stakeholders' issues will be ensured.	Minor	Community Relations Dept	During Decommissioning	Consultation Sessions Records, Regulatory Approvals and MOU with the host community	Once, prior to Decommissioning	Community Relations Manager
			Regular consultation will be made with stakeholders (Govt., Community, NGOs, CBOs etc.) to understand community perceptions, issues and concerns.	Minor	Community Relations Dept	During Decommissioning	Consultation Records	Throughout decommissioning	Community Relations Manager
			Effective liaison/ communication channels with communities (via Community interface coordinators/ community relations officers	Minor	Community Relations Dept	During Decommissioning	MOU between all Parties	Throughout decommissioning	Community Relations Manager

Project Phase and Activities	Description of Impacts	Impact Rating before Mitigation	Mitigation Measures	Residual Rating	Action Party	Timing	Parameters for Monitoring	Monitoring Frequency	Responsible Party
			[CIC/CROs]) will be maintained						
			There will be inclusion of decommissioning issues in the Terms of Reference for the MOU	Minor	Community Relations Dept	During Decommissioning	MOU with community and Community Complaints Register	Before Commencement of Project	Community Relations Manager

The HSE-MS methodology has been designed to ensure that each potentially critical HSE impact recognized in this EIA will have suitable operational controls that indicate appropriate procedures, work instructions, EMPs, roles, responsibilities, authorities, monitoring, measurement, and record keeping that avoid or reduce impacts. Other GVLNG's operating procedures will be appraised and, where appropriate, tailored to contain information for planning and minimizing HSE impacts, or in any case, reference relevant documents that address HSE impact avoidance and mitigation.

GVLNG Limited plans to put into operation its HSE-MS throughout the lifetime of project activities to ensure compliance with applicable HSE regulations and other requirements to which GVLNG pledges, and to mitigate substantial adverse impacts.

The HSE-MS is modelled after and is also compliant with the International Organization for Standardization 14001: 1996 Technical Specification Guidance for Use (ISO 14001) and the draft standard ISO 18001.

7.1.1 HSE Management Plan

GVLNG plans to employ an official, documented HSE Management System (HSE-MS) for all its undertakings. Highlights of the HSE-MS are briefly discussed below.

7.1.1.1 Policy and Strategic Objectives

The GVLNG Limited HSE-MS initiates the direction and objectives of HSE management within the company and makes them applicable to all of the Company's activities. Several daughter policies addressing specific HSE issues complement this HSE policy. The policies relating to the environment include guidelines on:

- Spills,
- Environmental assessment,
- Use of chemicals
- Materials and energy use and
- Waste management.

Managers and supervisors are authorised to give the detailed content of the HSE Policy and applicable daughter policies to all personnel and contractors, concentrating on individual roles and responsibilities required of them.

7.1.1.2 Organization, Responsibilities, Resources, Standards and Documentation

Responsibilities for HSE are outlined in the GVLNG's HSE-MS, and are described in detail in various supporting documents.

HSE Management is a line responsibility in GVLNG, assisted by a team of specialist

HSE advisers and consultants. Contractor organizations will perform some of the activities associated with the operation of the Plant and are required to satisfy defined standards in HSE management before they can carry out any GVLNG's operations. Contractors' HSE performance will be screened and reviewed during project execution.

GVLNG Limited is committed to complying with applicable legislation and other requirements, including:

- Nigerian legislations,
- International conventions and agreements to which Nigeria is a signatory,
- GVLNG Limited HSE Standards, and
- International oil industry standards and practices.

The development and operational activities at the Plant have been drawn up to comply with these standards and all areas of interest will focus on complying with applicable legal and regulatory requirements.

7.1.2 Implementation

Environmental matters are tackled across all levels in GVLNG's planning activities; these include:

- GVLNG Limited's Business Plans, containing critical issues for HSE with set goals aimed at improvement and associated performance indicators,
- Emergency and contingency planning (e.g., the oil spill contingency and response plan),
- Asset HSE Plans,
- Department HSE Plans, and
- Contractor HSE Plans.

Actions from this EMP will be integrated into this planning framework.

GVLNG maintains a hierarchy of written standards, procedures and work instructions. These include standards on waste management and chemicals management.

