# Draft

## Environmental & Social Impact Assessment (ESIA)

## Report for CNG Autogas Mother Station Project at Nasarawa Kofa, Bebeji Local Government Area, Kano State.

**By**

**Greenville LNG Company Limited**

**Submitted to Federal Ministry of Environment, Abuja**

**August, 2026**

# TABLE OF CONTENTS

LIST OF FIGURES ..... vi
LIST OF TABLES ..... vii
LIST OF PLATES ..... ix
ABBREVIATIONS ..... x
EIA PREPARERS ..... xiv
EXECUTIVE SUMMARY ..... i
CHAPTER ONE: INTRODUCTION .....
1.0 Background ..... 1
1.1 The Project Proponent ..... 1
1.2 Project Location and Accessibility ..... 2
1.3 Terms of Reference for the ESIA ..... 2
1.4 ESIA Objectives ..... 3
1.5 ESIA Methodology ..... 3
1.5.1 Desktop Research ..... 3
1.5.2 Field Data Collection ..... 4
1.5.3 Consultation with Stakeholders and Experts ..... 4
1.7 Legal and Administrative Framework for ESIA in Nigeria ..... 9
1.7.1 National Regulations ..... 10
1.7.2 FCT Policy, Guidelines and Regulations ..... 23
1.7.3 International Legal Framework ..... 25
1.7.4 Greenville LNG Health, Safety and Environment (HSE) Policy ..... 37
1.8 Structure of the Report ..... 38
CHAPTER TWO: PROJECT JUSTIFICATION ..... 40
2.0 Preamble ..... 40
2.1 Proposed Project Justification ..... 40
2.2 Need for Project ..... 41
2.3 Benefits of the Proposed Project ..... 41
2.4 Value for the Proposed Project ..... 41
2.5 Envisaged Sustainability ..... 42
2.5.1 Economic Sustainability ..... 42
2.5.2 Technical Sustainability ..... 42
2.5.3 Environmental Sustainability ..... 42
2.5.4 Social Sustainability ..... 42
2.5.5 Legal/Legislative Sustainability ..... 43
2.5.6 Political Sustainability ..... 43
2.6 Project Options ..... 43
2.6.1 No- Project Option ..... 43

2.6.2 Delayed Project ..... 44
2.6.3 "Go Ahead Project Option" ..... 44
2.6.4 Alternate Site/ Locations ..... 44
CHAPTER THREE: PROJECT AND OPERATIONS DESCRIPTION ..... 46
3.0 Project Introduction ..... 46
3.1 Geographical Location ..... 46
3.2 Project/Process Description ..... 46
3.3 Facilities Description ..... 50
3.4 Project Phases ..... 51
3.4.1 Pre-Construction Activities ..... 51
3.4.2 Construction Phase ..... 52
3.4.3 Operations Phase ..... 52
3.4.4 Decommissioning Activities ..... 52
3.4.5 Maintenance Activities ..... 53
3.4.6 Health, Safety, Security and Environmental Issues - Construction Stage ..... 53
3.4.7 Health, Safety, Security and Environmental Issues - Operations Phase ..... 54
3.4.8 Health, Safety, Security and Environmental Issues - Decommissioning Stage 55
3.5 Emergency Response Procedures ..... 55
3.6 Waste Generation ..... 57
3.6.1 Waste Identification and Characterisation ..... 58
3.6.2 Construction Wastes ..... 61
3.6.3 Operations Waste ..... 61
3.6.4 Decommissioning Waste ..... 62
3.6.5 Waste Segregation ..... 62
3.6.7 Waste Tracking ..... 62
3.6.8 Waste Disposal ..... 62
3.7 Traffic Management ..... 66
3.7.1 Vehicle Routes ..... 67
3.7.2 Signage ..... 67
3.7.3 Facility Protection ..... 68
3.7.4 Safe Crossings and Pedestrian Zones ..... 68
3.7.5 Training and Review ..... 69
3.7.6 Responsibilities and Duties ..... 69
3.7.7 Spill Risk Analysis ..... 69
3.7.8 Spill Prevention Mechanisms ..... 70
3.7.9 Equipment and Materials for Spill Response and Clean-up ..... 70
CHAPTER FOUR: DESCRIPTION OF THE EXISTING ENVIRONMENT ..... 72
4.1 The Study Approach ..... 72
4.2 Environmental Baseline Data Acquisition Methods ..... 73
4.2.1 Desktop Studies ..... 74
4.2.2 Field Sampling ..... 74

4.2.3 Field Studies and Sampling Design ..... 74
4.2.4 Desktop Studies ..... 75
4.2.5 Fieldwork Activities/Laboratory Analysis ..... 75
4.2.6 Field Data ..... 76
4.3 Environmental Conditions of the Proposed Project Area ..... 79
4.3.1 Climate and Meteorological Features ..... 79
4.3.2 Air Quality and Noise Characteristics ..... 83
4.3.3 Groundwater and Surface Water Quality Assessment ..... 85
4.3.4 Soil Quality Assessment ..... 93
4.3.5 Geology and Hydrogeology of the Project Area ..... 102
4.3.6 Terrestrial Flora and Fauna ..... 107
4.4 Socio-Economics ..... 108
4.4.1 Methodology ..... 113
4.4.2 Study Area ..... 113
4.4.3 Sampling ..... 114
4.4.4 Data Collection ..... **Error! Bookmark not defined.**
4.4.5 Data Analysis ..... **Error! Bookmark not defined.**
4.5 Profile of the Study Area ..... 115
4.5.1 Location and Administration ..... 115
4.5.2 Traditional Governance Structure ..... 115
4.5.3 Ethnicity and Cultural Heritage ..... 116
4.6 Demographic Characteristics ..... 116
4.6.1 Population Size and Households ..... 116
4.6.2 Gender Distribution ..... 116
4.6.3 Age Distribution ..... 118
4.6.4 Religion ..... 118
4.6.5 Marital Status ..... **Error! Bookmark not defined.**
4.6.6 Household Size ..... 119
4.7 Economic Livelihoods ..... 119
4.7.1 Main Occupations ..... 119
4.7.2 Monthly Income Levels ..... 121
4.7.3 Household Expenditure Priorities ..... 122
4.8 Education and Health ..... 122
4.5.2 Healthcare Facilities and Common Diseases ..... 124
4.5.3 Frequency of Hospital Visits ..... **Error! Bookmark not defined.**
4.6 Housing and Infrastructure ..... 125
4.6.1 Housing Types and Materials ..... 126
4.6.2 Land Tenure ..... 127
4.6.3 Water Supply ..... 128
4.6.4 Electricity Access ..... 128
4.6.6 Sanitation and Waste Management ..... 129
4.7 Stakeholder Engagement and Perception ..... 131

4.7.1 Stakeholders Identified ..... 131
4.7.2 Community Consultation Process ..... 133
4.7.3 Community Support Level ..... 133
4.7.4 Perceived Benefits ..... 134
4.7.5 Concerns and Fears ..... 135
4.7.6 Community Demands and Expectations ..... 136
CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS ..... 139
5.0 Overview ..... 139
5.1 Methodology for Impact Prediction ..... 139
5.2 Preliminary Impact Identification and Screening ..... 140
5.3 Impact Qualification and Categorization ..... 141
5.4 Description of Qualitative Impacts ..... 150
5.4.1 Preliminaries ..... 150
5.4.2 Site Preparation and Pre-Construction Phase ..... 150
5.4.3 Activities at Construction Phase ..... 151
5.4.4 Operation and Maintenance Phase Activities ..... 155
5.4.5 Decommissioning and Abandonment Phase Activities ..... 157
5.4.6 Significant Positive Impacts of the Project ..... 157
CHAPTER SIX: MITIGATION MEASURES ..... 159
6.0 Introduction ..... 159
CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN ..... 180
7.0 Overview and Scope ..... 180
7.1 Environmental and Social Management Plan ..... 181
7.1.1 HSE Management Plan ..... 221
7.1.2 Implementation ..... 222
7.1.3 Management Review ..... 223
7.2 Operational Controls ..... 223
7.2.1 Oil/Chemical Management ..... 223
7.2.2 Waste Management ..... 223
7.3 Environmental Monitoring Programme ..... 223
7.3 Internal and External Auditing ..... 228
7.4 Training, Awareness and Capacity Building ..... 228
7.5 Regulatory Oversight ..... 229
7.5.1 Reporting ..... 230
7.5.2 Financial Resources ..... 230
CHAPTER EIGHT: REMEDIATION / DECOMMISSIONING PLAN ..... 231
8.0 Introduction ..... 231
8.1 Planned Remediation /Closure Programme ..... 231
8.1.1 Soil Remedial Measures ..... 232
8.1.2 Groundwater Remedial Measures ..... 232

8.1.3 Re-Use/Recycling of Equipment ..... 232
8.2 Re-Use/Recycling of Equipment ..... 233
8.3 Reporting ..... 233
CHAPTER NINE: CONCLUSION AND RECOMMENDATION ..... 235
9.0 Conclusions ..... 235
9.1 Recommendations ..... 235
REFERENCES ..... 237

# LIST OF FIGURES


| | | |
|---|---|---|
| 1.1 | Nigeria Showing Kano State | 3 |
| 1.2 | Kano showing Bebeji LGA | 3 |
| 1.3 | ESIA Flow Diagram | 8 |
| 3.1 | Nigeria Showing Kano State | 45 |
| 3.2 | Kano State showing Bebeji LGA | 45 |
| 3.3 | Layout of the Proposed Project Location | 46 |
| 3.4 | Process Flow Diagram for the CNG Mother Station Operations | 47 |
| 4.1 | Average Daily Rainfall Distribution | 77 |
| 4.2 | Average Monthly Rainfall Distribution | 78 |
| 4.3 | Temperature Trends and Variability | 79 |
| 4.4 | Relative Humidity Trends and Variability | 80 |
| 4.5 | Wind Speed Trends and Variability | 81 |
| 4.6 | Geology of Nigerian regions | 117 |
| 4.7 | Ethnic and Religious Composition | 135 |
| 4.8 | Demographic Characteristics of the project Area | 140 |
| 4.9 | Main Occupations of Respondents | 142 |
| 4.10 | Economic Livelihoods | 145 |
| 4.11 | Education and Health Indicators | 149 |
| 4.12 | Housing and Infrastructure Indicators | 157 |
| 4.13 | Perceived Benefit of the Project | 161 |

# LIST OF TABLES


| | | |
|---|---|---|
| 1.1 | Equator Principles | 28 |
| 2.1 | Key Equipment | 47 |
| 3.1 | Expected Wastes, Sources and Characterization of Wastes in the Various Project Phases | 55 |
| 3.2 | Construction Waste Streams | 62 |
| 3.3 | Operations Waste Streams | 64 |
| 4.1 | Sample Matrix | 73 |
| 4.2 | Summary of Laboratory Methods | 75 |
| 4.3 | Air Quality Assessment Result | 83 |
| 4.4 | Ground and Surface Water Quality Assessment Result | 92 |
| 4.5a | Physio-chemical Analysis of Soil Sample of the proposed project site (Part 1) | 103 |
| 4.5b | Physio-chemical Analysis of Soil Sample of the proposed project site (Part 2) | 108 |
| 4.6 | Major Habitat Types within the Project Area | 119 |
| 4.7 | Dominant Flora Recorded During the Field Survey | 120 |
| 4.8 | Some Floral Species Recorded around the project area with their IUCN Status | 121 |
| 4.9 | Fauna Observed During the Field Survey | 124 |
| 4.10 | Some Faunal Species around the project area | 125 |
| 4.11 | Summary of Ecological Characteristics | 127 |
| 4.12 | Summary of Data Collection and Analysis | 131 |
| 4.14 | Ethnic and Religious Composition | 135 |
| 4.15 | Gender Distribution of Respondents | 136 |
| 4.16 | Age Distribution of Respondents | 137 |
| 4.17 | Religious Affiliation of Respondents | 137 |
| 4.18 | Marital Status of Respondents | 138 |
| 4.19 | Household Size of Respondents | 139 |
| 4.20 | Summary of Key Demographic Characteristics | 140 |
| 4.21 | Main Occupations of Respondents | 142 |
| 4.22 | Monthly Household Income Levels | 143 |
| 4.23 | Major Household Expenditure Priorities | 144 |
| 4.24 | Summary of Economic Livelihoods | 145 |
| 4.25 | Educational Attainment of Respondents | 146 |
| 4.26 | Nearest Healthcare Facility Accessed by Respondents | 147 |
| 4.27 | Common Sicknesses in Households | 148 |
| 4.28 | Summary of Education and Health Indicators | 149 |
| 4.29 | Housing Types and Wall Materials | 150 |
| 4.30 | Land Ownership Pattern | 151 |
| 4.31 | Main Sources of Water Supply | 152 |
| 4.32 | Electricity Access | 153 |
| 4.33 | Main Means of Transportation | 154 |
| 4.34 | Types of Toilet Facilities | 155 |
| 4.35 | Waste Disposal Methods | 156 |
| 4.36 | Summary of Housing and Infrastructure Indicators | 157 |

| | | |
|---|---|---|
| 4.37 | Stakeholders Consulted During the ESIA Study | 158 |
| 4.38 | Summary of Community Consultation Process | 160 |
| 4.39 | Community Support for the Proposed Project | 160 |
| 4.40 | Expected Benefits of the Proposed Project | 161 |
| 4.41 | Community Concerns Regarding the Proposed Project | 162 |
| 4.42 | Community Expectations from the Project | 163 |
| 4.43 | Preference for Local Contractor Participation | 164 |
| 4.44 | Summary of Stakeholder Engagement and Perception Findings | 165 |
| 5.1 | Environmental Components and their Impact Indicators | 167 |
| 5.2 | Environmental Impact Significance Rankings | 169 |
| 5.3 | Risk Assessment Matrix for Environmental Consequences | 169 |
| 5.4 | Evaluation of Associated and Potential Impacts of the Proposed CNG Mother/Daughter Station | 171 |
| 6.1 | Mitigation Measures | 193 |
| 7.1 | Environmental and Social Management and Monitoring Plan for GVLNG CNG Mother/Daughter Stations | 217 |
| 7.2 | Environmental Monitoring Plan for GVLNG Limited's CNG Mother Stations | 244 |
| 7.3 | Training Programme | 253 |

# LIST OF PLATES


| | | |
|---|---|---|
| 4.1 | FMEnv Representative with the Lab Staff | 72 |
| 4.2 | Measurements of air quality and meteorological parameters | 76 |
| 4.3 | Soil Sampling at the Proposed Project Site | 101 |
| 4.4 | Farmland around the project area | 119 |
| 4.5 | Shrub Land within the project area | 120 |
| 4.6 | A Well within the Host Community | 153 |
| 4.7 | Engagement with community Head | 158 |
| 4.8 | Engagement with Youth and Women Group | 158 |

# 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 |
| KASEPPA | Kano State Environmental Planning and Protection Agency |
| 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 Nasarawa Kofa, Bebeji Local Government Area, Kano State. The proposed project site falls within the following geographical coordinates: 11°33.353'N,8°16.654'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 Kano State Government. The key State administrative authorities and legal instruments that apply to the Project are briefly described below.

**Kano State Ministry of Environment**

The Ministry of Environment is currently responsible for environmental service matters and resources in the state. Other objectives include initiating formulation, execution, and monitoring of all issues relating to all environmental matters, solid waste management, and mineral resources. A recent law passed established the Kano State Environmental Law 2021.

The Ministry was formed to ensure sustainable development and environmental protection of the state. Its functions include:

- Routine liaison and ensuring effective harmonization with the FMEnv to achieve the objectives of the National Policy on the Environment;
- Cooperate with FMEnv and other relevant National Directorates/Agencies in the promotion of environmental education;
- Monitoring compliance with waste management standards;
- Monitor the implementation of the ESIA and the Environmental Audit Report (EAR) guidelines and procedures on all developments policies and projects within the State.

**Kano State Environmental Planning and Protection Agency (KASEPPA)**

Kano State Environmental Planning & Protection Agency (KASEPPA) is an agency of the state ministry of environment. The agency promotes a safe and healthy environment for the people of Kano, ensure sustainable development and enforce environmental protection. Its duties include:

- Research and development activities for environmental protection
- Educate the general public on the types of disposal methods acceptable by the State Government for domestic and industrial wastes
- Co-ordinate the activities of all the agencies in the state connected with environmental matters;
- Conduct public enlightenment campaigns and disseminate vital information on environmental matters
- Render advisory services and support to all Local Government in the state in areas of solid waste management matters;

### *Kano State Lands and Survey*

This Ministry was created for the purpose of overseeing the land resources in the state. They are also charged with the responsibility to plan, devise and implement the state policies on land and its resources.

### Bebeji Local Government Area Council

The Bebeji Local Government Area Council is one of the Local Government Areas of Kano State established to administer local government functions within its jurisdiction. Bebeji 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.

### 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 Kano State.

**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 Nasarawa Kofa Community, Bebeji LGA, kano State. 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 Nasarawa Kofa, Bebeji LGA, Kano State.

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 (wet season) from 18th to 19th June, 2026 as approved by the Federal Ministry of Environment (FMEnv)).

**Climate and Meteorology**

The dominant climatic condition of the study area is humid tropical type of equatorial zone of Nigeria. The formal evergreen rain forest vegetation has been widely encroached upon because of human development activities. The study area can be characterized as being a mixture of commercial and residential inhabitation. The climate and meteorological data obtained from the various literatures. A previous study was used to describe the climatic elements of the study area. The data provide information on the general climate and meteorology conditions in Kano, the air temperature, rainfall, and relative humidity. The weather and climate of the study area is closely linked to the general mesoscale trend in Nigeria.

***Relative Humidity:*** Relative humidity is high in August up to 80% and lowest in January, November and December with 23%. The rainy season has a moderate effect on temperature which falls to the lowest in August with a mean monthly value of 24.5° C. The monthly evaporation rate for Kano varied from 55% in March and April at the beginning of wet season to 78% in September during the end of rainy season. Figure 4.2 shows the average relative humidity per month.

**Wind Speed:** The climate of the area is strongly influenced by the tropical maritime air mass and the tropical continental air mass like in most part of West Africa. The tropical maritime air mass which originates from the southern high-pressure belt is humid in nature and is attended with onshore south-western winds off and the Gulf of Guinea. The tropical continental air mass on the other hand is dry and accompanied by north-east trade winds. These two air masses control the climate of the Kano Region making it the wet and dry type which is more dry than wet in the Sudan and Sahel regions of Nigeria.

***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:** in the region is generally high throughout the year. There are four main seasons at the study area based on temperature element: a dry and cool season – Kaka (mid- November to February) characterized with cool and dry weather plus occasional dusty haze; a dry and hot season, bazara (March to mid-May) where maximum temperature value reaches as high as $43^0$C, and which is a transition period between the harmattan and the wet season; the wet and warm season, damina (mid-May to September), is the proper rainy season when the lowest diannual temperature is recorded; and lastly a dry warm season, rani (October to mid- November) marked by high humidity and high temperature. This season followed bazara in hotness

**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.

**The Particulate Matter ($PM_{1.0}$, $PM_{2.5}$ and $PM_{10}$)**

Particulate matter concentrations across the project area were moderately elevated compared to the control locations but remained generally within acceptable regulatory limits. $PM_1$ concentrations ranged from 16–21 µg/m³, $PM_{2.5}$ ranged from 23–30 µg/m³, while $PM_{10}$ concentrations varied from 39–48 µg/m³. Background control locations recorded lower concentrations, with $PM_{2.5}$ ranging from 18–19 µg/m³ and $PM_{10}$ ranging from 29–31 µg/m³.

**Carbon Monoxide (CO)**

Carbon monoxide was not detected (0 ppm) at any monitoring location. This is well below the FMEnv limit of 10 ppm (1-hour average) and the WHO guideline value of 4 mg/m³ (24-hour average). The absence of carbon monoxide demonstrates that there are currently no significant sources of incomplete combustion within the study area. From an ESIA perspective, this finding provides an excellent baseline because any future increase in CO concentrations during project operation can be directly attributed to compressor engines, standby generators or increased vehicle movements associated with the CNG Mother Station.

**Ozone ($O_3$)**

Ground-level ozone concentrations ranged approximately from 0.05 to 1.17 ppm. The WHO guideline for ozone is 100 µg/m³ (maximum daily 8-hour mean). Because ozone is a secondary pollutant produced through atmospheric reactions involving nitrogen oxides and volatile organic compounds, its relatively low concentration suggests limited photochemical pollution in the area. The results indicate that the project environment presently experiences minimal atmospheric oxidation associated with urban or industrial emissions.

***Nitrogen Dioxide ($NO_2$)***

Nitrogen dioxide concentrations ranged from 0.05 to 1.53 ppm. FMEnv regulates $NO_2$ with guideline values based on averaging periods, while the WHO Air Quality Guidelines recommend 25 µg/m³ (24-hour average) and 10 µg/m³ (annual average). The values reported by the laboratory appear higher than these guideline values if interpreted directly in ppm. However, the report does not specify whether the measurements represent instantaneous field readings, time-weighted averages or instrument-specific indices.