The environmental performance of the Station's operations will be monitored in line with relevant regulatory and GVLNG requirements.

7.1.2.1 Monitoring

Monitoring activities during the development and operational phases of the Plant are described in **Section 7.5**. Results obtained from the monitoring programme will be reported regularly to the FMEnv and other regulatory authorities and to the GVLNG HSE Manager.

7.1.2.2 Audit

GVLNG Limited will prepare a programme of internal and external audits that evaluates the effectiveness of business controls, including the usefulness of the HSE-MS. The audit shall include the activities during the construction, operations and maintenance of the Plant.

7.1.3 Management Review

GVLNG Limited management appraises the efficiency of the HSE-MS from time to time to meet the business requirements set out by the organization and its stakeholders. Activities and operations at the Stations are included in this review, incorporating the results of the environmental monitoring.

7.2 Operational Controls

GVLNG Limited's HS-EMS, employs comprehensive operational controls to guarantee that all GVLNG operations are environmentally sustainable. Those operational controls that are applicable to the proposed project are discussed below.

7.2.1 Oil/Chemical Management

To limit the potential for oil/chemical to accidentally enter the environment and to make sure that the impacts of those substances whose entry to the environment cannot be avoided are minimized, a thorough selection and management procedure is being put into operation.

This procedure highlights the requirements for the evaluation, selection, supply, transport, storage, use and handling of such oil/chemical and other hazardous substances. A comparable process will be used in the Plant's operations.

Also incorporated into the plan is the requirement that adequate spill response materials will be made available at all locations where oil /chemicals are handled, stored or used. In the unlikely event that a an accidentally released, the toxicity and recommended spill management procedures used in GVLNG's operations will be detailed in a standard manual for managing such wastes.

7.2.2 Waste Management

Separate fit-for-purpose Waste Management Plans have been drawn up for the entire lifecycle of the proposed Stations. The waste management strategy implemented in these plans focuses on the standard waste handling hierarchy, including avoidance, tracking, minimization, reuse, recycling and finally responsible disposal.

7.3 Environmental Monitoring Programme

Monitoring will be carried out to ensure compliance with regulatory requirements

and as a way of evaluating the effectiveness of GVLNG Limited's operational controls and other measures intended to mitigate potential impacts associated with development and operations at the proposed Plant.

With regard to the significant impacts identified in this EIA Report, GVLNG Limited has mapped out a programme to monitor the effectiveness of the mitigation measures (**Table 7.1**). The programme describes the effect to be measured and the frequency.

Together with monitoring of the efficiency of specific mitigation measures, GVLNG has designed a programme to monitor for compliance with relevant regulatory standards. This programme also ensures that contractors keep their contractual obligations relating to work practices and design requirements. Monitoring will be done by GVLNG's HSE department and/or by contractors pursuant to their contractual obligations. The parameters to be measured during the course of operations at the proposed Plant are provided in **Table 7.1**.

Table 7.2: Environmental Monitoring Plan for GVLNG Limited's CNG Mother Stations

Environmental Components/ Matrix	Sampling Locations	Sampling Method	Environmental/ Social Parameters to be monitored	Compliance Requirement	Frequency of Monitoring	Responsible Party	Project Development Phase	Estimated Cost (₦)
Atmosphere (Air Quality & Noise)	Site boundary, nearest receptor, compressor area	Air Quality Monitoring Equipment Sound level meter	$PM_{2.5}$, PM_{10}, NOx, SO_2, CO, CH_4, VOCs TSP, CO, , Noise Level (dBA)	FMEnv/ NESREA WHO/ AfDB	Monthly monitoring; Monthly reporting	HSE Officer / Accredited Consultant, EPC Contractor	Construction & Operation Phase	500,000.00
Fugitive Gas Emissions	Compressor area, storage cascades, loading and unloading points	Portable gas detector and leak survey	Methane (CH_4), natural gas leaks	NMDPRA Requirements, IFC EHS Guidelines	Monthly	Operations Supervisor / HSE Officer	Operation	150,000/month
Noise Levels	Site boundary, compressor house, nearest residence	Sound level meter	Daytime and nighttime noise levels (dB(A))	NESREA Noise Standards	Quarterly	HSE Officer	Construction & Operation	250,000/event
Groundwater Quality	Monitoring boreholes, nearby wells within the project site	Water samples collected in sampling containers and analysed in accredited laboratory. In-situ parameters checked	Temperature, pH, salinity, TDS, conductivity, DO, BOD, TOC, COD, NO3, PO4, Chloride, sulphate, Microbiology, Heavy metals, TSS and Turbidity	FMEnv/ WHO/ Nigerian Drinking Water Standards	Quarterly monitoring; Monthly reporting	EPC Contractor Environmental Consultant	Construction & /Operations Phases	250,000.00
1	Fuel storage area, compressor	Soil samples collected at various points at	pH, Moisture, TOC, THC, TPH, NO3, PO4, Chloride, sulphate,	FMEnv, NESREA/ NMDPAR/	Quarterly monitoring and	EPC Contractor &	Construction /Operations Phases	250,000.00

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 (₦)
	area, dispensing bays	the Plant for laboratory analysis.	Microbiology, Heavy metals.	AfDB	reporting	Environmental Consultant		
Solid Waste	Waste storage areas	Waste shall be collected in designated bins. Monitor the handling and disposal of solid wastes generated onsite; waste tracking documentation.	Waste types, quantities generated, disposal records. Operational solid wastes including used packaging waste.	FMEnv/ NESREA/ NMDPRA/ AfDB	Monthly monitoring; Quarterly reporting	HSE Officer EPC Contractor	Construction, Operation & Decommissioning phases	300,000.00
Hazardous Waste	Waste storage facility	Inspection and manifest review	Used oils, filters, contaminated materials	Hazardous Waste Regulations	Monthly	HSE Officer	Construction & Operation	300,000/month
Occupational Health and Safety	Workers and Operational areas	Observe compliance to PPE and unsafe working conditions, Safety inspections and record review	Health and Safety Plan, Lost Time Injury Frequency Rate (LTIFR), near misses, incidents, PPE compliance	FMEnv/ NESREA/Factory Act, NMDPRA HSE Requirements	Daily monitoring; Quarterly reporting	EPC Contractor	Pre-construction, Construction /Operations & Decommissioning Phase	250,000.00
Fire and Explosion Risk	Compressor area, storage cascade, dispensers	Inspection and testing	Functionality of fire extinguishers, gas detectors, ESD systems	NMDPRA, NFPA Standards	Monthly	HSE Officer	Operation	200,000/month

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 (₦)
Emergency Preparedness	Entire facility	Drill evaluation and audit	Emergency response time, drill performance	Emergency Response Plan	Bi-annually	HSE Manager	Operation	500,000/dr ill
Training	Workers	Observe compliance with existing training plan	Training plan and records	FMEnv/ NESREA/ NMDPRA	Quarterly monitoring and reporting	EPC Contractor	Construction /Operations Phase	500,000.00
General Housekeeping	Construction sheds and operational areas	Observe cleanliness and aesthetics of Plant	Cleanliness and aesthetics of Plant	FMEnv/ NMDPRA/ NESREA	Daily monitoring; Quarterly reporting	EPC Contractor	Construction /Operations Phase	200,000.00
Stakeholder Engagement	Local community, Regulatory Agencies	Observe evidence of stakeholder consultations	Stakeholder Engagement Plan	FMEnv/ NMDPRA/ NESREA	Quarterly monitoring and reporting	EPC Contractor	Construction /Operations Phase	200,000.00

7.3 Internal and External Auditing

Apart from the scheduled inspections and monitoring activities, audits shall be carried out internally by GVLNG to ensure compliance with regulatory requirements as well as in-house HSE standards and policies. Audits to be conducted shall also cover the contractor HSE department's self-reported monitoring and inspection activities. The audit shall be carried out by qualified personnel and the results shall be reported to the HSE Manager.

The audit shall include a review of compliance with the requirements of the EIA and of this ESMP and include, but not limited to, the following:

- Completeness of HSE documentation, together with planning documents and inspection records;
- Conformance with monitoring requirements;
- Efficacy of activities to address any non-conformance with monitoring requirements; and
- Training activities and record keeping.