***Sulphur Dioxide ($SO_2$):*** Sulphur dioxide concentrations remained generally low throughout the study area. FMEnv prescribes guideline values for $SO_2$, while the WHO recommends a 24-hour guideline value of 40 µg/m³. Although the laboratory values are reported in ppm without specifying the averaging period, the concentrations were sufficiently low to indicate the absence of significant sulphur-containing fuel combustion within the project area.

**Ammonia ($NH_3$):** Ammonia concentrations were either zero or below instrument detection limits. These concentrations indicate that the surrounding environment is largely unaffected by intensive livestock production, fertilizer storage or industrial ammonia emissions. Consequently, ambient ammonia levels comply with acceptable

environmental conditions.

**Formaldehyde** concentrations ranged from 0.000 to 0.009 mg/m³. The WHO guideline value for formaldehyde is 0.1 mg/m³ (30-minute average). Consequently, all measured concentrations are substantially below the WHO guideline and indicate that the atmosphere is free from significant aldehyde contamination. The results suggest minimal influence from combustion processes, biomass burning or industrial emissions.

**Ambient Noise Level: Ambient noise levels ranged from approximately 46.3 to 65.9 dB(A). The FMEnv National Environmental (Noise Standards and Control) Regulations prescribe a daytime limit of 90 dB(A) for industrial areas and 55 dB(A) for residential areas, while the WHO recommends outdoor daytime noise levels not exceeding 55 dB(A) for residential environments to minimize community disturbance. Most locations fell within or slightly above the WHO residential guideline but remained well below the FMEnv industrial limit.**

**Geology:** Pre-Cambrian rock of the basement complex which comprises of gneisses, amphibolites, marbles and the older granites which underlie large part of Nigeria including 80% of the Kano Region. The plant site is underlain by crystalline Basement Complex of pre-Cambrian origin which losses its identity by disappearing into the Chad Formation. The Basement complex consists of granite rocks extending up to Kibiya towards the Formation. The Basement complex consists of granite rocks extending up to Kibiya towards the North and Doguwa towards the East. The Granites are generally Gneissic and commonly developed in a mixture of Pegmatite of schist granite, Gneiss and irregular mass of pegmatite.

**Hydrology:** The Region is divided into two hydrological zones, demarcated by the hydro-geological divide. To the west of the divide is the zone of high surface water discharge and retention which coincides with the zone of Basement Complex structure. To the east and north east of the divide is the zone of large accumulation of ground water which is part of upper aquifer of Chad Basin. Retention and flow of water on the surface are very limited in this zone. The climate of the region controls the amount of water that is available both on the surface and at sub-surface at any given time within a water year (Olofin, 1984). The construction of dams which started about 1969 marked the beginning of the modification of drainage and hydrology in Kano Region. More than 30 earth- dams were planned for the region, and by 1984, about 22 of these have been completed.

**Groundwater and Surface Water Quality**

The baseline water quality assessment was undertaken to determine the existing physicochemical, chemical, heavy metal, organic and microbiological characteristics of groundwater and surface water within and around the proposed CNG Mother Station at Nassarawa Kofa, Bebeji Local Government Area, Kano State. The assessment provides an important environmental baseline for evaluating potential impacts that may arise during the construction and operational phases of the project.

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*** The measured pH values ranged from 6.34 to 8.51. Groundwater samples generally recorded values between 6.34 and 8.01, while surface water ranged from 8.18 to 8.51. The FMEnv National Environmental (Surface and Groundwater Quality Control) Regulations and the WHO Guidelines for Drinking Water Quality recommend a pH range of 6.5 to 8.5 for potable water.

**Temperature:** Water temperatures ranged from approximately 27 to 33°C, remaining below the FMEnv maximum allowable temperature of 40°C. The measured temperatures are typical of shallow groundwater and surface water bodies in northern Nigeria during the sampling period.

***Electrical Conductivity (EC):*** Electrical conductivity ranged from 186 to 1,141 µS/cm. The FMEnv guideline value is 1,000 µS/cm. All groundwater samples complied with the FMEnv standard. However, the upstream, midstream and downstream surface water samples exceeded the permissible limit, indicating elevated concentrations of dissolved ions. High conductivity is commonly associated with mineral weathering, agricultural runoff and domestic wastewater discharges. Since groundwater remained within acceptable limits, the elevated conductivity appears to be confined to the surface water environment and does not indicate widespread groundwater contamination.

***Turbidity*** Turbidity values ranged between 0 and 4 NTU, remaining well below the FMEnv permissible limit of 50 NTU and the WHO drinking water guideline of 5 NTU.

The low turbidity values indicate that both groundwater and surface water contain very little suspended particulate matter. The results demonstrate that erosion and sediment transport within the project area are presently limited.

***Total Dissolved Solids (TDS*** Total dissolved solids ranged from 105 to 201 mg/L, considerably lower than the FMEnv and WHO maximum permissible limit of 500 mg/L. The low TDS concentrations indicate fresh water with minimal dissolved mineral content and confirm that the groundwater has not been affected by saline intrusion or industrial contamination. The results also suggest that the surrounding geological formations contribute only moderate quantities of dissolved minerals to the groundwater system.

**Total suspended solids (TSS)** Total suspended solids varied from 4 to 28 mg/L. Groundwater samples remained below the FMEnv limit of 20 mg/L, whereas one downstream surface water sample slightly exceeded this guideline.

The elevated TSS in the downstream section of the stream most likely results from natural surface runoff, streambank erosion and sediment transport during rainfall events. Although the exceedance is localized, it indicates that sediment control measures should be implemented during project construction to prevent additional siltation of nearby water bodies.

**Sulphate** concentrations ranged between 12 and 212 mg/L. Groundwater complied with the FMEnv limit of 100 mg/L, whereas all surface water samples exceeded this regulatory limit. However, the concentrations remained below the WHO drinking water guideline of 250 mg/L.

**Nickel** concentrations ranged from 0.00 to 0.08 mg/L. Most samples complied with the FMEnv guideline value of 0.07 mg/L, although one surface water sample slightly exceeded the limit. The minor exceedance is unlikely to pose immediate environmental concern but should be monitored throughout project implementation.

**Lead and Mercury:** Lead and mercury were either not detected or occurred only at trace concentrations below guideline values. The absence of these toxic heavy metals confirms that the groundwater and surface water have not been affected by industrial or mining-related contamination.

**Oil and Grease, BTEX and Phenols:** Oil and grease, benzene, toluene, ethylbenzene and xylene (BTEX) were not detected in any groundwater or surface water sample. Phenols were absent in groundwater but occurred at slightly elevated concentrations in some surface water samples.

**The microbiological assessment** The microbiological assessment revealed that surface water contained total coliform counts of 118 to 143 cfu/mL and *Escherichia coli* concentrations of 11 to 16 cfu/mL. Both FMEnv and WHO require zero *E. coli* in drinking water, while total coliform counts should be absent or extremely low.

The observed concentrations clearly indicate faecal contamination of the surface water, rendering it unsuitable for direct domestic consumption without adequate treatment. The contamination is most likely associated with livestock activities, open defecation, agricultural runoff or domestic wastewater discharges. In contrast, groundwater exhibited minimal microbial contamination, indicating that the aquifer remains relatively protected from surface sources of pollution.

Generally, Comparison of the analytical results with FMEnv and WHO standards indicates that groundwater quality within the proposed CNG Mother Station is generally satisfactory, with most parameters complying with national and international guideline values. Surface water also complied with several physical and chemical standards but exceeded FMEnv limits for electrical conductivity, sulphate, iron, zinc, total suspended solids at one location, and microbiological indicators. Importantly, no petroleum hydrocarbons (oil and grease or BTEX compounds) were detected, confirming that the project area has not experienced historical fuel contamination.

**Soil Quality Assessment**

The baseline soil quality assessment was conducted to establish the existing physicochemical, nutrient, heavy metal, organic and microbiological characteristics of soils within the proposed CNG Mother Station at Nassarawa Kofa, Bebeji Local Government Area, Kano State. Soil quality is a critical component of the Environmental and Social Impact Assessment (ESIA) because construction and operation of the facility have the potential to alter soil properties through excavation, equipment movement, accidental hydrocarbon spills, leakage of lubricants, waste disposal and stormwater runoff.

**Soil Reaction (pH):** The soil pH ranged from 6.60 to 9.52, indicating soils that vary from neutral to moderately alkaline. Most sampling locations recorded pH values between 7.5 and 8.8, while only a few control samples exceeded 9.0. Nigeria does not prescribe a specific FMEnv regulatory limit for soil pH; however, soils with pH values between 6.0 and 8.5 are generally considered suitable for engineering works and vegetation establishment.

**Electrical Conductivity (EC):** Electrical conductivity ranged from 57.6 to 3,183 µS/cm, indicating considerable variation across the study area. Although FMEnv has not established regulatory limits for soil electrical conductivity, values below

approximately 2,000 µS/cm are generally regarded as indicating non-saline soils suitable for most land uses.

**Exchangeable cations** Calcium concentrations ranged from 0.14 to 3.01 mg/kg, magnesium from 0.15 to 7.16 mg/kg, sodium from 4 to 103 mg/kg, potassium from 0.06 to 6.21 mg/kg, and ammonium from 0.8 to 36.5 mg/kg. There are currently no FMEnv regulatory standards for these exchangeable cations in soils.

**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

**Nutrient Status**

Sulphate concentrations ranged from 12 to 83 mg/kg, nitrate from 0.5 to 54.6 mg/kg, nitrite from 0.001 to 32 mg/kg, phosphate from 0.26 to 3.11 mg/kg, and chloride from 0.6 to 34.3 mg/kg. No FMEnv soil quality standards currently exist for these nutrients.

The observed concentrations indicate moderate soil fertility with no evidence of excessive nutrient enrichment or contamination. The relatively low phosphate concentrations suggest limited fertilizer accumulation, while nitrate concentrations indicate normal nitrogen cycling within the soil. These findings demonstrate that agricultural activities surrounding the project area have not significantly degraded soil nutrient balance.

**Soil Texture**

The soils are dominated by loam, with loam content ranging from 44 to 86%, sand ranging from 8 to 39%, clay from 0 to 30%, and silt generally below 7%.

Loamy soils are considered favourable for engineering development because they provide moderate permeability, good drainage, adequate moisture retention and satisfactory bearing capacity. These characteristics reduce the likelihood of excessive settlement and provide suitable conditions for construction of the proposed facility. However, exposed loamy soils are susceptible to erosion during intense rainfall; therefore, erosion control measures such as temporary drainage channels, sediment traps and rapid revegetation should be implemented during construction.

**Microbiological Characteristics**

The microbiological assessment recorded *Escherichia coli* concentrations ranging from 2 to 41 cfu/100 g, while fungal counts ranged from 19 to 356 cfu/100 g. Nigeria currently has no FMEnv soil quality standards for microbiological parameters.

The observed microbial populations are typical of naturally occurring soils and indicate active biological decomposition of organic matter. The higher microbial counts at some locations are likely associated with agricultural activities, livestock grazing and natural organic matter decomposition rather than contamination from industrial sources.

***Terrestrial Flora and Fauna***

The proposed project area falls within the sudan 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.

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***

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 Nasarawa Kofa Community, Bebeji LGA, Kano State. 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 Nasarawa Kofa Community, located within Bebeji Local Government Area of kano State. The Community is a predominantly rural agrarian settlement situated along the 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**

The proposed CNG Mother Station Project is located within Nasarawa Kofa Community in Bebeji Local Government Area (LGA) of Kano State, Nigeria. The project site lies within the influence zone of the Ajaokuta-Kaduna-Kano (AKK) Natural Gas Pipeline corridor and forms part of the growing industrial and commercial development axis of Kano State.

**Traditional Governance Structure:** Traditional leadership remains an important institution within the Community. The traditional administration serves as the primary channel for community mobilisation, conflict resolution, cultural preservation, and stakeholder engagement.

The District Head serves as the highest traditional authority within the district and provides leadership on matters affecting the communities under his jurisdiction. The Village Head oversees local community affairs and works closely with elders, youth leaders, and women leaders to ensure effective administration and community development.

Community elders provide advisory functions and contribute to decision-making on issues relating to land, culture, security, and social welfare. Youth and women leaders represent their respective groups and facilitate communication between community members and traditional authorities.

The traditional institution was actively engaged during the stakeholder consultation process and played a significant role in mobilising community members for the socioeconomic survey and public consultation meetings.

**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 Nasarawa Kofa Community is a growing rural settlement with relatively large household sizes, reflecting the prevailing family structure and cultural practices of the Hausa 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 3% of the population. Traditional religious practices are observed by a small proportion of residents, often alongside mainstream religious beliefs.

### Gender Distribution

Gender also indicates the roles individuals play in households, although this varies depending on the society in question. It is usually seen as clear-cut male and female. Table 4.10 shows the gender profile of heads of households. Whereas females constitute only 25%, males constitute 75%.

### Age Distribution

Age is an indicator of the phase of adult life an individual might have attained. Table 4.9 shows that 11 – 20 years had 12.40%, 21 – 30 years had 20%, 31 – 40 years had 23.40%, 41 – 50 years had 24.50%, 51 – 60 years had 15.50%, while above 60 years had only 4.20%. This result shows that young or starter households (of either below 11 – 20 and 21 – 30) constitute 32.40% while the established households (households in the town 31 – 40 and 41 – 50 age categories) constitute 47.90% of the population. The ageing households (51 – 60 years and above) constitute 19.70%.

### Marital Status

Majority of the total respondents (90.00%) of the households are married or have been married previously (widowed = 7%; divorced = 3%).

### Main Occupations

The economic activities of the study area are diverse, with agriculture remaining the dominant source of livelihood. Other activities include trading, artisan work, civil service, and informal labour.

The survey results show that farming is the most common occupation, accounting for 50 percent of respondents. This is followed by trading at 25 percent, while civil servants and artisans each account for 10 percent. A small proportion of respondents (5 percent) are engaged in other forms of livelihood activities.

### Monthly Income Levels

The survey shows that 45 percent of respondents earn less than ₦30,000 per month. About 30 percent earn between ₦31,000 and ₦60,000, while 15 percent earn between

₦61,000 and ₦90,000. Only a small proportion of respondents earn above ₦90,000 per month.

### 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 Nasarawa Kofa Community. The findings are based on responses obtained from the 300 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 results indicate that 50 percent of respondents rely primarily on clinics and primary healthcare centres for medical services, while 40 percent access hospitals. However, 10 percent of respondents reported 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 Nasarawa Kofa 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 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 Nasarawa Kofa Community, Bebeji LGA, Kano State. 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, Kano State Environmental Protection Authority, 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 Nasarawa Kofa, Bebeji Local Government Area, Kano State. The proposed project site falls within the following geographical coordinates: 11°33.353'N,8°16.654'E.

**Figure 1.1: Nigeria Showing KANO State.**

**Figure 1.2: Kano State showing Bebeji LGA in Red 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;
- Kano State Environmental Planning and Protection Agency (KASEPPA)
- Bebeji Local Government Area Council
- Nasarawa Kofa 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 Nasarawa Kofa 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)
- Kano State Environmental Protection and Planning Agency (KASEPPA)
- Bebeji Local Government Area Council
- Nasarawa Kofa 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.

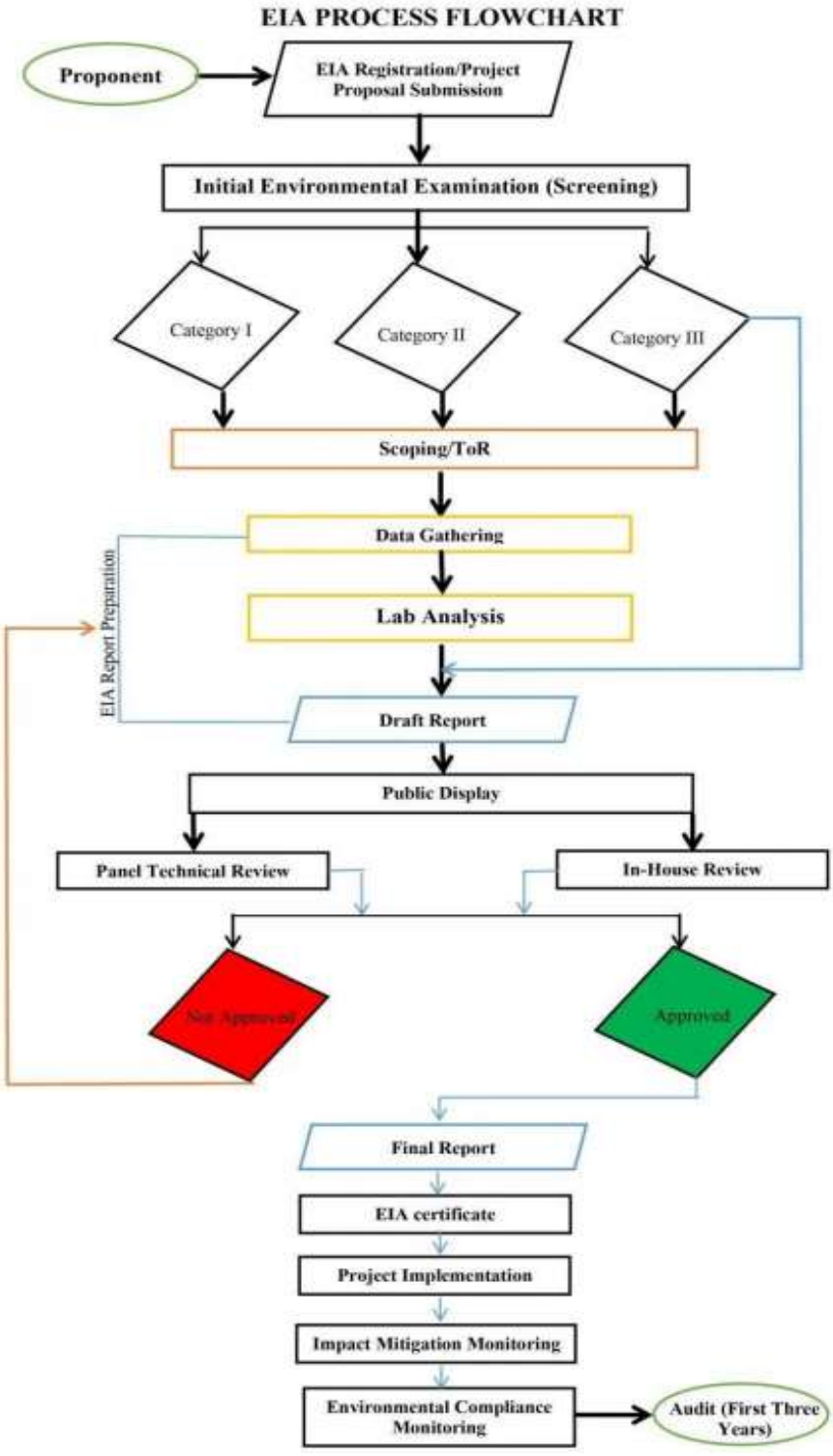


**Figure 1.3**: ESIA Flow Diagram

## 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 Kaduna Environmental Protection Authority (KASEPPA);
- 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 State Policy, Guidelines and Regulations

#### 1.7.2.1 Kano State Ministry of Environment

The Ministry of Environment is currently responsible for environmental service matters and resources in the state. Other objectives include initiating formulation, execution, and monitoring of all issues relating to all environmental matters, solid waste management, and mineral resources. A recent law passed established the Kano State Environmental Law 2021.

The Ministry was formed to ensure sustainable development and environmental protection of the state. Its functions include:

- Routine liaison and ensuring effective harmonization with the FMEnv to achieve the objectives of the National Policy on the Environment;
- Cooperate with FMEnv and other relevant National Directorates/Agencies in the promotion of environmental education;
- Monitoring compliance with waste management standards;
- Monitor the implementation of the ESIA and the Environmental Audit Report (EAR) guidelines and procedures on all developments policies and projects within the State.
- Identify the ecological problems of the State including the devastating erosion and flood, brief the government on their sources and effects and find solutions to them;
- Monitor degradations of river basins and estuaries take measures to protect their ecosystems;
- Identify water, air and soil pollution and their sources and carryout measures to prevent them;

- Carry out activities necessary for the protection and sustainable development of the environment.

#### 1.7.2.2 Kano State Environmental Planning and Protection Agency (KASEPPA)

Kano State Environmental Planning & Protection Agency (KASEPPA) is an agency of the state ministry of environment. The agency promotes a safe and healthy environment for the people of Kano, ensure sustainable development and enforce environmental protection. Its duties include:

- Research and development activities for environmental protection
- Educate the general public on the types of disposal methods acceptable by the State Government for domestic and industrial wastes
- Co-ordinate the activities of all the agencies in the state connected with environmental matters;
- Conduct public enlightenment campaigns and disseminate vital information on environmental matters
- Render advisory services and support to all Local Government in the state in areas of solid waste management matters;
- Take measures to guarantee consistent effectiveness of environmental structures throughout the state for solid waste collection and disposal,
- Formulate master plans for solid wastes management for development of environmental standard mobilize the inhabitants of all areas in the state.

#### 1.7.2.3 Kano State Lands and Survey

This Ministry was created for the purpose of overseeing the land resources in the state. They are also charged with the responsibility to plan, devise and implement the state policies on land and its resources.

#### 1.7.2.4 Bebeji Local Government Area Council

The Bebeji Local Government Area Council is one of the Local Government Areas of Kano State established to administer local government functions within its jurisdiction. Bebeji 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 Nasarawa Kofa Community*

Nasarawa Kofa Community is situated within the jurisdiction of the Bebeji Local Government Area. Accordingly, implementation of the proposed project will require appropriate coordination with the 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 at Nasarawa Kofa, Bebeji Local Government Area of Kano State is justified by the growing national transition toward cleaner fuels, and the need to expand affordable energy access. The site's proximity to existing Abuja-Kaduna-Kano (AKK) 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 Abuja-Kaduna-Kano (AKK) 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 Abuja-Kaduna-Kano 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 Kaduna State. 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 deepened investment in the 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 minimize 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 100m from the gas node along the Abuja-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 Nasarawa Kofa Community, Bebeji Local Government Area, Kano State. 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 a 10ha of land at Nasarawa Kofa, Bebeji Local Government Area, Kano State. The proposed project site falls within the following geographical coordinates: 11°33.353'N,8°16.654'E.

**Figure 3.1: Nigeria Showing KANO State.**

**Figure 3.2: Kano State showing Bebeji LGA in Red Colour**

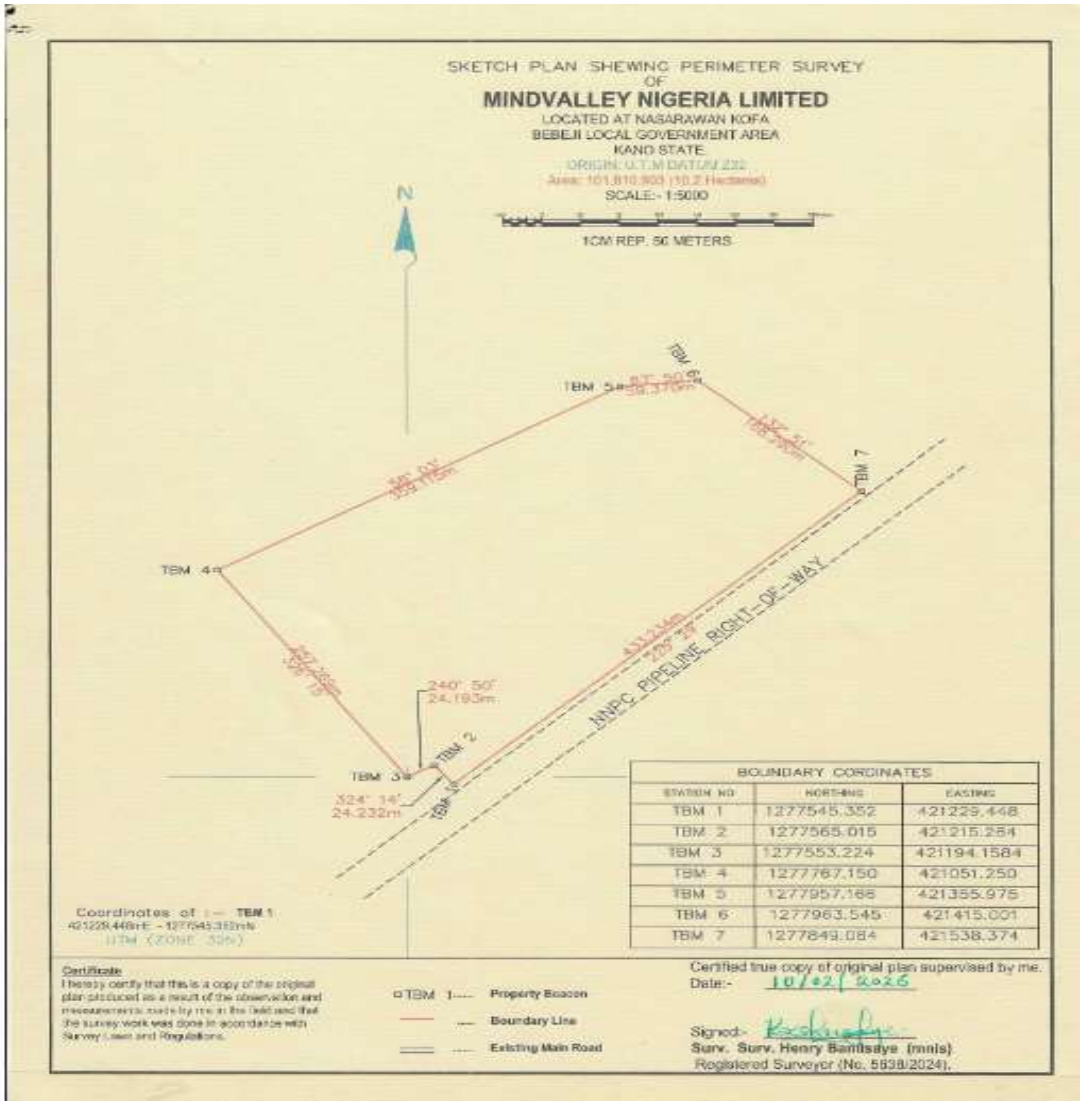


**Figure 3.3: Layout of the Proposed Project Location**

## 3.2 Project/Process Description

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.

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.

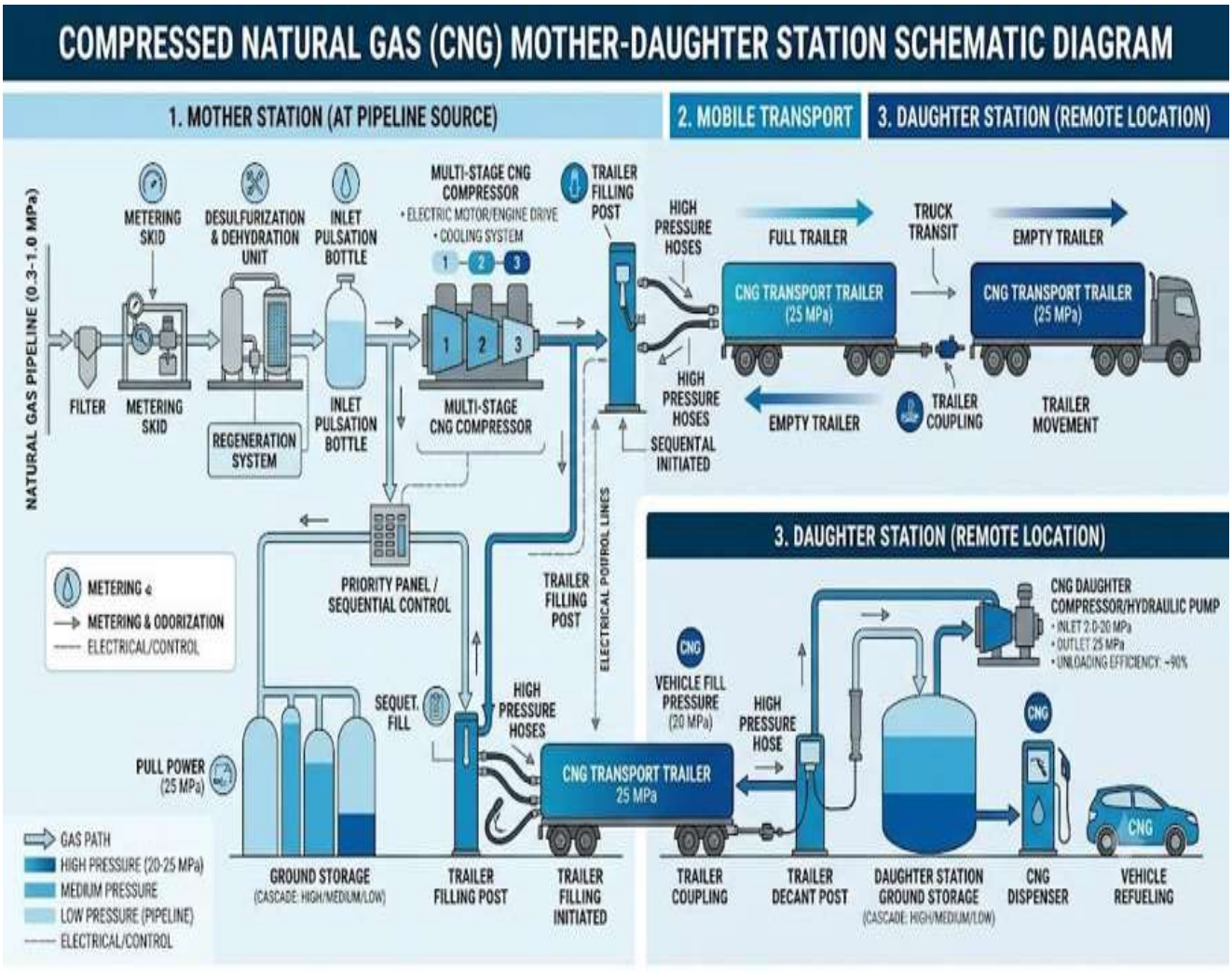


**Fig 3.4: Process Flow Diagram for the CNG Mother Station Station Operations**

**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 |

## 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.

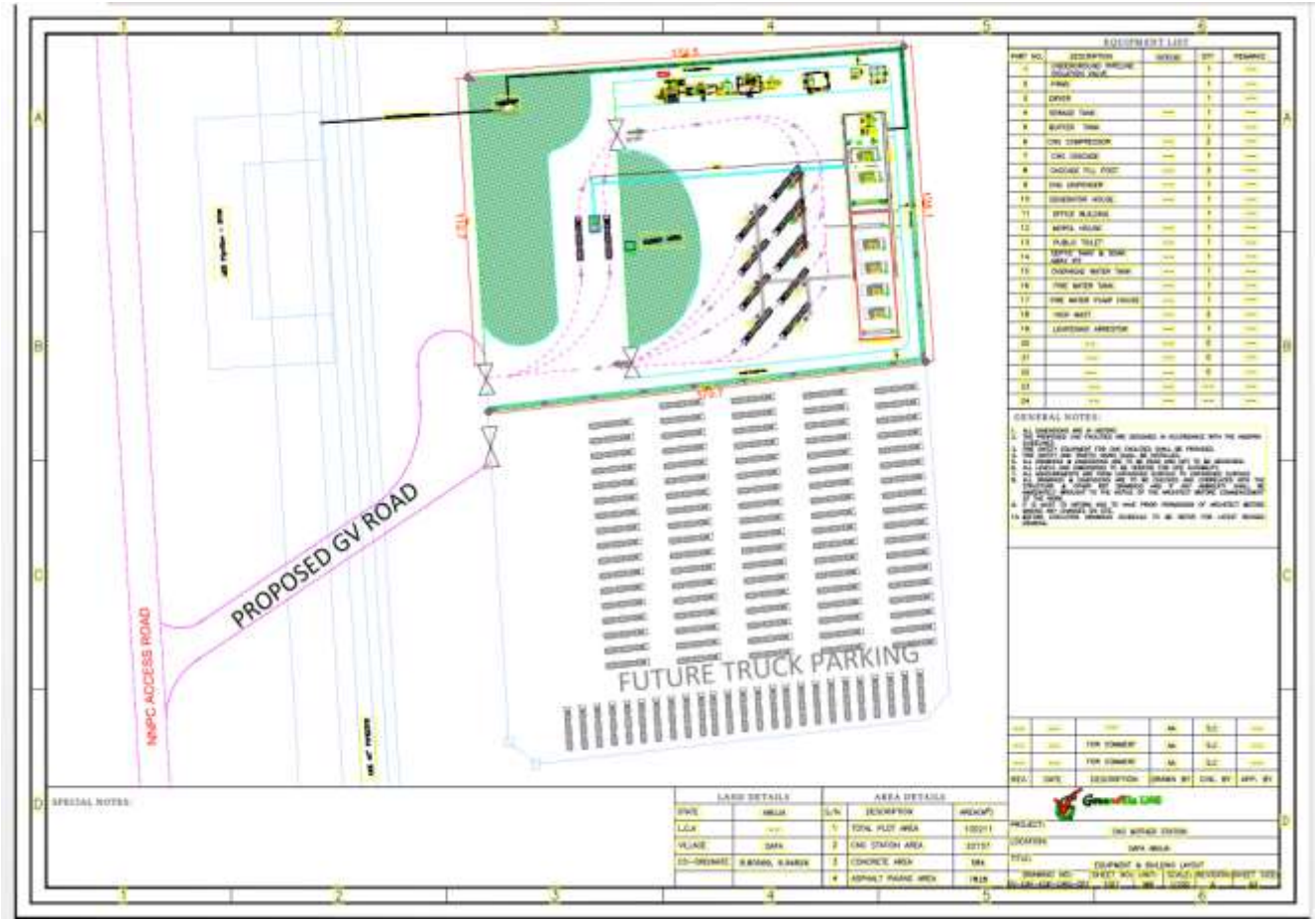


**Figure 3.5: CNG Mother Station Facility Layout**

## 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/ Kaduna 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 KASEPPA 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<br>• Any good quality fill can be transported for reuse at other locations<br>• 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<br>• 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<br>• Proper storage will minimize the damage or contamination of construction materials<br>• Construction rubble will be reused as much as possible within the project<br>• 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<br>• As much steel as possible will be reused on-site<br>• Unused steel materials will be collected and reused offsite<br>• 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<br>• Scrap metal will be collected and sent for recycling |
| Wood | • Wood will be reused if practical<br>• Unused wood waste will be collected and transported to recycling or disposal facility |
| Gaseous Emissions | • Emissions will be minimized through strict equipment maintenance programs<br>• Total hours of operation of equipment will be optimized<br>• 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<br>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<br>• 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<br>from damaged drums or vessels.) |
| Oily Rags | • The potency for fires will be reduced by storing in air-tight containers<br>• 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.<br>• 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<br>• Old and poor-quality paints will be hardened and disposed to landfill (with the exception of oil paints)<br>• Residual oil paints will be collected and transport to disposal facility<br>• Unused paints to be returned to vendors |
| Nails, screws, bolts and nuts | • Waste quantities to be reduced through purchase control<br>• Nails, screws bolts and nuts to be reused if practical<br>• 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<br>• 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.<br>• These containers will be refilled and reused where possible<br>• 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<br>• 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<br>• Total hours of operation of equipment will be optimized<br>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<br>• 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.)<br>Spent oil to be discharged into sump pit and recycled |
| Oil Spills | • Planning and good housekeeping practices to be employed to minimize oil spills<br>• 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<br>• Rags containing oil and grease will be laundered, dried and reused<br>• 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.<br>• Thought will be given to the segregation of drainage from oil, fuel and chemical storage areas; loading/unloading areas;<br>• and production operations areas from the rest of the facility. |
| Paints | • Any leftover paints will be reused when required<br>• Old and poor-quality paints will be hardened and disposed to |

| | |
|---|---|
| | landfill (with the exception of oil paints)<br>• Residual oil paints will be collected and transported to disposal facility |
| Nails, screws, bolts and nuts | • Waste quantities to be reduced through purchase control<br>• Nails, screws bolts and nuts to be stored for reuse during maintenance<br>• 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<br>• Old bulbs to be collected and transported to disposal facility |
| Treated Wood | • Will be collected to be reused at another facility or recycled<br>• 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<br>• 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.<br>• Containers will be refilled and reused where possible,<br>• 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<br>• 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 training. 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 Kaduna Environment Protection Authority (KASEPPA) 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 at Nasarawa Kofa Village, Bebeji Local Government Area of Kano State 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 Kaduna State.

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 18th to 19th June, 2026 for the proposed, Projects at Nasarawa Kofa Village, Bebeji Local Government Area, Kano State. 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 |
| 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 |

| Sample Matrix | Parameter | Test Method | Test Equipment |
|---|---|---|---|
| Soil | All heavy metals | USEPA 6200 | X-ray fluorescence spectrometer |
| Soil | Extractable Sulphate | CAEM/APHA 4500 $SO_4^{2-}$E | UV/Visible Spectrophotometer |
| 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 4.1: Measurements of air quality and meteorological parameters**

The dominant climatic condition of the study area is humid tropical type of equatorial zone of Nigeria. The formal evergreen rain forest vegetation has been widely encroached upon because of human development activities. The study area can be characterized as being a mixture of commercial and residential inhabitation. The climate and meteorological data obtained from the various

literatures. A previous study was used to describe the climatic elements of the study area. The data provide information on the general climate and meteorology conditions in Kano, the air temperature, rainfall, and relative humidity. The weather and climate of the study area is closely linked to the general mesoscale trend in Nigeria. Ayaode (1988) indicated that the weather regime experienced at any given location in Nigeria during the year is determined primarily by geographical location in relation to the fluctuating position of the Inter-Tropical Convergence Zone (ITCZ).

The present climate of Kano region is the tropical wet and dry type, coded as Aw according to Koppen's classification, although climatic changes are believed to have occurred in the past. The climate characteristics in Kano as a whole are typical of West African savannah.

**Temperature** in the region is generally high throughout the year. There are four main seasons at the study area based on temperature element: a dry and cool season – Kaka (mid- November to February) characterized with cool and dry weather plus occasional dusty haze; a dry and hot season, bazara (March to mid-May) where maximum temperature value reaches as high as 43$^0$C, and which is a transition period between the harmattan and the wet season; the wet and warm season, damina (mid-May to September), is the proper rainy season when the lowest diannual temperature is recorded; and lastly a dry warm season, rani (October to mid- November) marked by high humidity and high temperature. This season followed bazara in hotness. Figure 4.1 shows average minimum and maximum temperatures in kano.

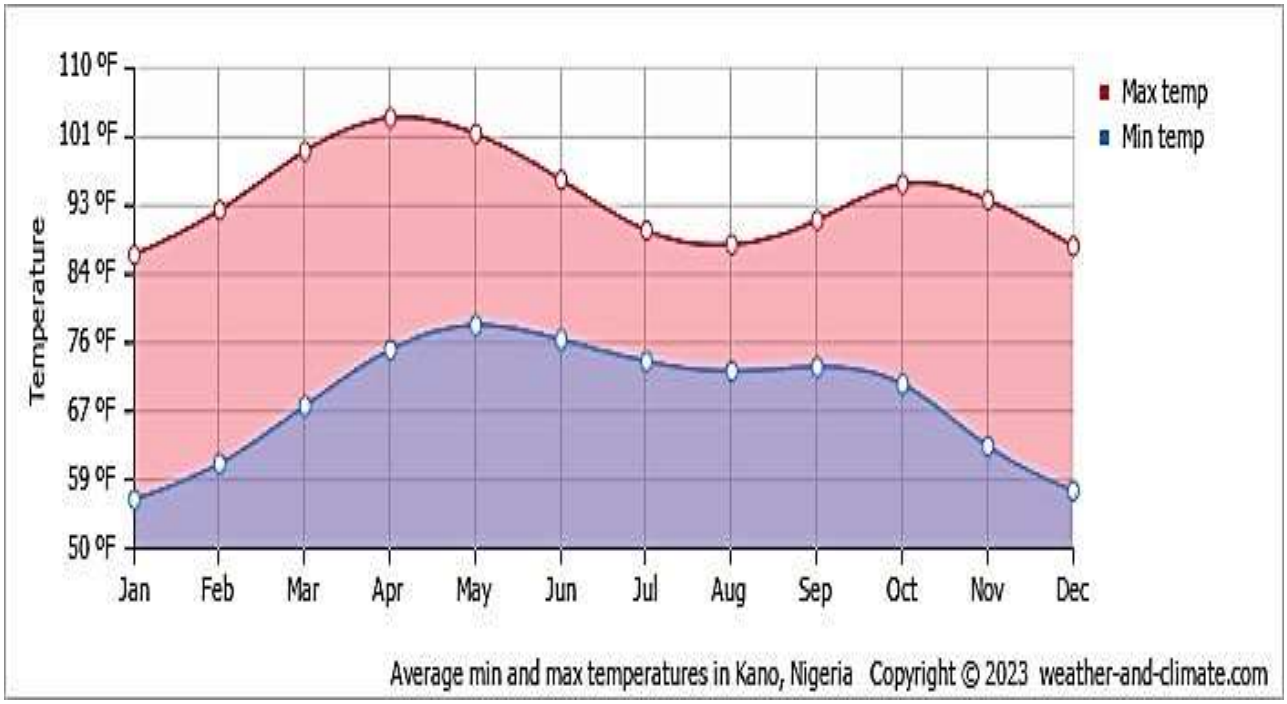

**Figure 4:1: Average min and max temperatures in Kano**

#### 4.3.1.1 Relative Humidity and Ambient Temperature

Relative humidity is high in August up to 80% and lowest in January, November and December with 23%. The rainy season has a moderate effect on temperature which falls to the lowest in August with a mean monthly value of 24.5° C. The monthly evaporation rate for Kano varied from 55% in March and April at the beginning of wet season to 78% in September during the end of rainy season. Figure 4.2 shows the average relative humidity per month.