Corrective Action

Identifying impacts and dealing with associated risks before an incident occurs is an integral part of the GVLNG HSE management approach. Investigating a "near miss" or actual incident after it occurs can be used to acquire valuable information. Lessons learned can be used to prevent similar or more severe episodes in the future.

GVLNG shall implement a formal corrective action procedure to manage the actions of its employees and contractors. The HSE Manager shall be tasked with keeping custody of records of corrective actions and for overseeing the revision of environmental, social, or health procedures and/or training programmes to avoid repetition of non-conformances and non-compliances.

7.4 Training, Awareness and Capacity Building

Personnel training needs shall be identified and appropriate training conducted especially for staff whose work may have a significant adverse impact upon the environmental or social conditions of the project. Competent personnel shall be engaged at each phase of the project. All staff employed will be trained in basic fire safety, oil spill contingency plan, occupational health and safety, environmental/social management and general operation of the plant.

New employees and visitors to the Plant shall be put through induction. There shall be periodic refresher courses and job specific specialized training. Some of the specific

training is presented in Table 7.3 below.

Table 7.3: Training Programme

S/N	Training Content	Participants	Mode	Cost (₦)
1.	Environmental and Social Management	HSE officers, Environmental & Social Safeguard Officer	In-house and External Consultant	200,000.00
2.	ESMP Implementation: mitigation, roles and responsibilities	Admin, HSE and Project Team	Accredited Consultants	250,000.00
3.	ESMP mitigation measures, Code of Conduct, OHS requirements	Contractors	External Accredited Consultants	100,000.00
4.	Contractor drivers, fleet management, traffic control	Drivers, Contractors and Safety Officers	External Accredited Consultants	250,000.00
5.	GBV/SEA/SH Prevention and Response Mechanisms	HSE Officers/Project team, Environmental & Safeguard Officer	External Accredited Consultants	250,000.00
6.	Grievance Redress Mechanism	Admin, Grievance Redress Committees: Project Level and Management Level	External Accredited Consultants	250,000.00
7.	Minimum Industry Safety Training for Downstream Operations (MISTDO) Training	HSE Officers/Project team, Environmental & Safeguard Officer	External NMDPRA Accredited Consultants	200,000.00

7.5 Regulatory Oversight

Regulatory requirements relevant to the operations at the proposed project and the associated governmental agencies have been described in **Chapter 1**.

Communications between the HSE personnel and government regulatory bodies throughout the project lifecycle will occur through various means, including written reports and memos, as well as informal and formal meetings. Most of the regular meetings will be scheduled, though additional meetings will be called on an as the need arises. Such meetings will be required to discuss scheduling/ planning issues, current areas of concern and emerging HSE and socio-economic issues.

At the management level, formal meetings do occur, but on a less frequent basis. Informal meetings and communications will also occur if there is a pressing need.

During formal meetings, the HSE Manager will meet with government regulatory agency representatives to review HSE and socio-economic performance, based on the analysis of internal HSE-MS audits. These meetings can be expected to include discussion of future work plans and coordinating issues and resolution of problems.

7.5.1 Reporting

GVLNG Limited shall ensure that regulatory officials are frequently updated with the project progress with respect to HSE matters via written status reports and face-to-face meetings. Official notification shall be made for any of the following:

- Significant modifications to this ESMP or the EIA;
- Significant design, routing or implementation changes;
- Results of empirical monitoring;
- HSE incidents such as:
    - Security incidents for potential or actual personnel-at-risk, sabotage attempts, asset losses and fraud/extortion;
    - Emergency medical situations (evacuations, hospitalization, etc.);
    - Fires;
    - Hazardous material and hazardous waste releases or spills;
    - Results from internal audits
    - Results from third-party independent audits;

GVLNG shall make appropriate documentation of HSE-related activities, including internal inspection records, training records and reports easily accessible, or to be provided on request.

7.5.2 Financial Resources

The costs associated with each of the mitigation measures and the related training and monitoring activities identified shall be included in the operational budget of the proposed project. It is fair to say that these costs shall be refined to reflect reality at the time of implementation. GVLNG Limited is committed to providing the necessary resources to fully implement the requirements of the EIA and this ESMP.