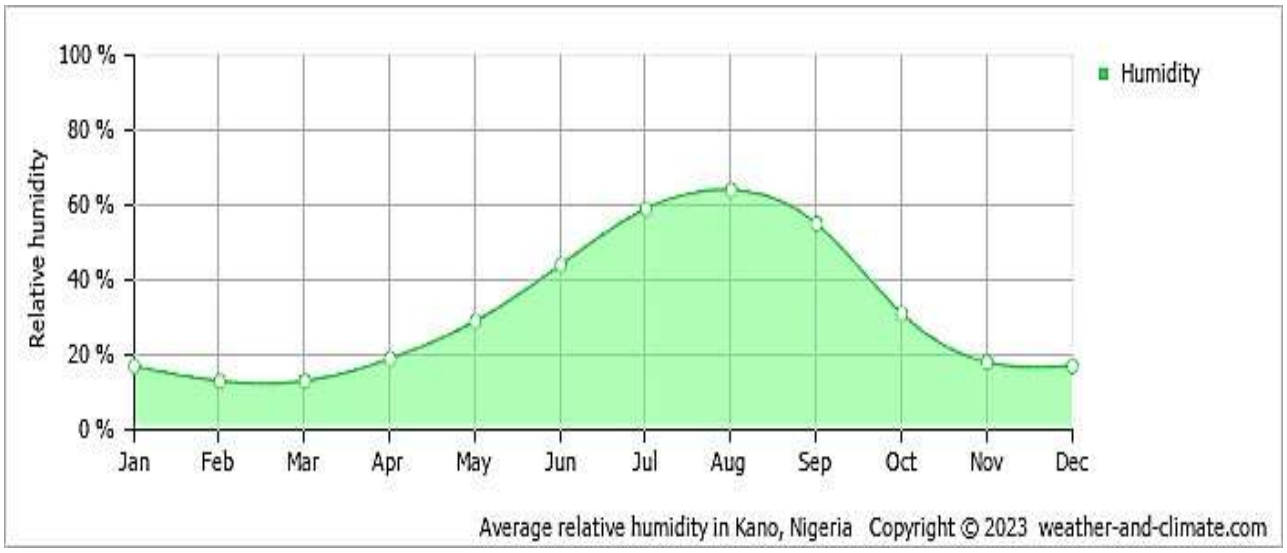


**Figure 4:2: Average relative humidity in Kano**

#### 4.3.1.2 Precipitation

The mean annual rainfall is about 800 mm around metropolitan Kano. Great temporal variation occurs in the amount of rainfall received and no two consecutive years record the same amount. The amount receives vary between Kano metropolis and it southern and northern extremes based on the latitudinal and continentals' factors. The annual amount of rainfall may reach about 1000 Mm in the southern Kano.

While in the northern extreme, the annual value received is lower than 800 mm especially toward the vicinity of desert. The annual rainfall values are inconsistent from one year to another. For instance 1999, 2004, 2010, 2012 witnessed highest annual values in both temperature and rainfall i.e. above normal. These resulted to frequent extreme weather hazards dominantly flood and global warming. The metropolis temperature is higher than that of the rural surrounding by about $9^0$C. However, the length of hydrological growing season has decreased from an average of about 120+/- 5days to about 100+/-5 days in the region. The mean

monthly precipitation over the year is shown in the Figure 4.3 below.

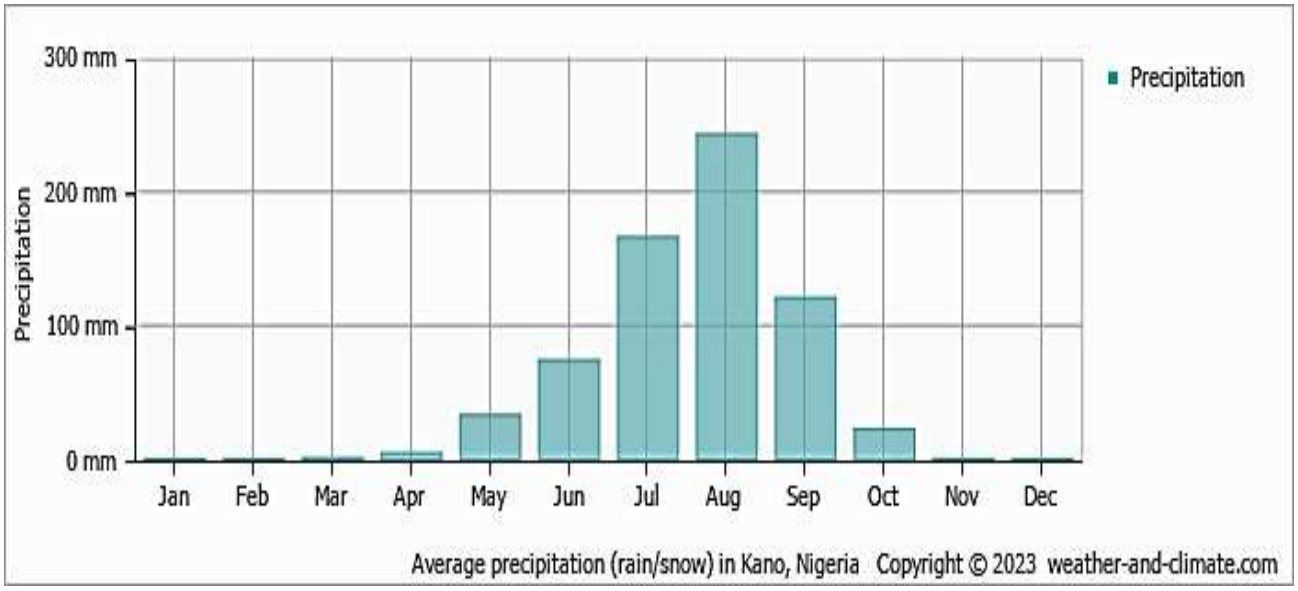


**Figure 4:3: Mean monthly precipitation in Kano**

#### 4.3.1.3 Wind Speed and Direction

The climate of the area is strongly influenced by the tropical maritime air mass and the tropical continental air mass like in most part of West Africa. The tropical maritime air mass which originates from the southern high-pressure belt is humid in nature and is attended with onshore south-western winds off and the Gulf of Guinea. The tropical continental air mass on the other hand is dry and accompanied by north-east trade winds. These two air masses control the climate of the Kano Region making it the wet and dry type which is more dry than wet in the Sudan and Sahel regions of Nigeria. The mean monthly wind speed over the year is shown in the Figure 4.4 below.

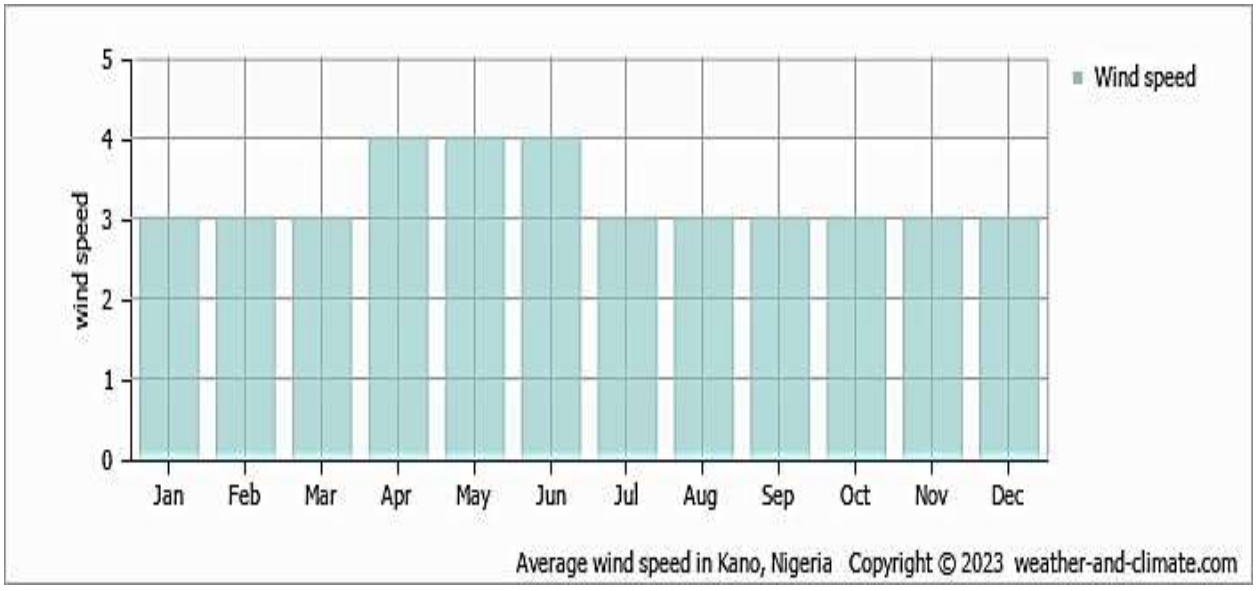

**Figure 4:4: Average monthly wind speed in Kano**

#### 4.3.1.5 Sunshine Pattern

In the study area, the mean monthly sunshine period is about 34 % and varies between 8% and 18% with the minimum and maximum in the months of February and November, respectively. The average monthly sun hours in the study area is shown in the Figure 4.6 below.

**Figure 4:6: Average monthly sun hours in Kano**

### *4.3.2* Air Quality and Noise Characteristics

The ambient air quality assessment was conducted to establish the existing atmospheric conditions within the proposed CNG Mother Station at Nassarawa Kofa, Bebeji Local Government Area, Kano State, prior to project implementation. Baseline air quality data are essential in an Environmental and Social Impact Assessment (ESIA) because they provide the reference against which future impacts resulting from site preparation, construction, equipment installation, and operational activities can be evaluated. The measured parameters were compared with the Federal Ministry of Environment (FMEnv) National Environmental (Air Quality Control) Regulations, 2014 and the World Health Organization (WHO) Global Air Quality Guidelines (2021) where applicable.

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.

| S/N | Location ID | NO (ppm) | $CH_4$ (ppm) | HCL (ppm) | TVOC (mg/m³) | O3 (ppm) | $C_2H_4$ (ppm | $PH_3$ (ppm) | PM 1.0 (µg/m³) | PM 2.5 (µg/m | PM 10 (µg | HCHO (m | Temp (°C) | Humd (%) | Sound (dB) | $CO_2$ (p | NOX (ppm) | $NO_2$ (ppm) | CO (ppm) | $H_2S$ (p | $SO_2$ (ppm | HCN (ppm | $NH_3$ (p | $CL_2$ (ppm) | AQI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | P1 | 0.82 | 0 | 0.00 | 0.000 | 1.05 | 9.732 | 0.00 | 8 | 8 | 7 | 0.000 | 33.8 | 54.2 | 65.9 | 700 | 2.15 | 0.77 | 0 | 0.00 | 2.15 | 0.000 | 0 | 1.07 | Excellent |
| 2 | P2 | 0.62 | 0 | 0.00 | 0.000 | 0.77 | 7.493 | 0.00 | 8 | 7 | 8 | 0.000 | 34.8 | 52.6 | 46.3 | 756 | 1.49 | 1.03 | 0 | 0.00 | 1.73 | 0.000 | 0 | 1.09 | Excellent |
| 3 | P3 | 0.40 | 0 | 0.00 | 0.000 | 0.43 | 6.910 | 0.00 | 7 | 6 | 6 | 0.000 | 35.8 | 51.6 | 59.3 | 971 | 0.98 | 1.51 | 0 | 0.00 | 1.27 | 0.000 | 0 | 1.07 | Excellent |
| 4 | P4 | 0.32 | 0 | 0.00 | 0.000 | 0.28 | 5.686 | 0.00 | 6 | 5 | 6 | 0.000 | 36.3 | 49.5 | 50.1 | 789 | 0.39 | 0.84 | 0 | 0.00 | 0.38 | 0.000 | 0 | 1.04 | Excellent |
| 5 | P5 | 0.24 | 0 | 0.00 | 0.000 | 0.23 | 5.402 | 0.00 | 5 | 5 | 6 | 0.000 | 36.5 | 49.4 | 47.1 | 780 | 0.31 | 0.90 | 0 | 0.00 | 0.33 | 0.000 | 0 | 1.04 | Excellent |
| 6 | P6 | 0.18 | 0 | 0.00 | 0.000 | 0.25 | 5.117 | 0.00 | 5 | 5 | 5 | 0.000 | 36.9 | 48.9 | 47.7 | 793 | 0.24 | 0.98 | 0 | 0.00 | 0.24 | 0.000 | 0 | 0.97 | Excellent |
| 7 | P7 | 0.14 | 0 | 0.00 | 0.000 | 0.35 | 4.854 | 0.00 | 10 | 5 | 5 | 0.000 | 36.2 | 53.1 | 52.1 | 834 | 0.19 | 1.10 | 0 | 0.00 | 0.15 | 0.000 | 0 | 0.90 | Excellent |
| 8 | P8 | 0.27 | 0 | 0.00 | 0.000 | 0.22 | 4.526 | 0.00 | 9 | 10 | 9 | 0.000 | 36.6 | 50.4 | 56.6 | 823 | 0.14 | 1.05 | 0 | 0.00 | 0.14 | 0.000 | 0 | 0.88 | Excellent |
| 9 | P9 | 0.14 | 0 | 0.00 | 0.000 | 0.14 | 3.361 | 0.00 | 8 | 11 | 5 | 0.000 | 35.4 | 51.2 | 58.4 | 754 | 1.05 | 0.25 | 0 | 0.00 | 0.25 | 0.000 | 0 | 1.03 | Excellent |
| 10 | P10 | 0.13 | 0 | 0.00 | 0.000 | 0.12 | 2.251 | 0.00 | 7 | 9 | 4 | 0.000 | 36.3 | 52.1 | 57.2 | 701 | 0.09 | 0.18 | 0 | 0.00 | 2.11 | 0.00 | 0 | 1.14 | Excellent |
| 11 | P11 | 0.23 | 0 | 0.00 | 0.000 | 0.13 | 4.286 | 0.00 | 6 | 9 | 3 | 0.000 | 37.2 | 54.3 | 51.8 | 751 | 1.04 | 1.47 | 0 | 0.00 | 0.27 | 0.000 | 0 | 0.06 | Excellent |
| 12 | P12 | 0.27 | 0 | 0.00 | 0.000 | 0.18 | 4.291 | 0.00 | 4 | 8 | 2 | 0.000 | 36.8 | 53.6 | 52.6 | 803 | 1.60 | 1.21 | 0 | 0.00 | 1.26 | 0.000 | 0 | 1.12 | Excellent |
| 13 | P13 | 0.18 | 0 | 0.00 | 0.000 | 0.16 | 5.351 | 0.00 | 5 | 9 | 5 | 0.000 | 37.0 | 50.2 | 56.2 | 811 | 1.34 | 0.26 | 0 | 0.00 | 0.34 | 0.000 | 0 | 1.00 | Excellent |
| 14 | P14 | 0.41 | 0 | 0.00 | 0.000 | 0.23 | 7.312 | 0.00 | 5 | 8 | 7 | 0.000 | 25.4 | 54.8 | 54.8 | 60.6 | 0.86 | 0.43 | 0 | 0.00 | 0.24 | 0.000 | 0 | 1.05 | Excellent |
| 15 | P15 | 0.23 | 0 | 0.00 | 0.000 | 0.25 | 7.056 | 0.00 | 6 | 11 | 7 | 0.000 | 26.3 | 53.0 | 53.0 | 63.9 | 0.05 | 1.28 | 0 | 0.00 | 0.14 | 0.000 | 0 | 1.02 | Excellent |
| 16 | P16 | 0.81 | 0 | 0.00 | 0.000 | 0.27 | 7.234 | 0.00 | 3 | 10 | 8 | 0.000 | 23.6 | 54.1 | 54.1 | 58.2 | 0.94 | 0.92 | 0 | 0.00 | 0.32 | 0.000 | 0 | 1.05 | Excellent |
| 17 | P17 | 0.24 | 0 | 0.00 | 0.000 | 0.16 | 5.561 | 0.00 | 8 | 13 | 8 | 0.009 | 28.4 | 54.2 | 54.2 | 59.4 | 1.37 | 0.97 | 0 | 0.00 | 0.25 | 0.000 | 0 | 1.13 | Excellent |
| 18 | P18 | 0.12 | 0 | 0.00 | 0.000 | 0.05 | 5.022 | 0.00 | 4 | 9 | 9 | 0.000 | 29.4 | 54.6 | 54.6 | 58.1 | 1.20 | 0.87 | 0 | 0.00 | 0.13 | 0.000 | 0 | 1.32 | Excellent |
| 19 | P19 | 0.26 | 0 | 0.00 | 0.000 | 1.17 | 2.205 | 0.00 | 9 | 8 | 6 | 0.000 | 29.3 | 53.3 | 53.3 | 59.1 | 0.25 | 0.51 | 0 | 0.00 | 0.18 | 0.000 | 0 | 1.05 | Excellent |
| 20 | P20 | 0.45 | 0 | 0.00 | 0.000 | 0.19 | 3.286 | 0.00 | 10 | 12 | 7 | 0.000 | 26.7 | 58.5 | 58.5 | 59.2 | 0.18 | 0.47 | 0 | 0.00 | 0.05 | 0.000 | 6 | 1.14 | Excellent |
| 21 | P21 | 0.24 | 0 | 0.00 | 0.000 | 0.25 | 4.081 | 0.00 | 10 | 9 | 8 | 0.000 | 26.9 | 55.4 | 55.4 | 56.3 | 1.17 | 0.55 | 0 | 0.00 | 0.10 | 0.000 | 0 | 1.03 | Excellent |
| 22 | P22 | 0.15 | 0 | 0.00 | 0.000 | 0.23 | 4.115 | 0.00 | 8 | 10 | 6 | 0.000 | 28.4 | 59.3 | 59.3 | 61.2 | 1.23 | 0.29 | 0 | 0.00 | 0.14 | 0.000 | 0 | 0.15 | Excellent |
| 23 | P23 | 0.22 | 0 | 0.00 | 0.000 | 0.28 | 4.236 | 0.00 | 9 | 14 | 7 | 0.000 | 29.0 | 48.2 | 48.2 | 63.5 | 2.28 | 1.53 | 0 | 0.00 | 2.05 | 0.000 | 0 | 0.07 | Excellent |
| 24 | P24 | 0.36 | 0 | 0.00 | 0.000 | 1.05 | 7.201 | 0.00 | 7 | 9 | 8 | 0.000 | 27.0 | 47.3 | 47.3 | 50.3 | 0.54 | 0.05 | 0 | 0.00 | 0.34 | 0.000 | 0 | 0.09 | Excellent |
| 25 | P25 | 0.38 | 0 | 0.00 | 0.000 | 0.19 | 6.251 | 0.00 | 6 | 10 | 9 | 0.000 | 26.5 | 50.1 | 50.1 | 54.9 | 1.09 | 0.86 | 0 | 0.00 | 0.54 | 0.000 | 0 | 0.05 | Excellent |
| 26 | P26 | 0.21 | 0 | 0.00 | 0.000 | 0.18 | 3.386 | 0.00 | 6 | 10 | 8 | 0.000 | 26.8 | 53.4 | 53.4 | 62.0 | 1.12 | 0.24 | 0 | 0.00 | 0.37 | 0.000 | 0 | 1.03 | Excellent |
| 27 | P27 | 0.42 | 0 | 0.00 | 0.000 | 0.13 | 4.241 | 0.00 | 6 | 10 | 8 | 0.000 | 26.5 | 59.8 | 59.8 | 65.0 | 1.05 | 1.05 | 0 | 0.00 | 2.25 | 0.000 | 0 | 0.05 | Excellent |
| 28 | P28 | 0.58 | 0 | 0.00 | 0.000 | 0.27 | 5.006 | 0.00 | 6 | 11 | 8 | 0.000 | 26.3 | 56.6 | 56.6 | 60.3 | 0.87 | 1.29 | 0 | 0.00 | 0.33 | 0.000 | 0 | 1.04 | Excellent |
| 29 | P29 | 0.27 | 0 | 0.00 | 0.000 | 0.15 | 7.301 | 0.00 | 6 | 13 | 7 | 0.000 | 21.6 | 53.3 | 53.3 | 51.5 | 0.92 | 1.36 | 0 | 0.00 | 0.41 | 0.000 | 0 | 1.05 | Excellent |
| 30 | P30 | 0.23 | 0 | 0.00 | 0.000 | 1.03 | 6.201 | 0.00 | 6 | 12 | 7 | 0.000 | 26.5 | 49.4 | 49.4 | 53.1 | 0.25 | 1.41 | 0 | 0.00 | 0.87 | 0.000 | 0 | 1.02 | Excellent |
| 31 | P31 | 0.14 | 0 | 0.00 | 0.000 | 0.05 | 3.986 | 0.00 | 8 | 10 | 7 | 0.000 | 28.1 | 49.3 | 49.3 | 54.2 | 2.28 | 0.39 | 0 | 0.00 | 0.15 | 0.000 | 0 | 1.10 | Excellent |
| 32 | P32 | 0.36 | 0 | 0.00 | 0.000 | 0.27 | 7.015 | 0.00 | 7 | 11 | 8 | 0.000 | 27.2 | 48.2 | 48.2 | 58.3 | 1.51 | 0.86 | 0 | 0.00 | 0.05 | 0.000 | 0 | 0.03 | Excellent |
| 33 | P33 | 0.31 | 0 | 0.00 | 0.000 | 0.14 | 7.012 | 0.00 | 4 | 10 | 7 | 0.000 | 24.3 | 49.9 | 49.9 | 59.0 | 0.34 | 0.74 | 0 | 0.00 | 0.00 | 0.000 | 0 | 0.01 | Excellent |

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

#### *4.3.2.1 Air Quality and Noise Result Discussion*

Ambient air quality monitoring was conducted at thirty (30) grid-based sampling locations distributed across the proposed Greenville LNG Nigeria Limited CNG Mother Station project site. The assessment provides baseline information on the existing air environment prior to project development and serves as a benchmark for evaluating future environmental changes associated with project construction and operation. Overall, the results indicate that the project area presently experiences good to excellent ambient air quality, with most measured pollutants either below detection limits or within acceptable national and international guideline values.

**The Particulate Matter ($PM_{1.0}$, $PM_{2.5}$ and $PM_{10}$)**

Particulate matter concentrations across the project area were moderately elevated compared to the control locations but remained generally within acceptable regulatory limits. $PM_1$ concentrations ranged from 16–21 µg/m³, $PM_{2.5}$ ranged from 23–30 µg/m³, while $PM_{10}$ concentrations varied from 39–48 µg/m³. Background control locations recorded lower concentrations, with $PM_{2.5}$ ranging from 18–19 µg/m³ and $PM_{10}$ ranging from 29–31 µg/m³.

The FMEnv permissible limits for ambient particulate matter are 35 µg/m³ for $PM_{2.5}$ and 250 µg/m³ for $PM_{10}$, while the WHO Air Quality Guidelines prescribe more stringent 24-hour limits of 15 µg/m³ for $PM_{2.5}$ and 45 µg/m³ for $PM_{10}$.

All recorded $PM_{2.5}$ and $PM_{10}$ concentrations complied with FMEnv standards. However, $PM_{2.5}$ concentrations at all monitoring locations exceeded the WHO guideline value, while $PM_{10}$ concentrations at a few locations, particularly GRPAQ05, GRPAQ09, GRPAQ15, GRPAQ19, GRPAQ24 and GRPAQ28, marginally exceeded the WHO guideline of 45 µg/m³. The elevated particulate levels are likely attributable to the urban and peri-urban setting of Rigasa, characterized by unpaved road networks, intense vehicular movement, commercial activities, construction activities, and wind-blown dust. For the proposed CNG Mother Station, particulate matter represents one of the most important environmental indicators during site preparation and construction activities. Dust generation from excavation, grading, equipment movement and transportation activities may further increase particulate concentrations if appropriate mitigation measures are not implemented.

**Carbon Monoxide (CO)**

Carbon monoxide was not detected (0 ppm) at any monitoring location. This is well below the FMEnv limit of 10 ppm (1-hour average) and the WHO guideline value of 4 mg/m³ (24-hour average). The absence of carbon monoxide demonstrates that there are currently no significant sources of incomplete combustion within the study area. From an ESIA perspective, this finding provides an excellent baseline because any future increase in CO concentrations during project operation can be directly attributed to compressor engines, standby generators or increased vehicle movements associated with the CNG Mother Station.

**Ozone ($O_3$)**

Ground-level ozone concentrations ranged approximately from 0.05 to 1.17 ppm. The WHO guideline for ozone is 100 µg/m³ (maximum daily 8-hour mean). Because ozone is a secondary pollutant produced through atmospheric reactions involving nitrogen oxides and volatile organic compounds, its relatively low concentration suggests limited photochemical pollution in the area. The results indicate that the project environment presently experiences minimal atmospheric oxidation associated with urban or industrial emissions.

**Nitrogen Dioxide (NO)**

Nitrogen oxide concentrations ranged from approximately 0.12 to 0.82 ppm across the sampling locations. Although the FMEnv regulations do not prescribe a separate ambient limit for nitric oxide (NO), NO is rapidly oxidized in the atmosphere to nitrogen dioxide ($NO_2$), which is the regulated pollutant. The relatively low NO concentrations indicate that the study area is currently free from significant combustion sources such as major highways, power plants or heavy industrial facilities. These values are typical of rural and peri-urban environments where vehicular traffic and fossil fuel combustion are limited. The results therefore establish a favourable baseline condition for the proposed CNG Mother Station.

**Nitrogen Dioxide ($NO_2$)**

Nitrogen dioxide concentrations ranged from 0.05 to 1.53 ppm. FMEnv regulates $NO_2$ with guideline values based on averaging periods, while the WHO Air Quality Guidelines recommend 25 µg/m³ (24-hour average) and 10 µg/m³ (annual average). The values reported by the laboratory appear higher than these guideline values if interpreted directly in ppm. However, the report does not specify whether the measurements represent instantaneous field readings, time-weighted averages or instrument-specific indices. Consequently, direct comparison with FMEnv and WHO standards should be interpreted with caution. Nevertheless, the overall Air Quality Index (AQI) classified all monitoring locations as Excellent, indicating that ambient nitrogen oxide pollution within the project area is presently

insignificant.

**Sulphur Dioxide ($SO_2$)**

Sulphur dioxide concentrations remained generally low throughout the study area. FMEnv prescribes guideline values for $SO_2$, while the WHO recommends a 24-hour guideline value of 40 µg/m³. Although the laboratory values are reported in ppm without specifying the averaging period, the concentrations were sufficiently low to indicate the absence of significant sulphur-containing fuel combustion within the project area. This is expected because the surrounding environment is largely rural and lacks major industrial emission sources. Since natural gas contains very little sulphur, operational emissions from the proposed facility are expected to remain considerably lower than those associated with diesel-powered facilities.

**Methane ($CH_4$)**

Methane concentrations were 0 ppm at all sampling locations. There are presently no FMEnv or WHO ambient air quality standards specifically for methane because it is considered primarily a greenhouse gas rather than a direct human health pollutant. Nevertheless, methane is the principal constituent of compressed natural gas. Therefore, the absence of detectable methane is particularly significant because it confirms that no existing gas leakages or fugitive emissions occur within the proposed project site. This provides an excellent baseline for future operational leak detection monitoring.

**Total Volatile Organic Compounds (TVOCs)**

Total volatile organic compounds were not detected (0.000 mg/m³) throughout the study area. Neither FMEnv nor WHO prescribes a general ambient limit for total VOCs because individual compounds possess different toxicological properties. The absence of detectable VOCs demonstrates that the atmosphere is presently unaffected by hydrocarbon emissions, petroleum storage or industrial solvent usage. This finding is particularly important for a proposed CNG Mother Station because it confirms that baseline atmospheric hydrocarbon concentrations are negligible.

**Formaldehyde (HCHO)**

Formaldehyde concentrations ranged from 0.000 to 0.009 mg/m³. The WHO guideline value for formaldehyde is 0.1 mg/m³ (30-minute average). Consequently, all measured concentrations are substantially below the WHO guideline and indicate that the atmosphere is free from significant aldehyde contamination. The results suggest minimal influence from combustion processes, biomass burning or industrial emissions.

**Hydrogen Sulphide ($H_2S$)**

Hydrogen sulphide was not detected at any sampling location. Although FMEnv has no specific ambient standard for $H_2S$, international environmental guidelines recommend that ambient concentrations remain extremely low because of its odour and toxicity. The absence of detectable hydrogen sulphide confirms that the study area is unaffected by sewage decomposition, petroleum processing or sulphide-rich industrial emissions.

**Hydrogen Chloride (HCl)**

Hydrogen chloride concentrations were 0 ppm throughout the study area. This indicates the absence of acidic gaseous emissions from industrial processes involving chlorinated compounds. Since CNG operations do not normally produce hydrogen chloride, the results establish favourable baseline atmospheric conditions.

**Hydrogen Cyanide (HCN)**

Hydrogen cyanide was not detected at any monitoring location. This finding confirms that no industrial combustion processes or hazardous chemical releases currently affect the project environment. The absence of HCN represents an excellent environmental baseline.

**Ammonia ($NH_3$)**

Ammonia concentrations were either zero or below instrument detection limits. These concentrations indicate that the surrounding environment is largely unaffected by intensive livestock production, fertilizer storage or industrial ammonia emissions. Consequently, ambient ammonia levels comply with acceptable environmental conditions.

**Particulate Matter ($PM_{1.0}$)**

$PM_{1.0}$ concentrations ranged approximately from 3 to 10 µg/m³. Although neither FMEnv nor WHO has established specific ambient standards for $PM_{1.0}$, these concentrations indicate very low levels of ultrafine particulate pollution. The results suggest minimal dust generation within the project area before construction activities commence.

**$PM_{2.5}$**

Fine particulate matter ($PM_{2.5}$) concentrations ranged between 5 and 14 µg/m³. The FMEnv guideline value is 25 µg/m³ (24-hour average), while the WHO guideline is 15 µg/m³ (24-hour average). All measured concentrations complied with both FMEnv and WHO standards. These results indicate excellent air quality and minimal health risks associated with fine particulate inhalation. During construction, temporary increases may occur due to excavation, earthmoving and vehicle movement; however, these impacts can be effectively controlled through routine

dust suppression.

**$PM_{10}$**

$PM_{10}$ concentrations ranged from 2 to 9 µg/m³, remaining well below the FMEnv guideline of 150 µg/m³ and the WHO guideline of 45 µg/m³ (24-hour average). The very low particulate concentrations indicate that existing dust generation within the project area is minimal. This favourable baseline demonstrates that the surrounding environment is relatively free from industrial activities, quarrying operations or intensive vehicular traffic.

**Carbon Dioxide ($CO_2$)**

Carbon dioxide concentrations ranged approximately between 700 and 971 ppm. Neither FMEnv nor WHO prescribes ambient air quality standards for $CO_2$ because it is not considered a toxic pollutant at typical outdoor concentrations. The measured values are consistent with normal atmospheric background concentrations and indicate the absence of significant localized combustion sources. Since natural gas combustion produces lower $CO_2$ emissions than diesel or petrol, the proposed CNG Mother Station is expected to contribute relatively lower greenhouse gas emissions compared to conventional fuel facilities.

**Ethylene ($C_2H_4$)**

Ethylene concentrations ranged approximately between 2.20 and 9.73 ppm. No FMEnv or WHO ambient guideline exists for ethylene because it is not generally regarded as a priority air pollutant at environmental concentrations. The observed values likely originate from natural vegetation and limited combustion activities and do not indicate atmospheric contamination.

**Phosphine ($PH_3$)**

Phosphine was not detected in any sample. Since phosphine is typically associated with industrial fumigation and pesticide applications, its absence confirms that such activities do not presently influence the project area.

**Ambient Noise Level**

Ambient noise levels ranged from approximately 46.3 to 65.9 dB(A). The FMEnv National Environmental (Noise Standards and Control) Regulations prescribe a daytime limit of 90 dB(A) for industrial areas and 55 dB(A) for residential areas, while the WHO recommends outdoor daytime noise levels not exceeding 55 dB(A) for residential environments to minimize community disturbance. Most locations fell within or slightly above the WHO residential guideline but remained well below the FMEnv industrial limit. The measured values reflect normal environmental noise arising from local community activities and light vehicular movement. During operation of the CNG Mother Station, noise from compressors, generators and

heavy-duty trucks will require mitigation through equipment maintenance, acoustic enclosures and periodic monitoring.

**Air Quality Index (AQI)**

The Air Quality Index classified all thirty-three monitoring locations as "Excellent." This confirms that the proposed CNG Mother Station is located within an environment currently characterized by very good atmospheric conditions with minimal anthropogenic pollution. The absence of detectable carbon monoxide, methane, hydrogen sulphide, hydrogen cyanide, volatile organic compounds and petroleum-related pollutants, together with the low particulate matter concentrations, demonstrates that the site has not been impacted by industrial emissions before project commencement. Consequently, the measured values provide a robust environmental baseline against which future project-related impacts can be assessed. During construction and operation, routine monitoring should focus on particulate matter, nitrogen oxides, carbon monoxide, fugitive methane emissions and noise to ensure continued compliance with FMEnv regulations and WHO guidelines.

### 4.3.3 Groundwater and Surface Water Quality Assessment

The baseline water quality assessment was undertaken to determine the existing physicochemical, chemical, heavy metal, organic and microbiological characteristics of groundwater and surface water within and around the proposed CNG Mother Station at Nassarawa Kofa, Bebeji Local Government Area, Kano State. The assessment provides an important environmental baseline for evaluating potential impacts that may arise during the construction and operational phases of the project.

The analytical results indicate that groundwater is generally of good quality and complies with most Federal Ministry of Environment (FMEnv) and World Health Organization (WHO) guideline values, whereas surface water exhibits localized deterioration in quality, particularly with respect to electrical conductivity, sulphate, iron, zinc and microbiological contamination. These conditions represent existing environmental characteristics of the project area rather than impacts associated with the proposed development.

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 | Well GNK1 | Upstream SWNK | Midstream SWNK | Downstream SWNK | GNK2 | GNK3 | GNK4 | GNK5 | GNK6 | GNK7 | Control GNK | FM Limit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A)** | **Coordinate** | | | | | | | | | | | | | |
| 1 | Latitude | | 11°3247.027 | 11°33'1.644 | 11°33'4.821 | 11°33'2.081" | 11°32'3.004 | 11°323.241 | 11°3228.604 | 11°3201.006 | 11°3218.321 | 11°3263.461 | 11°3240.316 | - |
| 2 | Longitude | | 8°163 6.729 | 8°17'4.496" | 8°17'6.392" | 8°17'4.399" | 8°16'8.13 | 8°16'4.288" | 8°1622.86 | 8°1662.53 | 8°1634.86 | 8°16'3.349" | 8°162.185" | - |
| **B)** | **Physicochemical Test** | | | | | | | | | | | | | |
| 3 | Colour | TCU | Clear | Blackish | Blackish | Blackish | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear |
| 4 | Odour | - | Odourless | Rotten Smell | Odourless | Odourless | Odourless | Odourless | Odourless | Odourless | Odourless | Odourless | Odourless | Unobjectionable |
| 5 | Taste | - | Tasteless | ND | ND | ND | Tasteless | Tasteless | Tasteless | Tasteless | Tasteless | Tasteless | Tasteless | Unobjectionable |
| 6 | PH | - | 7.10 | 8.18 | 8.47 | 8.51 | 6.34 | 6.83 | 6.55 | 7.47 | 8.01 | 7.56 | 6.59 | 6.5-8.5 |
| 7 | Turbidity | NTU | 0 | 4 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 |
| 8 | TDS | mg/L | 136 | 201 | 197 | 184 | 126 | 141 | 122 | 135 | 182 | 115 | 105 | 500 |
| 9 | T.S.S | mg/L | 12 | 24 | 20 | 28 | 12 | 8 | 8 | 4 | 7 | 6 | 9 | 20 |
| 10 | Dissolved | mg/L | 4.0 | 3.6 | 4.4 | 4.8 | 4.8 | 3.9 | 3.8 | 3.9 | 4.0 | 3.8 | 4.1 | 2-8 |
| 11 | Salinity | % | 0.00 | 0.03 | 0.03 | 0.03 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | <1000 |
| 12 | ORP | mV | 186 | 181 | 185 | 193 | 210 | 231 | 196 | 211 | 214 | 220 | 215 | 200-600 |
| 13 | B.O.D | mg/L | 1.9 | 2.4 | 2.3 | 2.3 | 1.6 | 1.5 | 1.5 | 1.8 | 1.3 | 1.0 | 1.2 | NS |
| 14 | Temperature | °C | 28.6 | 30.4 | 31.6 | 31.7 | 31.6 | 34.4 | 28.7 | 28.9 | 28.5 | 28.9 | 32.4 | Ambient |
| 15 | Electrical Conductivity | µS/cm | 186 | 1063 | 1141 | 1054 | 339 | 348 | 306 | 371 | 334 | 328 | 314 | 1000 |
| **C)** | **Chemical Test** | | | | | | | | | | | | | |
| 16 | Calcium | mg/L | 4.62 | 0.96 | 1.88 | 1.53 | 2.81 | 1.99 | 2.56 | 2.01 | 1.49 | 1.55 | 0.69 | 200 |
| 17 | Magnesium ($Mg^{2+}$) | mg/L | 2.59 | 0.50 | 0.32 | 0.08 | 1.01 | 1.04 | 1.52 | 0.07 | 0.52 | 0.66 | 0.36 | 20 |
| 18 | Sodium ($Na^{+}$) | mg/L | 11 | 28 | 33 | 34 | 8 | 2 | 6 | 3 | 2 | 2 | 2 | 20 |
| 19 | Potassium ($K^{+}$) | mg/L | 0.1 | 0.9 | 1.7 | 2.0 | 0.7 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.5 | 20 |
| 20 | [illegible] | mg/L | 0.001 | 0.326 | 0.425 | 0.551 | 0.012 | 0.014 | 0.002 | 0.016 | 0.114 | 0.003 | 0.011 | NS |
| 21 | Sulphate ($SO_4$) | mg/L | 28 | 159 | 203 | 212 | 18 | 14 | 18 | 15 | 13 | 13 | 12 | 100 |
| 22 | [illegible] | mg/L | 0.8 | 25. | 26. | 31. | 11. | 6.7 | 2.9 | 2.0 | 0.9 | 0.7 | 2.7 | 50 |
| 23 | [illegible] | mg/L | 0.5 | 2.3 | 1.8 | 1.7 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | NS |
| 24 | [illegible] | mg/L | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 25 | [illegible] | mg/L | 1.7 | 3.3 | 16. | 5.1 | 1.0 | 1.0 | 0.8 | 0.1 | 1.2 | 0.5 | 0.7 | 150 |
| **D)** | **Heavy Metals** | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | ($Zn^{++}$) | mg/L | 4.8 | 9.8 | 5.0 | 6.3 | 1.8 | 0.9 | 1.5 | 0.5 | 3.0 | 2.8 | 0.3 | 3.0 |
| 27 | ($Cu^{2+}$) | mg/L | 0.3 | 0.0 | 0.1 | 0.1 | 0.6 | 0.5 | 0.3 | 0.5 | 0.0 | 0.3 | 0.1 | 1.2 |
| 28 | ($Cl^{-}$) | mg/L | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | ($CO_3^{2-}$) | mg/L | 0.0 | 1.7 | 0.8 | 0.8 | 0.0 | 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | 0.2 |
| 30 | ($Fe^{2+}$) | mg/L | 1.8 | 2.9 | 3.0 | 3.0 | 1.8 | 1. | 1.9 | 2.0 | 1.8 | 0.2 | 0.1 | 0.3 |
| 31 | ($Ni^{2+}$) | mg/L | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 32 | ($Hg^{2+}$) | µg/L | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 33 | ($Pb^{2+}$) | µg/L | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 34 | Manganese ($Mn^{2+}$) | mg/L | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | - |
| **E)** | **Organics** | | | | | | | | | | | | | |
| 35 | Phenols | mg/L | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 36 | Oil & Grease | mg/L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 37 | BTEX | mg/L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Nil |
| | **Microbiological** | | | | | | | | | | | | | |
| 38 | E. coli | cfu/m | 0 | 13 | 11 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Nil |
| 39 | Total Coliform | cfu/m | 2 | 125 | 118 | 143 | 3 | 2 | 4 | 2 | 0 | 1 | 3 | 10 |

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

#### *4.3.3.1 Result Discussions on Water Analysis*

**Physical Characteristics**

**pH:** The measured pH values ranged from 6.34 to 8.51. Groundwater samples generally recorded values between 6.34 and 8.01, while surface water ranged from 8.18 to 8.51. The FMEnv National Environmental (Surface and Groundwater Quality Control) Regulations and the WHO Guidelines for Drinking Water Quality recommend a pH range of 6.5 to 8.5 for potable water.

Almost all samples complied with both FMEnv and WHO standards. Only one groundwater sample (6.34) was slightly below the lower permissible limit, while one downstream surface water sample (8.51) marginally exceeded the upper limit. These slight deviations are insignificant and are likely attributable to the natural geochemistry of the area. The results indicate that the groundwater and surface water systems are chemically stable and are unlikely to experience adverse pH-related effects. For the proposed CNG Mother Station, the baseline pH values suggest that project activities should not significantly alter water acidity or alkalinity provided that wastewater and stormwater are properly managed.

**Temperature:** Water temperatures ranged from approximately 27 to 33°C, remaining below the FMEnv maximum allowable temperature of 40°C. The measured temperatures are typical of shallow groundwater and surface water bodies in northern Nigeria during the sampling period.

The results indicate that thermal pollution is currently absent within the project area. Since the proposed CNG Mother Station will not discharge heated industrial effluent, significant changes in water temperature are not anticipated during operation.

**Colour, Odour and Taste**

Groundwater samples were generally clear, colourless, odourless and tasteless, indicating good aesthetic quality. In contrast, the surface water samples were described as blackish, while the upstream sample exhibited a rotten odour. These observations do not comply with FMEnv and WHO recommendations that potable water should be free from objectionable colour, taste and odour.

The poor aesthetic quality of the surface water suggests the presence of decomposing organic matter, stagnant conditions or domestic and agricultural runoff. This indicates that the deterioration in surface water quality predates the proposed project and is unrelated to CNG activities.

**Electrical Conductivity (EC):** Electrical conductivity ranged from 186 to 1,141 µS/cm. The FMEnv guideline value is 1,000 µS/cm. All groundwater samples complied with the FMEnv standard. However, the upstream, midstream and downstream surface water samples exceeded the permissible limit, indicating

elevated concentrations of dissolved ions. High conductivity is commonly associated with mineral weathering, agricultural runoff and domestic wastewater discharges. Since groundwater remained within acceptable limits, the elevated conductivity appears to be confined to the surface water environment and does not indicate widespread groundwater contamination.