CHAPTER EIGHT: REMEDIATION / DECOMMISSIONING PLAN

8.0 Introduction

At the end of the project life, it shall be abandoned and/or decommissioned. GVLNG shall therefore draw an abandonment plan that meets national regulatory requirements (FMEnv & NMDPRA) and international standards. The expected life span shall be 25-30years. A general approach will be to commence detailed planning of decommissioning and abandonment activities about five years in advance. This would ensure a safe, environmentally friendly, and efficient decommissioning/abandonment programme.

At the end of life of the plant (before abandonment), a decommissioning plan shall be developed for:

- Facilities to be abandoned or removed.
- Environmental aspects of the decommissioning activity.
- Methods for facility re-use, recycling, disposal, removal or abandonment.
- Proper consultation with all stakeholders (communities, other land users and regulators).
- Efforts to mitigate negative environmental impacts and appropriately rehabilitate the site.
- Programmes for restoring the environment in accordance with national (FMEnv and NMDPRA) and international best-practices and regulatory requirements.
- Scope of work to assess possible residual impacts of the plant on the environment; specifically, any future restrictions on other activities.

8.1 Planned Remediation /Closure Programme

GVLNG shall develop a comprehensive Abandonment, Decommissioning and Closure Plan, to include necessary restoration efforts. The content of the plan will take into consideration the extent of the decommissioning (temporary or permanent, partial or complete shutdown), plans for future use of the site, and the condition of the site and environment at the time of decommissioning.

A detailed post-operational study of the impact of the project on the environment shall be conducted to determine appropriate restoration and remedial measures. The Decommissioning Plan shall be submitted and approved by the regulatory authorities prior to scheduled abandonment and decommissioning.

The Plant facilities shall be decommissioned as follows:

- Tanks, pipelines, etc shall be drained using a standard process for draining and entering of tanks, etc. As much liquid as possible would be pumped from the tanks and the remainder removed by vaporization.
- Interconnecting pipelines would be isolated and purged.
- The power supply for all motors and instrumentation locked out.
- All installed facilities on project sites will be adequately dismantled and removed to allow for proper remediation of the project site.
- GVLNG's Safety Health and Environmental (HSE) Management System will be implemented to ensure the health and safety of its personnel and the public during decommissioning as well as minimise negative environmental impacts. Particular attention will be paid to the following:
    - Protection from air pollutant emission
    - Protection from noise
    - Waste handling
    - Spill containment and management

8.1.1 Soil Remedial Measures

- Draining and cleaning of all pipes and removal of solid wastes;
- Demolition of project equipment, pipe racks, and related facilities, etc;
- Removal of any impacted soil; and
- Backfilling with clean soil/sand and re-vegetation of area with native plants.

8.1.2 Groundwater Remedial Measures

Groundwater remediation, if needed to remove contaminants. Once the facility has been properly and safely decommissioned,

- Water and power supply lines would be disconnected and removed.
- All surface buildings and structures would be dismantled and removed from the site.
- Disturbed areas on the plant site will be identified and restored using appropriate plant species.

8.1.3 Re-Use/Recycling of Equipment

- All facility components that can be used or recycled will be identified and quantified.
- Buildings will either be sold or converted to other uses. Alternatively, the buildings may be donated to host communities.
- Vehicles and other facilities will be scrapped and/or moved to other locations.
- Cleared locations will be re-vegetated using fast growing native species.
- Contaminated environmental component attributable to project activities

shall be restored.

8.1.4 Other Issues to be Considered

In addition, the following general items will be addressed:

- Possible decommissioning alternatives other than restoration of site (e.g. Re-use for industrial purposes);
- Conformance with applicable laws, ordinances, regulations, and standards and with local and regional land-use plans; and
- Provision of 24-hour security for the facility, until decommissioning activities is completed.

To accomplish the above, the Decommissioning and Abandonment Programme shall be managed by a team of competent personnel, including the HSE personnel of GVLNG. The methodology shall be in accordance with the provisions of FMEnv and NMDPRA.

8.2 Re-Use/Recycling of Equipment

All facility components that can be used or recycled shall be identified and quantified. Buildings shall either be sold or converted to other uses. Alternatively, the buildings may be donated to host communities. Vehicles and other facilities shall be scrapped and/or moved to other locations. Cleared locations shall be re-vegetated using fast growing native species. Contaminated environmental component attributable to project activities shall be restored.