**Turbidity:** Turbidity values ranged between 0 and 4 NTU, remaining well below the FMEnv permissible limit of 50 NTU and the WHO drinking water guideline of 5 NTU.

The low turbidity values indicate that both groundwater and surface water contain very little suspended particulate matter. The results demonstrate that erosion and sediment transport within the project area are presently limited. However, construction activities involving excavation and earthworks could temporarily increase turbidity if appropriate erosion and sediment control measures are not implemented.

**Total Dissolved Solids (TDS):** Total dissolved solids ranged from 105 to 201 mg/L, considerably lower than the FMEnv and WHO maximum permissible limit of 500 mg/L.
The low TDS concentrations indicate fresh water with minimal dissolved mineral content and confirm that the groundwater has not been affected by saline intrusion or industrial contamination. The results also suggest that the surrounding geological formations contribute only moderate quantities of dissolved minerals to the groundwater system.

**Total Suspended Solids (TSS):** Total suspended solids varied from 4 to 28 mg/L. Groundwater samples remained below the FMEnv limit of 20 mg/L, whereas one downstream surface water sample slightly exceeded this guideline.

The elevated TSS in the downstream section of the stream most likely results from natural surface runoff, streambank erosion and sediment transport during rainfall events. Although the exceedance is localized, it indicates that sediment control measures should be implemented during project construction to prevent additional siltation of nearby water bodies.

**Dissolved Oxygen (DO):** Dissolved oxygen concentrations ranged between 3.6 and 4.8 mg/L, falling within the FMEnv acceptable range of 2 to 8 mg/L.

These concentrations indicate that the aquatic environment remains capable of supporting aerobic biological processes. Although the surface water recorded slightly lower dissolved oxygen concentrations than groundwater, the values are

still adequate to sustain aquatic organisms and do not indicate severe oxygen depletion.

**Biological Oxygen Demand (BOD):** Biochemical oxygen demand ranged from 1.0 to 2.4 mg/L, remaining well below the FMEnv guideline value of 10 mg/L.

The relatively low BOD values indicate that the water bodies have not been subjected to significant biodegradable organic pollution. Consequently, organic loading within the project area is currently low despite evidence of microbiological contamination in the surface water.

**Nutrients**

**Sulphate:** Sulphate concentrations ranged between 12 and 212 mg/L. Groundwater complied with the FMEnv limit of 100 mg/L, whereas all surface water samples exceeded this regulatory limit. However, the concentrations remained below the WHO drinking water guideline of 250 mg/L.

The elevated sulphate concentrations in the surface water likely result from natural weathering of sulphate-bearing minerals, agricultural activities or domestic wastewater inputs. Although the concentrations are not considered a significant human health concern according to WHO standards, they indicate moderate environmental degradation of the stream.

**Nitrate:** Nitrate concentrations ranged from 0.74 to 31.82 mg/L, remaining below both the FMEnv and WHO guideline value of 50 mg/L.

These results indicate that neither groundwater nor surface water has been significantly affected by nitrate contamination from agricultural fertilizers or sewage. The measured concentrations do not pose a risk of nitrate toxicity or eutrophication.

**Nitrite:** Nitrite concentrations ranged from 0.00 to 0.10 mg/L, remaining below applicable FMEnv and WHO guideline values.

The low concentrations indicate that recent contamination from nitrogenous wastes is minimal.

**Sodium:** Sodium concentrations ranged from 2 to 34 mg/L. Groundwater complied with the FMEnv reference value of 20 mg/L, while several surface water samples exceeded this value.

The elevated sodium concentrations in surface water most likely reflect natural weathering processes and agricultural runoff rather than industrial contamination.

**Iron (Fe**): Iron concentrations ranged from 0.10 to 3.00 mg/L. The FMEnv and WHO guideline value is 0.30 mg/L.

Several groundwater samples and all surface water samples exceeded the recommended limit. Elevated iron concentrations are common in groundwater derived from iron-rich geological formations and are frequently encountered in northern Nigeria. Although iron is not generally considered a major toxicological concern, excessive concentrations may impart undesirable colour, metallic taste and staining of plumbing fixtures. The observed concentrations therefore represent naturally elevated background conditions that should be monitored during project implementation.

**Zinc (Zn):** Zinc concentrations ranged between 0.34 and 9.86 mg/L. The FMEnv and WHO guideline value is 3.0 mg/L.

Groundwater generally complied with the standard, whereas several surface water samples exceeded the permissible limit. The elevated zinc concentrations may result from natural mineral weathering or localized anthropogenic inputs such as agricultural runoff. Continued monitoring during project operation is recommended to ensure that project activities do not contribute further to zinc enrichment.

**Copper:** Copper concentrations ranged from 0.01 to 0.66 mg/L, remaining below the FMEnv limit of 1.25 mg/L and the WHO guideline value of 2.0 mg/L.

These results indicate that copper contamination is absent within the study area.

**Chromium:** Chromium concentrations ranged from 0.00 to 0.04 mg/L, remaining below the FMEnv guideline value of 0.05 mg/L.

The results demonstrate that chromium contamination is absent and that the surrounding geological formations do not contribute significant chromium to the water resources.

**Nickel:** Nickel concentrations ranged from 0.00 to 0.08 mg/L. Most samples complied with the FMEnv guideline value of 0.07 mg/L, although one surface water sample slightly exceeded the limit.

The minor exceedance is unlikely to pose immediate environmental concern but should be monitored throughout project implementation.

**Lead and Mercury:** Lead and mercury were either not detected or occurred only at trace concentrations below guideline values.

The absence of these toxic heavy metals confirms that the groundwater and surface water have not been affected by industrial or mining-related contamination.

**Oil and Grease, BTEX and Phenols**

Oil and grease, benzene, toluene, ethylbenzene and xylene (BTEX) were not detected in any groundwater or surface water sample. Phenols were absent in groundwater but occurred at slightly elevated concentrations in some surface water samples.

The absence of petroleum hydrocarbons is particularly significant for the proposed CNG Mother Station because it demonstrates that the project site has not experienced previous hydrocarbon contamination. This provides a reliable environmental baseline for future monitoring during project operation.

**Microbiological Quality**

The microbiological assessment revealed that surface water contained total coliform counts of 118 to 143 cfu/mL and *Escherichia coli* concentrations of 11 to 16 cfu/mL. Both FMEnv and WHO require zero *E. coli* in drinking water, while total coliform counts should be absent or extremely low.
The observed concentrations clearly indicate faecal contamination of the surface water, rendering it unsuitable for direct domestic consumption without adequate treatment. The contamination is most likely associated with livestock activities, open defecation, agricultural runoff or domestic wastewater discharges. In contrast, groundwater exhibited minimal microbial contamination, indicating that the aquifer remains relatively protected from surface sources of pollution.

**Overall ESIA Interpretation**
Generally, Comparison of the analytical results with FMEnv and WHO standards indicates that groundwater quality within the proposed CNG Mother Station is generally satisfactory, with most parameters complying with national and international guideline values. Surface water also complied with several physical and chemical standards but exceeded FMEnv limits for electrical conductivity, sulphate, iron, zinc, total suspended solids at one location, and microbiological indicators. Importantly, no petroleum hydrocarbons (oil and grease or BTEX compounds) were detected, confirming that the project area has not experienced historical fuel contamination.
From the ESIA perspective, these findings demonstrate that the principal environmental objective should be the protection of the relatively good-quality groundwater and the prevention of further deterioration of the already stressed surface water. This can be achieved through proper stormwater management, impermeable pavement in operational areas, secondary containment for fuels and lubricants, spill prevention and response procedures, effective wastewater management, and routine groundwater and surface water monitoring throughout

the construction and operational phases of the proposed CNG Mother Station.

### 4.3.4 Soil Quality Assessment

The baseline soil quality assessment was conducted to establish the existing physicochemical, nutrient, heavy metal, organic and microbiological characteristics of soils within the proposed CNG Mother Station at Nassarawa Kofa, Bebeji Local Government Area, Kano State. Soil quality is a critical component of the Environmental and Social Impact Assessment (ESIA) because construction and operation of the facility have the potential to alter soil properties through excavation, equipment movement, accidental hydrocarbon spills, leakage of lubricants, waste disposal and stormwater runoff. Establishing the current condition of the soil therefore provides a benchmark against which future environmental changes can be assessed. Comparison of the analytical results with available FMEnv guidelines and internationally accepted soil quality criteria indicates that the soils are generally uncontaminated and suitable for the proposed development. The principal characteristics of the site are slightly alkaline soils, moderate nutrient status and the absence of petroleum hydrocarbon contamination.

**Plate 4.2: Soil Sampling at the Proposed Project Site**

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 | $NK_1$ | $NK_2$ | $NK_3$ | $NK_4$ | $NK_5$ | $NK_6$ | $NK_7$ | $NK_8$ | $NK_9$ | $NK_{10}$ | $NK_{11}$ | $NK_{12}$ | $NK_{13}$ | $NK_{14}$ | $NK_{15}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A)** | **Physical test** | | | | | | | | | | | | | | | | |
| 1 | pH | - | 7.96 | 8.01 | 8.34 | 8.07 | 7.71 | 8.85 | 8.05 | 8.11 | 8.53 | 6.91 | 7.58 | 8.11 | 8.38 | 8.57 | 8.56 |
| 2 | Colour | | Pale Brown | Brown | Brown | Brown | Pale Brown | Dark Brown | Dark Brown | Dark Brown | Dark Brown | Yellowish Gray | Brown | Dark Brown | Dark Brown | Dark Brown | Dark Brown |
| 3 | Temperature | $^0C$ | 27.0 | 30.7 | 31.4 | 26.0 | 27.0 | 25.0 | 26.1 | 27.6 | 26.0 | 25.1 | 27.1 | 29.0 | 25.4 | 25.7 | 26.0 |
| 4 | Electrical Conductivity | µs/cm | 1041 | 941 | 872 | 584 | 1310 | 355 | 369 | 60 | 450 | 3183 | 57.6 | 663 | 1382 | 1445 | 1295 |
| **B)** | **Exchangeable Cation** | | | | | | | | | | | | | | | | |
| 5 | Ammonium | mg/kg | 6.6 | 4.1 | 2.4 | 3.9 | 1.2 | 3.9 | 8.7 | 12.8 | 5.2 | 4.0 | 1.0 | 1.0 | 36.5 | 15.3 | 1.1 |
| 6 | Calcium | mg/kg | 1.19 | 1.77 | 0.43 | 0.46 | 0.31 | 0.28 | 0.62 | 2.84 | 2.67 | 1.21 | 0.29 | 0.14 | 0.93 | 1.82 | 0.39 |
| 7 | Magnesium | mg/kg | 0.64 | 0.31 | 0.34 | 0.32 | 0.23 | 1.15 | 2.06 | 1.74 | 1.34 | 0.99 | 0.21 | 0.15 | 1.27 | 0.66 | 0.22 |
| 8 | Sodium | mg/kg | 15 | 11 | 27 | 4 | 59 | 36 | 23 | 19 | 22 | 51 | 8 | 77 | 38 | 25 | 20 |
| **9** | Potassium | mg/kg | 0.32 | 0.15 | 0.06 | 0.17 | 0.25 | 0.19 | 0.06 | 0.31 | 0.11 | 0.25 | 0.86 | 0.18 | 0.99 | 0.14 | 0.58 |
| **C)** | **Exchangeable Anion** | | | | | | | | | | | | | | | | |
| 10 | Sulphate | mg/kg | 56 | 37 | 46 | 18 | 16 | 45 | 83 | 29 | 69 | 52 | 17 | 16 | 27 | 15 | 20 |
| 11 | Nitrate | mg/kg | 34.8 | 29.0 | 16.4 | 28.7 | 51.3 | 11.4 | 48.3 | 25.9 | 11.7 | 2.5 | 54.6 | 17.9 | 13.3 | 41.4 | 20.0 |
| 12 | Nitrite | mg/kg | 0.19 | 0.35 | 0.02 | 0.5 | 1.6 | 0.016 | 1.0 | 0.18 | 0.15 | 0.001 | 2.1 | 0.013 | 0.001 | 1.1 | 2.0 |
| 13 | Phosphate | mg/kg | 1.82 | 2.77 | 1.05 | 0.55 | 0.66 | 0.97 | 1.48 | 0.72 | 1.36 | 0.75 | 0.79 | 0.26 | 1.83 | 2.02 | 1.30 |
| 14 | Chloride | mg/kg | 1.0 | 2.7 | 4.6 | 4.2 | 9.9 | 2.9 | 3.1 | 34.3 | 0.6 | 1.3 | 5.5 | 4.1 | 2.3 | 1.8 | 19.4 |
| **D)** | **Heavy Metal** | | | | | | | | | | | | | | | | |
| 15 | Iron ($Fe^{2+}$) | mg/kg | 1.00 | 1.02 | 0.01 | 0.03 | 0.47 | 1.97 | 2.92 | 0.33 | 0.41 | 3.63 | 0.15 | 0.11 | 1.05 | 1.94 | 0.29 |
| 16 | Zinc ($Zn^{2+}$) | mg/kg | 2.860 | 1.271 | 0.120 | 0.173 | 0.094 | 1.820 | 1.566 | 0.701 | 0.413 | 1.188 | 0.216 | 0.041 | 0.073 | 1.722 | 0.073 |
| 17 | Cupper | mg/kg | 0.86 | 0.37 | 0.20 | 0.28 | 0.19 | 0.21 | 1.00 | 0.00 | 0.35 | 0.72 | 0.18 | 0.29 | 0.36 | 0.27 | 0.24 |
| 18 | Cobalt | mg/kg | 0.01 | 0.03 | 0.10 | 0.10 | 0.04 | 0.47 | 0.82 | 0.59 | 0.06 | 0.05 | 0.05 | 0.00 | 0.11 | 0.03 | 0.02 |
| 19 | Manganese(M | mg/kg | 0.316 | 0.416 | 0.081 | 0.074 | 0.211 | 0.146 | 0.111 | 0.112 | 0.192 | 0.311 | 0.296 | 0.282 | 0.520 | 0.029 | 0.069 |
| 20 | Chromium | mg/kg | 0.24 | 0.60 | 0.02 | 0.01 | 0.01 | 0.03 | 0.02 | 0.01 | 0.03 | 0.05 | 0.08 | 0.02 | 0.00 | 0.00 | 0.00 |
| 21 | Nikel ($Ni^{2+}$) | mg/kg | 0.087 | 0.10 | 0.511 | 0.550 | 0.643 | 0.562 | 1.888 | 1.298 | 0.367 | 0.821 | 0.60 | 042 | 0.566 | 0.328 | 1.90 |
| 22 | Mercury ($Hg^{+}$) | | 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 |
| 23 | Lead ($Pb^{2+}$) | 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 |
| **E)** | **Organic** | | | | | | | | | | | | | | | | |
| 24 | Phenols | 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 |

| S/N | Parameter | Unit | $NK_1$ | $NK_2$ | $NK_3$ | $NK_4$ | $NK_5$ | $NK_6$ | $NK_7$ | $NK_8$ | $NK_9$ | $NK_{10}$ | $NK_{11}$ | $NK_{12}$ | $NK_{13}$ | $NK_{14}$ | $NK_{15}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | BTEX | mg/kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | Oil & Grease | mg/kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **F)** | **Soil** | | | | | | | | | | | | | | | | |
| 27 | Sandy | % | 3 | 2 | 2 | 3 | 9 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| 28 | Loam | % | 4 | 6 | 5 | 4 | 8 | 5 | 6 | 6 | 6 | 7 | 5 | 4 | 5 | 5 | 6 |
| 29 | Clay | % | 1 | 1 | 1 | 2 | 4 | 8 | 6 | 1 | 5 | 4 | 1 | 1 | 7 | 1 | 9 |
| 30 | Silt | % | 7 | 2 | 3 | 0 | 1 | 4 | 3 | 1 | 2 | 2 | 1 | 0 | 4 | 5 | 2 |
| **H)** | **Microbiological** | | | | | | | | | | | | | | | | |
| 31 | E. Coli | cfu/100k | 1 | 2 | 1 | 9 | 9 | 9 | 7 | 3 | 3 | 9 | 6 | 1 | 1 | 1 | 1 |
| 32 | Fungal | cfu/100k | 1 | 1 | 1 | 1 | 1 | 9 | 8 | 4 | 3 | 5 | 5 | 7 | 1 | 2 | 1 |
| **I)** | **Coordinate** | | | | | | | | | | | | | | | | |
| 33 | Latitude | N | $11^0$332 | $11^0$332 | $11^0$3323. | $11^0$3327. | $11^0$3331. | $11^0$3331. | $11^0$3327. | $11^0$3331. | $11^0$3331. | $11^0$3332. | $11^0$3330. | $11^0$3314. | $11^0$3315. | $11^0$332.4 | $11^0$3314. |
| 34 | Longitude | E | $8^0$1639. | $8^0$1638. | $8^0$1638.5 | $8^0$1635.0 | $8^0$1639.6 | $8^0$1645.5 | $8^0$1645.6 | $8^0$174.47 | $8^0$174.46 | $8^0$117.24 | $8^0$162.50 | $8^0$162.56 | $8^0$163.44 | $8^0$1639.6 | $8^0$1633.9 |

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

| SN | Parameter | Unit | $NK_{16}$ | $NK_{17}$ | $NK_{18}$ | $NK_{19}$ | $NK_{20}$ | $NK_{21}$ | $NK_{22}$ | $NK_{23}$ | $NK_{24}$ | $NK_{25}$ | $NK_{26}$ | $NK_{27}$ | $NK_{28}$ | $NK_{29}$ | $NK_{30}$ | $NK_{31}$ Control (1) | $NK_{32}$ Control | $NK_{33}$ Control |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A)** | **Physical test** | | | | | | | | | | | | | | | | | | | |
| 1 | pH | - | 8.56 | 8.71 | 8.51 | 7.77 | 8.01 | 6.92 | 8.81 | 8.37 | 8.52 | 8.09 | 8.06 | 7.77 | 8.03 | 6.60 | 8.61 | 8.91 | 9.20 | 9.52 |
| | | | | | | | | | | | | | | | | | | | | |
| 2 | Colour | | Brown | Reddish Brown | Brown | Pale Brown | Brown | Pale Brown | Pale Brown | Brown | Dark Brown | Brown | Brown | Reddish Brown | Brown | Brown | Dark Brown | Brown | Pale Brown | Dark Brow |
| 3 | Temperature | $^0$C | 26.0 | 26.3 | 25.5 | 29.6 | 28.4 | 26.6 | 27.1 | 26.2 | 27.1 | 23.8 | 24.5 | 23.7 | 25.3 | 28.6 | 26.1 | 28.2 | 29.2 | 30.1 |
| 4 | Electrical Conductivity | µs/cm | 1295 | 396 | 1600 | 741 | 1521 | 641 | 504 | 1605 | 707 | 735 | 1300 | 641 | 1510 | 510 | 604 | 1704 | 844 | 808 |
| **B)** | **Exchangeable Cation** | | | | | | | | | | | | | | | | | | | |
| 5 | Ammonium | mg/kg | 1.1 | 2.5 | 1.7 | 6.6 | 1.9 | 3.1 | 19.7 | 20.9 | 0.8 | 1.2 | 1.1 | 6.5 | 1.7 | 2.1 | 16.5 | 18.1 | 19.7 | 25.9 |
| 6 | Calcium | mg/kg | 0.43 | 3.01 | 2.89 | 0.55 | 1.77 | 0.52 | 0.63 | 0.20 | 0.56 | 1.82 | 1.90 | 1.55 | 1.99 | 1.01 | 0.69 | 1.52 | 2.11 | 2.60 |
| 7 | Magnesium | mg/kg | 3.15 | 2.36 | 1.93 | 0.33 | 6.27 | 0.88 | 1.47 | 0.16 | 0.33 | 2.69 | 3.01 | 2.33 | 5.23 | 4.44 | 1.59 | 4.88 | 6.47 | 7.16 |
| 8 | Sodium | mg/kg | 16 | 103 | 14 | 9 | 47 | 38 | 12 | 28 | 28 | 12 | 11 | 10 | 13 | 28 | 25 | 40 | 47 | 50 |
| **9** | Potassium | mg/kg | 2.81 | 2.55 | 6.21 | 1.81 | 0.92 | 0.36 | 2.00 | 1.73 | 1.52 | 1.00 | 2.20 | 2.33 | 1.92 | 3.05 | 2.22 | 2.36 | 3.11 | 1.88 |
| **C)** | **Exchangeable Anion** | | | | | | | | | | | | | | | | | | | |

| SN | Parameter | Unit | $NK_{16}$ | $NK_{17}$ | $NK_{18}$ | $NK_{19}$ | $NK_{20}$ | $NK_{21}$ | $NK_{22}$ | $NK_{23}$ | $NK_{24}$ | $NK_{25}$ | $NK_{26}$ | $NK_{27}$ | $NK_{28}$ | $NK_{29}$ | $NK_{30}$ | $NK_{31}$ Control (1) | $NK_{32}$ Control | $NK_{33}$ Control |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Sulphate | mg/kg | 36 | 41 | 12 | 24 | 53 | 66 | 25 | 16 | 37 | 18 | 3 | 4 | 14 | 22 | 4 | 45 | 4 | 4 |
| 11 | Nitrate | mg/kg | 15.5 | 3.4 | 0.5 | 31. | 16.9 | 8.7 | 27.1 | 29.6 | 4.9 | 21.1 | 14.5 | 2. | 0.7 | 35. | 12.9 | 13.3 | 14.8 | 16.6 |
| 12 | Nitrite | mg/kg | 17.1 | 2.3 | 0.9 | 28 | 17,1 | 7.10 | 25.2 | 25.2 | 5.11 | 2.50 | 17.9 | 1. | 0.99 | 32 | 18.5 | 19.1 | 2 | 2 |
| 13 | Phosphate | mg/kg | 0.47 | 2.36 | 0.88 | 1.47 | 0.8 | 2.321 | 1.75 | 1.05 | 1.00 | 2.43 | 1.47 | 1.36 | 1.77 | 1.57 | 2. | 2.40 | 2.51 | 3.11 |
| 14 | Chloride | mg/kg | 2.6 | 3.0 | 1.2 | 18.2 | 2.4 | 1.8 | 12.6 | 4.2 | 33.8 | 8.3 | 2. | 2. | 1.5 | 14.3 | 1. | 16.22 | 18.1 | 1 |
| **D)** | **Heavy Metal** | | | | | | | | | | | | | | | | | | | |
| 15 | Iron ($Fe^{2+}$) | mg/kg | 3.86 | 2.74 | 1.84 | 0.42 | 0.82 | 0.14 | 1.93 | 0.11 | 0.29 | 0.43 | 2.84 | 0.77 | 0.99 | 0.19 | 1.23 | 2.89 | 2.90 | 2.94 |
| 16 | Zinc ($Zn^{2+}$) | mg/kg | 1.833 | 0.551 | 1.927 | 0.0821 | 1.530 | 0.86 | 1.008 | 0.169 | 0.072 | 0.053 | 0.927 | 0.871 | 1.087 | 1.33 | 0.178 | 2.27 | 2.87 | 2.997 |
| 17 | Cupper ($Cu^{2+}$) | mg/kg | 0.82 | 0.15 | 0.86 | 0.19 | 1.22 | 0.87 | 1.05 | 0.25 | 0.17 | 0.11 | 0.77 | 0.20 | 0.99 | 1.03 | 0.55 | 1.07 | 1.22 | 1.30 |
| 18 | Cobalt ($Co^{3+}$) | mg/kg | 0.14 | 0.03 | 0.05 | 0.03 | 0.06 | 0.00 | 0.00 | 0.02 | 0.04 | 0.06 | 0.07 | 0.07 | 0.09 | 0.03 | 0.01 | 0.08 | 0.09 | 0.10 |
| 19 | Manganese (Mn) | mg/kg | | | | | | | | | | | | | | | | | | |
| 20 | Chromium ($Cr^{3}$) | mg/kg | 0.01 | 0.02 | 0.02 | 0.01 | 0.06 | 0.00 | 0.01 | 0.02 | 0.00 | 0.08 | 0.02 | 0.03 | 0.01 | 0.02 | 0.07 | 0.08 | 0.09 | 0.10 |
| 21 | Nikel ($Ni^{2+}$) | mg/kg | 0.544 | 0.800 | 0.721 | 1.238 | 0.321 | 0.008 | 1.438 | 0.541 | 1.963 | 2.034 | 1.481 | 1.308 | 0.558 | 1.363 | 0.59 | 2.060 | 2.44 | 2.55 |
| 22 | Mercury ($Hg^{+}$) | | 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 | 0.000 |
| 23 | Lead ($Pb^{2+}$) | 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 | 0.000 | 0.000 |
| **E)** | **Organic** | | | | | | | | | | | | | | | | | | | |
| 24 | Phenols | 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 | 0.000 |
| 25 | BTEX | mg/kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | Oil & Grease | mg/kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **F)** | **Soil Characteristics** | | | | | | | | | | | | | | | | | | | |
| 27 | Sandy | % | 16 | 22 | 16 | 8 | 11 | 18 | 29 | 31 | 14 | 23 | 1 | 2 | 39 | 35 | 1 | 25 | 2 | 3 |
| 28 | Loam | % | 75 | 63 | 80 | 74 | 83 | 79 | 67 | 50 | 65 | 69 | 7 | 8 | 77 | 60 | 5 | 59 | 6 | 6 |
| 29 | Clay | % | 5 | 13 | 0 | 12 | 6 | 2 | 4 | 17 | 19 | 5 | 4 | 4 | 5 | 11 | 2 | 25 | 2 | 3 |
| 30 | Silt | % | 4 | 2 | 4 | 6 | 0 | 1 | 0 | 2 | 2 | 3 | 1 | 2 | 0 | 1 | 0 | 4 | 6 | 6 |
| **H)** | **Microbiologica** | | | | | | | | | | | | | | | | | | | |
| 31 | E. Coli | cfu/100kg | 8 | 7 | 2 | 4 | 2 | 16 | 1 | 9 | 7 | 3 | 8 | 4 | 1 | 1 | 1 | 16 | 1 | 2 |
| 32 | Fungal | cfu/100kg | 92 | 5 | 1 | 3 | 2 | 136 | 1 | 2 | 2 | 1 | 2 | 5 | 7 | 8 | 7 | 81 | 1 | 2 |
| **I)** | **Coordinate** | | | | | | | | | | | | | | | | | | | |
| 33 | Latitude | N | $11^{0}33$ 32.02 | $11^{0}334.$ 20 | $11^{0}332.$ 56 | $11^{0}334.$ 20 | $11^{0}332.$ 62 | $11^{0}330.$ 264 | $11^{0}331.$ 56 | $11^{0}331.$ 23 | $11^{0}336.$ 42 | $11^{0}335.$ 26 | $11^{0}336$ | $11^{0}337$ | $11^{0}338.$ 22 | $11^{0}339.$ 52 | $11^{0}334$ | $11^{0}3240$ 33 | $11^{0}324$ 0 | $11^{0}32$ 41 |
| 34 | Longitude | E | $8^{0}163$ 551 | $8^{0}162.8$ 61 | $8^{0}1634.$ 011 | $8^{0}1631.$ 289 | $8^{0}164.4$ 32 | $8^{0}1645.$ 062 | $8^{0}1640.$ 341 | $8^{0}1630.$ 402 | $8^{0}1604.$ 551 | $8^{0}1632.$ 962 | $8^{0}1646$ | $8^{0}1645$ | $8^{0}1632.$ 303 | $8^{0}1643.$ 552 | $8^{0}1635$ | $8^{0}162.1$ 83 | $8^{0}162.$ 1 | $8^{0}162$ 0 |

**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.

**Soil Reaction (pH)**

The soil pH ranged from 6.60 to 9.52, indicating soils that vary from neutral to moderately alkaline. Most sampling locations recorded pH values between 7.5 and 8.8, while only a few control samples exceeded 9.0. Nigeria does not prescribe a specific FMEnv regulatory limit for soil pH; however, soils with pH values between 6.0 and 8.5 are generally considered suitable for engineering works and vegetation establishment.

The slightly alkaline nature of the soils is characteristic of the semi-arid environment of northern Nigeria, where low rainfall and high evaporation promote the accumulation of basic cations. These conditions reduce the mobility of many heavy metals, thereby lowering the risk of groundwater contamination. However, excessive alkalinity may reduce the availability of micronutrients such as iron, zinc and phosphorus to plants. From the ESIA perspective, the measured pH values do not constitute a constraint to the proposed CNG Mother Station, although landscaping species selected for site rehabilitation should be tolerant of moderately alkaline soils.

**Soil Temperature**

Measured soil temperatures ranged between 23.7°C and 31.4°C, reflecting the prevailing climatic conditions during sampling. There are no FMEnv standards for soil temperature because it is primarily influenced by seasonal weather conditions rather than pollution.

The observed temperatures are typical of northern Nigeria and are unlikely to adversely affect foundation stability, construction activities or soil biological processes. Seasonal fluctuations are expected but will not significantly influence the proposed project.

**Electrical Conductivity (EC)**

Electrical conductivity ranged from 57.6 to 3,183 µS/cm, indicating considerable variation across the study area. Although FMEnv has not established regulatory limits for soil electrical conductivity, values below approximately 2,000 µS/cm are generally regarded as indicating non-saline soils suitable for most land uses.

Most sampling locations recorded relatively low conductivity values, while a few locations exceeded 2,000 µS/cm, suggesting localized salt accumulation. The elevated conductivity is most likely associated with natural evaporation, mineral weathering or agricultural activities rather than industrial contamination. Since high salinity may reduce plant growth, appropriate salt-tolerant vegetation should be considered during site landscaping where elevated conductivity occurs. Overall, the measured conductivity values do not present significant environmental concerns for the proposed CNG Mother Station.

**Exchangeable Cations**

Calcium concentrations ranged from 0.14 to 3.01 mg/kg, magnesium from 0.15 to 7.16 mg/kg, sodium from 4 to 103 mg/kg, potassium from 0.06 to 6.21 mg/kg, and ammonium from 0.8 to 36.5 mg/kg. There are currently no FMEnv regulatory standards for these exchangeable cations in soils.

The measured concentrations indicate that the soils possess adequate mineral reserves to support natural vegetation. Sodium concentrations remain relatively low and do not indicate sodic soil conditions that could adversely affect soil structure or permeability. Similarly, calcium and magnesium occur at concentrations typical of naturally weathered tropical soils and are unlikely to pose engineering or environmental concerns.

**Nutrient Status**

Sulphate concentrations ranged from 12 to 83 mg/kg, nitrate from 0.5 to 54.6 mg/kg, nitrite from 0.001 to 32 mg/kg, phosphate from 0.26 to 3.11 mg/kg, and chloride from 0.6 to 34.3 mg/kg. No FMEnv soil quality standards currently exist for these nutrients.

The observed concentrations indicate moderate soil fertility with no evidence of excessive nutrient enrichment or contamination. The relatively low phosphate concentrations suggest limited fertilizer accumulation, while nitrate concentrations indicate normal nitrogen cycling within the soil. These findings demonstrate that agricultural activities surrounding the project area have not significantly degraded soil nutrient balance.

**Iron (Fe)**

Iron concentrations ranged from 0.01 to 3.86 mg/kg. FMEnv does not prescribe soil quality limits for iron because it is naturally abundant in tropical soils.

The measured concentrations are very low and indicate that iron occurs primarily as a natural component of the parent geological materials. There is no evidence of iron contamination associated with industrial activities.

**Zinc (Zn)**

Zinc concentrations ranged between 0.041 and 2.99 mg/kg. Although FMEnv has not established soil guideline values for zinc, the Dutch Target Value of 140 mg/kg, which is widely applied in Nigerian ESIAs where national soil standards are unavailable, provides a useful benchmark.

All measured zinc concentrations were substantially below this value, indicating that zinc contamination is absent. The observed concentrations represent natural background levels and are unlikely to adversely affect soil quality or vegetation.

**Copper (Cu)**

Copper concentrations ranged from 0.00 to 1.30 mg/kg, remaining far below the Dutch Target Value of 36 mg/kg.

These results demonstrate that the soils are free from copper contamination and that there is no evidence of historical industrial or agricultural inputs that could elevate copper concentrations.

**Chromium (Cr)**

Chromium concentrations ranged from 0.00 to 0.60 mg/kg, which is considerably lower than the Dutch Target Value of 100 mg/kg.

The very low chromium concentrations indicate that the proposed project site has not been affected by industrial contamination or disposal of chromium-containing wastes.

**Nickel (Ni)**

Nickel concentrations varied from 0.008 to 2.55 mg/kg, remaining substantially below the Dutch Target Value of 35 mg/kg.

These results indicate that nickel occurs only at natural background concentrations and poses no environmental concern.

**Cobalt (Co)**

Cobalt concentrations ranged between 0.00 and 0.82 mg/kg. Although Nigeria has no regulatory standard for cobalt in soils, the observed concentrations are consistent with naturally occurring background levels in tropical soils.

The results demonstrate that cobalt contamination is absent.

**Mercury (Hg)**

Mercury was not detected in any soil sample. The absence of mercury is particularly significant because it confirms that the project site has not been affected by mining activities, industrial emissions or hazardous waste disposal. This represents an excellent environmental baseline for future monitoring.

**Lead (Pb)**

Lead was not detected throughout the study area. Compared with the Dutch Target Value of 85 mg/kg, the results indicate excellent soil quality.

The absence of lead contamination confirms that previous industrial activities, leaded fuel residues or waste disposal have not adversely affected the project site.

**Phenols**

Phenols were not detected in any soil sample. This demonstrates that the soils have not been contaminated by industrial organic chemicals or petroleum-derived compounds before project commencement.

**BTEX Compounds**

Benzene, toluene, ethylbenzene and xylene (BTEX) were not detected in any sample. The absence of BTEX is particularly important because these compounds are widely recognized indicators of petroleum contamination. Their absence confirms that no historical fuel spills or hydrocarbon leakages have occurred within the proposed project area, thereby providing an excellent baseline for monitoring future operational impacts.

**Oil and Grease**

Oil and grease were not detected in any soil sample. This finding confirms that the soils remain free from petroleum hydrocarbon contamination. Since accidental fuel or lubricant spills represent one of the principal environmental risks associated with CNG Mother Stations, the current results establish a reliable baseline for future environmental monitoring.

**Soil Texture**

The soils are dominated by loam, with loam content ranging from 44 to 86%, sand ranging from 8 to 39%, clay from 0 to 30%, and silt generally below 7%.

Loamy soils are considered favourable for engineering development because they provide moderate permeability, good drainage, adequate moisture retention and satisfactory bearing capacity. These characteristics reduce the likelihood of excessive settlement and provide suitable conditions for construction of the proposed facility. However, exposed loamy soils are susceptible to erosion during intense rainfall; therefore, erosion control measures such as temporary drainage channels, sediment traps and rapid revegetation should be implemented during construction.

**Microbiological Characteristics**

The microbiological assessment recorded *Escherichia coli* concentrations ranging from 2 to 41 cfu/100 g, while fungal counts ranged from 19 to 356 cfu/100 g. Nigeria currently has no FMEnv soil quality standards for microbiological parameters.

The observed microbial populations are typical of naturally occurring soils and indicate active biological decomposition of organic matter. The higher microbial counts at some locations are likely associated with agricultural activities, livestock grazing and natural organic matter decomposition rather than contamination from industrial sources.

Generally, the baseline soil quality assessment demonstrates that the proposed CNG Mother Station is located on generally uncontaminated soils that are suitable for the proposed development. Comparison with available FMEnv guidance and internationally accepted soil quality criteria indicates that heavy metals occur only at natural background concentrations, while mercury, lead, BTEX compounds, oil and grease and phenols were not detected. These findings confirm the absence of historical petroleum or industrial contamination within the project area. The slightly alkaline pH and localized elevated electrical conductivity reflect natural environmental conditions rather than anthropogenic pollution.

From an ESIA perspective, the principal soil-related environmental risks during project implementation will not arise from existing contamination but from potential future impacts associated with excavation, accidental fuel or lubricant spills, improper waste handling and erosion. These risks can be effectively mitigated through implementation of spill prevention measures, impermeable surfaces in operational areas, secondary containment for fuels and lubricants, proper waste management, erosion control structures and periodic soil quality

monitoring throughout the construction and operational phases of the proposed CNG Mother Station.

### 4.3.5 Geology and Hydrogeology of the Project Area

**Regional Geology:** Pre-Cambrian rock of the basement complex which comprises of gneisses, amphibolites, marbles and the older granites which underlie large part of Nigeria including 80% of the Kano Region. The plant site is underlain by crystalline Basement Complex of pre-Cambrian origin which losses its identity by disappearing into the Chad Formation. The Basement complex consists of granite rocks extending up to Kibiya towards the Formation. The Basement complex consists of granite rocks extending up to Kibiya towards the North and Doguwa towards the East. The Granites are generally Gneissic and commonly developed in a mixture of Pegmatite of schist granite, Gneiss and irregular mass of pegmatite. The Aeolian sand derived from wind deposits cover most part of the area with thickness of about 5 meters in the upland and 10 meters along the lowland plains (Olofin, 1987). The geological structure influences the relief as well as landforms which are relatively flat, with some undulation especially around upstream. The relief of the Region can be categorized into four types: South and south eastern highlands, the middle and western high plain, the central lowland and the Chad plain. The highlands occupy more than 50% of the surface area of the Kano Region and lie on the elevation ranging between 450m to 650m. The high plains consist of areas of low relief, usually less than 20m and areas of grouped hills where the hill may rise higher than 100m above the plains. The plains are developed on rocks of the Basement Complex. Figure 4.14 below shows the geological map of the state.

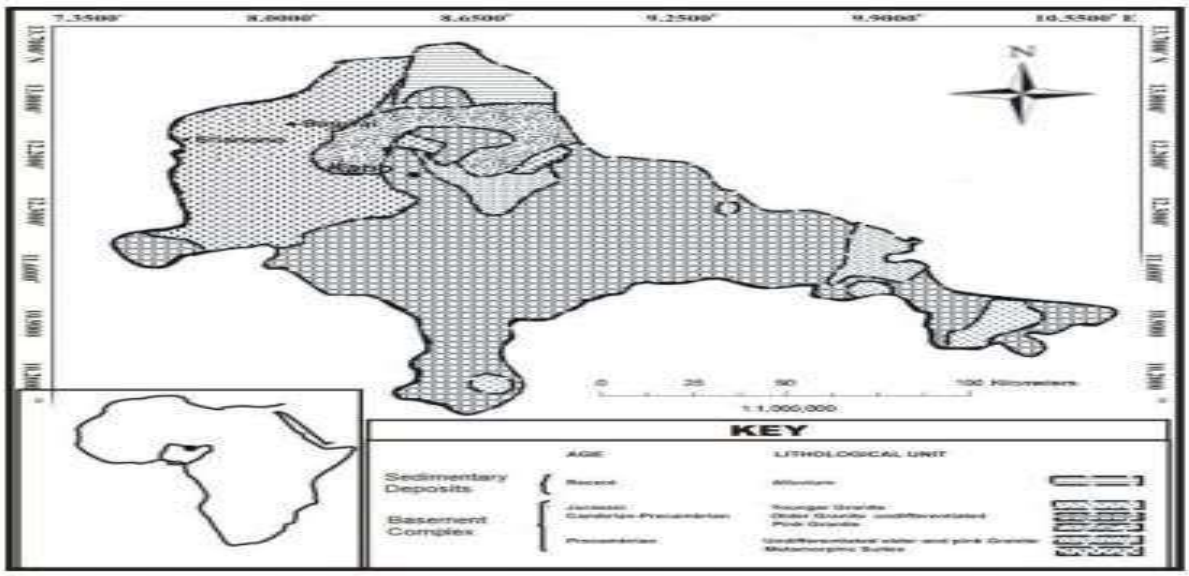


**Figure 4:7: Geological map of Kano State (Source; Kankara, I.A, 2021)**

**Hydrology:** The Region is divided into two hydrological zones, demarcated by the hydro-geological divide. To the west of the divide is the zone of high surface water discharge and retention which coincides with the zone of Basement Complex structure. To the east and north east of the divide is the zone of large accumulation of ground water which is part of upper aquifer of Chad Basin. Retention and flow of water on the surface are very limited in this zone. The climate of the region controls the amount of water that is available both on the surface and at sub-surface at any given time within a water year (Olofin, 1984). The construction of dams which started about 1969 marked the beginning of the modification of drainage and hydrology in Kano Region. More than 30 earth- dams were planned for the region, and by 1984, about 22 of these have been completed. The reservoir of the completed dam and the intricate networks of main distribution and field canals in numerous irrigated sites have created different type of surface drainage. The hydrogeology of the region is to a large extent controlled by geologic settings, climatic condition and human activities. The surface situation, which is directly governed by the underlying geology, has its infiltration, evaporation, runoff and other flow components as the major factors responsible for the groundwater recharge and development in the region's hydrologic environment. Groundwater occurrence within the basement complex areas is limited to fissures and weathered overburden. This has consequently given rise to two main types of aquifers which are the weathered zone fractured zone aquifers (Yakudima, 2009). In the Chad formation, groundwater occurs within the sedimentary strata that made up the upper level sandy horizons. Generally, water in the basement complex area is higher relatively to the water table in the Chad formation. In the basement complex areas water level generally vary from 6 m to 25 m and in some rare cases may reach up to 50 m in some places. Within Chad formation, in contrast, water table ranges from 20 m to 50m (WRECA, 1987).

### 4.3.6 Vegetation Study of the Proposed Project Area

The vegetation is restricted along agriculture field boundary, roadside and other open spaces. Trees species observed in core zone include Neem and Adonsonia digitata, Azadaraca indica, Ailanthus excels, Parkia biglobus, Tamarindus indica, Mangifera indica. The herbs and shrubs includes Bauhinia reticulata, Acacia Sieberiana, Phyllanths pentandnes and Isoberlina doka were observed in the core zone. Among the grasses species of Piliostigma thonningii (Kargo) and Acacia Sieberiana (Farar kaya) observed in the core zone. The major land use in the area is agriculture and settlement. There is no forest area present within the 5 km radius.