8.3 Reporting

As required by regulations, a post decommissioning report (PDR) shall be prepared and submitted to the FMEnv and NMDPRA. The NMDPRA shall provide the following details:

- Overview of decommissioned facilities.
- Details of methods used for decommissioning.
- Nature of decommissioning (partial or whole).
- Record of consultation meetings.
- Details of recyclable/reusable materials/facility components.
- Decontaminated facilities.
- Decommissioning Schedule.
- State of the surrounding environment.
- Waste Management Plan.
- Plans for restoration/remediation where necessary.

CHAPTER NINE: CONCLUSION AND RECOMMENDATION

9.0 Conclusions

This chapter aims to highlight the major findings and recommendations of the study. This will ensure an environmentally friendly development of the CNG Mother/Daughter Station. This report was carried out in accordance with the regulatory requirements established by the Federal Ministry of Environment (FMEnv.) and international standards.

This Environmental and Social Impact Assessment (ESIA) evaluated the potential environmental and social impacts associated with the proposed GVLNG Limited's Compressed Natural Gas (CNG) Mother/Daughter Station during the pre-construction, construction, operation, and decommissioning phases. The assessment identified a range of potential impacts, including: air emissions, noise generation, occupational health and safety risks, traffic-related impacts, and potential fire and explosion hazards associated with the handling and storage of high-pressure natural gas.

The assessment also identified significant positive impacts, including increased access to cleaner transportation fuel, reduction in greenhouse gas and particulate emissions relative to conventional petroleum fuels, employment generation, economic development, and enhanced energy security.

Based on the findings of the study, the majority of adverse impacts are localised, temporary, and manageable through the implementation of appropriate mitigation measures and industry best practices. The adoption of a comprehensive Environmental and Social Management Plan (ESMP), Emergency Response Plan (ERP), Occupational Health and Safety Management System, and Environmental Monitoring Plan will further reduce potential impacts to acceptable levels.

Consequently, it is concluded that the proposed CNG Mother/Daughter Station is environmentally and socially viable and can proceed, provided that all recommended mitigation, monitoring, and management measures are effectively implemented throughout the project lifecycle.

9.1 Recommendations

Details of recommendations proffered to mitigate identified/potential impacts are contained in Chapter Six. Nevertheless, the following specific recommendations are re-emphasised.

1. Implement all mitigation measures identified in the Environmental and Social Management Plan (ESMP) throughout the project lifecycle.

2. Ensure full compliance with applicable national environmental, health, safety, and petroleum industry regulations, standards, and permit requirements.
3. Establish and maintain a robust Occupational Health, Safety, Security, and Environment (HSSE) Management System for all project phases.
4. Install and regularly maintain gas detection systems, emergency shutdown systems, fire protection equipment, and other safety-critical infrastructure at both Mother and Daughter Stations.
5. Conduct routine leak detection and preventive maintenance programs to minimize fugitive methane emissions and operational risks.
6. Implement a comprehensive Emergency Response Plan (ERP), including regular emergency drills, personnel training, and coordination with relevant emergency response agencies.
7. Maintain effective stakeholder engagement and grievance management mechanisms to address community concerns promptly and transparently. GVLNG should endeavour to engage in Corporate Social Responsibility to enhance the relationship with the host community so as to checkmate agitation and restiveness.
8. Undertake periodic environmental monitoring of air quality, noise, soil, groundwater, waste management practices, and occupational health and safety performance in accordance with the approved monitoring plan.
9. Prioritise local employment and procurement opportunities where practicable to enhance socio-economic benefits to host communities.
10. Develop and implement a Decommissioning and Site Restoration Plan to ensure safe facility closure, waste management, and rehabilitation of disturbed areas at the end of the project life.
11. Environmental auditing of the project shall be conducted as recommended by FMEnv An accredited consultant should be commissioned to handle this exercise
12. The waste management plan should be implemented as recommended.

With the application implementation of these recommendations, the proposed GVLNG CNG Mother/Daughter Station is expected to deliver substantial environmental and socio-economic benefits, and shall be constructed, operated and decommissioned with negligible adverse impacts on the environment. The approval of this report is therefore solicited.

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