The natural vegetation is a mixture of Sudan, Savannah and Sahel thorn shrubs species, sparsely distributed over the entire area, with variation in density from place to place due to human imprint. The Sudan Savannah trees are composed of variety

of species hardly taller than 20 m ranging from baobab to different types of acacias, for example Acacia Albida SPP, Acacia nilotica spp, and Acacia seyal spp. Most of these trees adapt to drought conditions through long tap roots, leathery leaves, and tiny leaves. With the exception of Acacia albida which retain their green leaves throughout the year, the other trees shed their leaves during the dry season. Vegetation of the region was originally defined as undisturbed Sudan savanna and guinea savanna. The normal vegetation has always been the dry Guinea in the southern fringe and the Sudan in the larger part of the region. The vegetation has now been subjected to destruction through fuel wood extraction, urban encroachment and population pressure, hence eventuated the formation of four vegetation zones in the region namely: Sudano Sahelian Savanna, Sudan Savanna, Open Guinea Savanna and Protected Guinea Savanna.

There are thorny shrubs and small tree species which normally cover the forested area of the basin and abandoned areas of irrigation cultivation. Peculiar among the thorny shrubs are Isoberlina, Acanthospermum Hispidum and Guiera senegalensis to mention but a few. Grasses are the main species of vegetation that dominate both cultivable and uncultivated lands, and these include Striga senegalenses, Pennisetum, Cyperus Rotundus and many others.

Some of these grasses as well as tree species are regarded as cultural vegetation. These include neem, guava, mango and cashew. These vegetation species dominates most parts of the channel width with average height of 1.5m, while mango, guava and cashew are purposely planted for sale as cash crops in irrigation plots. The neem trees are found in the rural settlements and sometimes in the upland farms to provide shades for the farmers.

The type of trees in Sudano -Sahelian Savanna of Kano Region includes Andosonia nilotica (bagaruwa), Neem and Adonsonia digitata (Kuka). Both trees, shrubs and grasses are scattered, the Dominant tree Species is Azadaraca indica (Neem). While the Dominant grass is Cassia tora (Tafasa) and thorny Shrubs like Zizuphus Jujube (Magarya). Most of the trees of Kano Region are the ones adapted to drought condition for the fact that they are large and have leathery leaves. These trees include Parkia biglobus (Dorawa), Tamarindus indica (Tsamiya) and Mangifera indica (Mango).Cassia tora (Tafasa) and Senna occidentalis (Rai-rai) are the grasses of this area. indica (Mango).Cassia tora (Tafasa) and Senna occidentalis (Rai-rai) are the grasses of this area. Open Guinea Savanna trees found include Isoberinia doka (Doka), Tamarindus indica (Tsamiya), Azadaradita indica (Neem).

Trees are absent but shrub and grasses are abundant. Dominant among them are Bauhinia reticulata (Kargo), Acacia Sieberiana (farar kaya), Zizuphus Jujube (Magarya), Cassia= 75 X100% = 100% Gorantensia, (Runhu) and Phyllanths

pentandnes (Geron Tsun tsu). The Protected Guinea 75 Savanna is woodland with grasses undergrowth, in the class species such as Isoberlina doka and Isoberlina. tomentosaform the bulk of the scattered woodland. Parkia filicoidea (locust bean tree, 4,700 Butyrospermum parkii (Kadanya) and mangoes (Mangifera indica) are also found in this class.

Shrub and grasses are abundant; dominant among them are Piliostigma thonningii (Kargo) and Acacia Sieberiana (Farar kaya). Within the region, there is disparity between the northern and southern part. In the southern part more intensive agricultural activities is practiced both in the dry and rainy seasons, while the northern part there has low vegetation growth. There is high level of vegetation setback along Hadejia-Jama'are wetland as well as the dam site of the region, caused by emergence of Typha grass. The following tables summarize some of the results of the plant species identification exercise conducted by the ecologist during the field work. Table 4.12 shows some identified fruits and crops in the project area.

**Table 4.6: Summary of identified vegetation in the project area**

| BOTANICAL NAME | COMMON NAME | USES |
|---|---|---|
| *Azadaraca indica* | *Nee* | Herb |
| *Andosonia nilotica* | *bagaru* | Herb/Fruit |
| *Neem and Adonsonia digitata* | *Kuk* | soup |
| *Cassia tora* | *Tafas* | Herb |
| *Zizuphus Jujube* | *Magar* | Herb/Friut |
| *Parkia biglobus* | *Doraw* | Herb/Fruit |
| *Tamarindus indica* | *Tsamiy* | Herb/Food |
| *Mangifera indica* | *Mang* | Fruit |
| *Senna occidentalis* | *rai-rai* | Herb |
| *Isoberinia doka* | *Dok* | Concoction |
| *Bauhinia reticulata* | *Karg* | Herb |
| *Acacia Sieberiana* | *farar* | Herb |
| *Phyllanths pentandnes* | *Geron Tsun tsu* | Food |
| *Parkia filicoidea* | *locust bean tree,* | Food |
| *4,700 Butyrospermum parkii* | *Kadan* | Fruit |

**Faunal/ Wildlife Study**

For a record of information about animals, tracks and animal behaviours were monitored. To complement these, interviews was conducted. We established that there is a process of progressive extermination of animals in the area.

Life in the soil is diverse ranging from microscopic single celled organisms to large burrowing animals. Hence there are well-defined food chain/energy flows within the soil ecosystem. The soil macro-fauna encountered within the study area include various arthropods (insects, millipedes, and mites), molluscs (snails), annelids (earthworms) and nematodes. These organisms are primary consumers; decomposers, mixers and utilizers of energy stored in plants and plant residues, and contribute to the re-cycling of nutrients. Others were secondary consumers such as centipedes, scorpions and spiders. These animals consume smaller sized animals and they may serve as food for organisms occupying higher levels of the food chain.

The soil fauna of special interest within the ecosystem under study were termites and earthworms. The importance of earthworms to soil includes aeration, improvement of texture, mixing (materials from the surface taken to lower depths and vice versa) and nutrient re-cycling. Currently, 16 genera of earthworms have been described in Nigeria, and of these, seven occur in the Savanna ecosystem (Segun, 1980). However, three genera (Hyperiodrilus, Ephyriodrilus and Eudrilus) were encountered in the present study. The earthworms were mainly encountered in the moist-wet soils.
Dry cow dung, (regarded as partly decomposed plant material) was common in the study area and was particularly consumed by Macrotermes subhyalinus and Odontotermes spp. (O. soeathmani, O. pauperans). Among the Macrotermes, there appears to be a fungus- termite symbiotic system, which ensures complete utilization of ingested food (Wood, 1978). The dung beette (Oryetes sp) was also associated with fresh cow dung; they re- distributed the dung to different locations. These animal groups are the major contributors to the re-cycling of material within the ecosystem of the study area.

The distribution of wildlife is low during the study area due to anthropogenic factors. The vegetation is a disturbed secondary forest, which have been disturbed by urbanization, bush burning, clearing and faming hence, leading to the relocation of the wildlife to a suitable niche/habitat. Few of the mammals species encountered was due to the presence of abandoned farmland and light forest brush around the forest brush. The species checklist of the encountered wildlife is presented in the table below. However, no endangered species was encountered during the study. Table 4.7 below shows some of the soil Fauna encountered in the project site.

**Table 4.7: Soil Fauna found in the Project Area**

| Arthropods | *Trinervitermes* | Termite | Primary |
|---|---|---|---|
| | *Ancistrotermes* | Termites | Consumers |
| | *Amitermes* | Termites | Decomposes |
| | *Macrotermes* | Termites | " |
| | *Odontotermes* | Termites | " |
| | *Cubitermes* | Termites | " |
| | *Collembola* | Beetle | Decomposers |
| | *Oryetes* | Dung beetle | " |
| | *Gryllotalpa* | Mole cricket | *Gryllotalpa* |
| Myriapoda | | | |
| | *Spirotreplus* | Millipedes | Primary |
| | *polydesmus* | Millipede | Primary |
| Arachnida | *Gastrocantha* | Spiders | Secondary |
| | *Pandinus* | Scorpion | Secondary |
| Annelids | *Eudrilus* | Earthworm | Decomposers |
| | *Lumbricus* | Earthworm | " |
| Molluscs | *Limicolaria* | Garden snail | Primary |
| | archachatina | Land snail | Primary |

## 4.4 Socio-Economics

This section presents the findings of the socioeconomic assessment conducted for the proposed Installation of a Compressed Natural Gas (CNG) Mother Station along the AKK Pipeline.

The socioeconomic assessment was undertaken to establish the existing social, economic, cultural, and demographic conditions of the host community and surrounding settlements that may be influenced by the proposed project. The assessment provides baseline information that will assist in evaluating potential project impacts, identifying community expectations, and developing appropriate mitigation and enhancement measures.

The study focused on understanding the characteristics of the population, sources of livelihood, income levels, educational attainment, health conditions, housing characteristics, access to infrastructure and social services, land ownership patterns, and community perceptions regarding the proposed project.

Data for the assessment were obtained through household questionnaire surveys, stakeholder consultations, key informant interviews, field observations, and review of relevant secondary information. The information generated forms an important component of the Environmental and Social Impact Assessment (ESIA) process and serves as a basis for planning sustainable community engagement and social investment programmes.

The socioeconomic survey covered Nasarawa Kofa Community and neighbouring settlements within the project area of influence. Particular attention was given to residents living closest to the proposed project site because they are more likely to experience both the positive and negative effects of the project during construction and operation phases.

### 4.4.1 Methodology

The survey was conducted through constructed questionnaires which were administered by trained personnel in order to get the desired result. The target area coverage for the survey is three (3km) kilometer radius from the centre of the site.
A total of three hundred (300) questionnaires were administered and distributed to eight areas which falls within the 3km radius of the proposed project site. The population of the area was the key determinant of the number of questionnaires distributed in the area. The names of the area covered with the total number of questionnaires administered is summarized in the table below:

**Table 4.8: Area Covered and Total Questionnaire Administered**

| S/N | Name of Area | Total No. of Questionnaire Administered |
|---|---|---|
| 1. | Kofa | 75 |
| 2. | Kabawa | 75 |
| 3. | Gwarmai | 75 |
| 4. | Rimin Nakada | 75 |
| **Total** | | **300** |

### 4.4.1.3 Data Collection

Both primary and secondary sources of data were utilized during the study.

Primary Data Collection

Primary data were collected through:

1. Household questionnaire survey.
2. Key Informant Interviews (KIIs).
3. Stakeholder consultation meetings.
4. Community leader engagements.
5. Direct field observations.
6. Discussions with women and youth groups.

The structured questionnaire covered demographic characteristics, livelihood activities, income levels, housing conditions, health status, access to infrastructure, community concerns, and perceptions regarding the proposed project.

Key informant interviews were conducted with traditional rulers, community leaders, youth representatives, women leaders, and other knowledgeable persons within the study area.

Field observations were also undertaken to verify existing conditions relating to housing, roads, drainage systems, sanitation facilities, healthcare infrastructure, educational facilities, and economic activities.

**Secondary Data Collection:** Secondary information was obtained from:

- Published literature.
- Government reports.
- National Population Commission records.
- Kano State Government publications.
- Previous environmental studies.
- Academic journals.
- Relevant online demographic and socioeconomic databases.

The secondary information assisted in understanding the broader socioeconomic context of the study area and supported validation of field findings.

### 4.4.2 Profile of the Study Area

This section provides a comprehensive description of Nasarawa Kofa Village, the host community for the proposed Compressed Natural Gas (CNG) Mother Station Project. The profile covers the location and administrative framework, traditional governance structure, and the ethnic and cultural characteristics of the community. Understanding these aspects is essential for assessing the social context within which the project will operate and for identifying potential social impacts and appropriate mitigation measures.

#### 4.4.2.1 Location and Administration

The proposed CNG Mother Station Project is located within Nasarawa Kofa Community in Bebeji Local Government Area (LGA) of Kano State, Nigeria. The project site lies within the influence zone of the Ajaokuta-Kaduna-Kano (AKK) Natural Gas Pipeline corridor and forms part of the growing industrial and commercial development axis of Kano State.

**Plate 4.5: Site Verification Exercise**

#### 4.4.2.2 Traditional Governance Structure

Traditional leadership remains an important institution within the Community. The traditional administration serves as the primary channel for community mobilisation, conflict resolution, cultural preservation, and stakeholder engagement.

The District Head serves as the highest traditional authority within the district and provides leadership on matters affecting the communities under his jurisdiction. The Village Head oversees local community affairs and works closely with elders, youth leaders, and women leaders to ensure effective administration and community development.

Community elders provide advisory functions and contribute to decision-making on issues relating to land, culture, security, and social welfare. Youth and women leaders represent their respective groups and facilitate communication between community members and traditional authorities.

The traditional institution was actively engaged during the stakeholder consultation process and played a significant role in mobilising community members for the socioeconomic survey and public consultation meetings.

### 4.4.3 Demographic Characteristics

This unit presents the demographic characteristics of respondents within the study area. Understanding the demographic profile of the host community is important for assessing existing social conditions and evaluating how different population groups may be affected by the proposed project.

The demographic variables assessed include population and household characteristics, gender distribution, age structure, religion, marital status, and household size.

#### 4.4.3.1 Age Distribution

Age is an indicator of the phase of adult life an individual might have attained. Table 4.9 shows that 11 – 20 years had 12.40%, 21 – 30 years had 20%, 31 – 40 years had 23.40%, 41 – 50 years had 24.50%, 51 – 60 years had 15.50%, while above 60 years had only 4.20%. This result shows that young or starter households (of either below 11 – 20 and 21 – 30) constitute 32.40% while the established households (households in the town 31 – 40 and 41 – 50 age categories) constitute 47.90% of the population. The ageing households (51 – 60 years and above) constitute 19.70%.

**Table 4.9: Age Structure of Households Heads**

| Age Bracket | Number | Percentage (%) |
|---|---|---|
| 11 – 20 | 37 | 12.40 |
| 21 – 30 | 60 | 20.00 |
| 31 – 40 | 70 | 23.40 |
| 41 – 50 | 73 | 24.50 |
| 51 – 60 | 47 | 15.50 |

| | | |
|---|---|---|
| Above 60 | 13 | 4.20 |
| **TOTAL** | **300** | **100** |

***Source: Fieldwork, 2026***

The results show that young or starter household heads (between the ages of 11 - 30) and established household heads (between the ages of 31 – 50) in the areas sampled were almost equal having 32.40% and 47.90% respectively. This result indicates that the areas have young population.

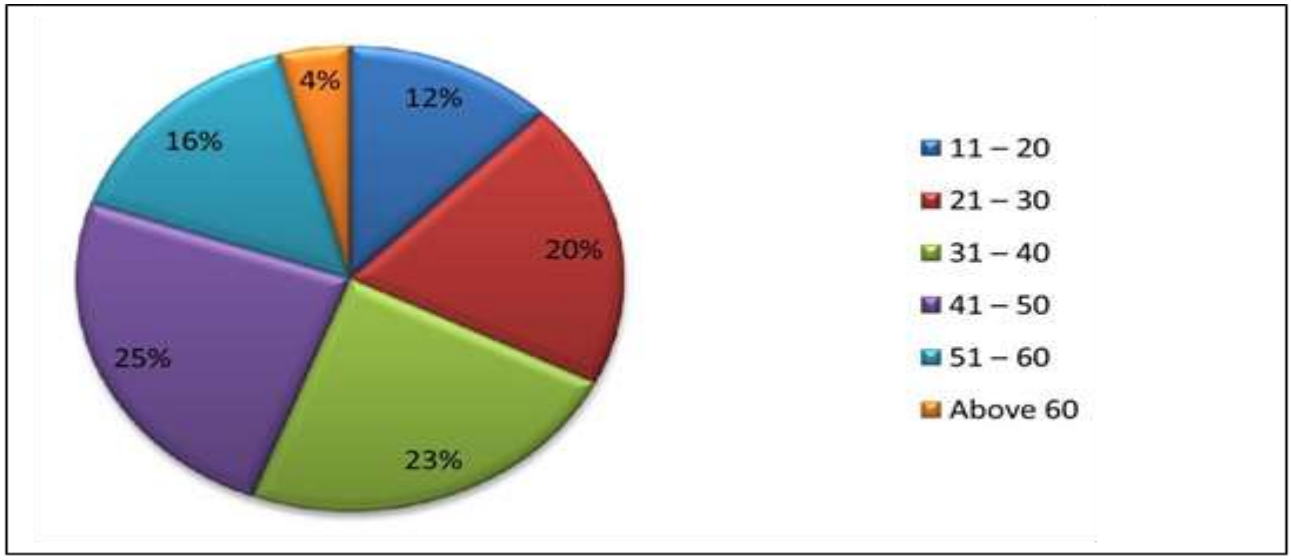


**Figure 4.9: Age Distribution of the study area**

### 4.4.3.2 Gender Distribution

Gender composition is an important indicator for understanding community structure and participation in socioeconomic activities.

Gender also indicates the roles individuals play in households, although this varies depending on the society in question. It is usually seen as clear-cut male and female. Table 4.10 shows the gender profile of heads of households. Whereas females constitute only 25%, males constitute 75%.

**Table 4.10: Gender Distribution of Respondents**

| Gender | Frequency | Percentage (%) |
|---|---|---|
| Male | 224 | 75 |
| Female | 76 | 25 |
| **TOTAL** | **300** | **100** |

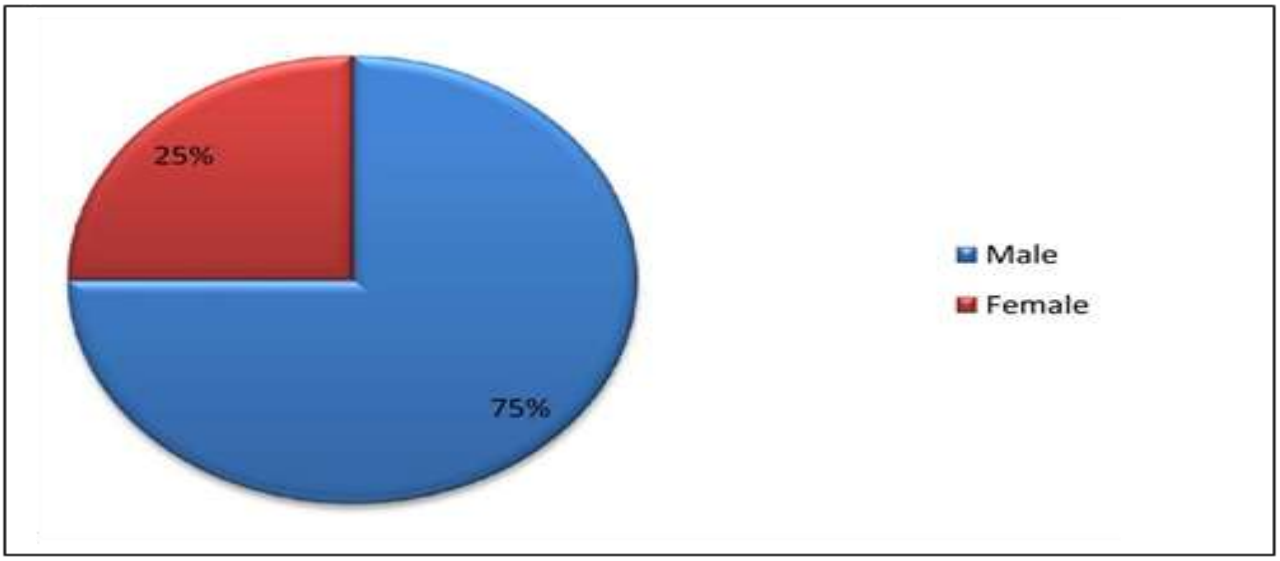


**Figure 4.10: Gender Distribution of the Study Area**

The relatively balanced gender representation suggests that both men and women actively participate in household decision-making and community affairs. The inclusion of female respondents also provided valuable insight into issues relating to family welfare, healthcare, education, and community development.

#### 4.4.3.3 Marital Status of Respondent

Majority of the total respondents (90.00%) of the households are married or have been married previously (widowed = 7%; divorced = 3%). As Table 4.11 shows only 10.00% are single.

**Table 4.11: Age Distribution of Respondents**

| Marital Status | Number | Percentage (%) |
|---|---|---|
| Married | 269 | 90.00 |
| Single | 31 | 10.00 |
| **TOTAL** | **300** | **100** |

#### 4.4.3.4 Tribal Affiliations of Respondents

The residents around the project area comprises of people from various ethnic groups as shown in table 4.12 below. This can be attributed to peaceful co-existence the communities have enjoyed over time, nevertheless, the Hausa Tribe dominates the project area with 65% of the respondents indicating that they are Hausa by tribe.

**Table 4.12: Tribe of Respondents**

| Place of Birth | Number | Percentage (%) |
|---|---|---|
| Fulani | 48 | 16 |
| Hausa | 195 | 65 |
| Kanuri | 12 | 4 |
| Yoruba | 9 | 3 |
| Igbo | 6 | 2 |
| Idoma | 3 | 1 |
| Igala | 9 | 3 |
| Ebira | 3 | 1 |
| Waja | 3 | 1 |
| Bolewa | 3 | 1 |
| Babur | 3 | 1 |
| Yungur | 3 | 1 |
| Mbachama | 3 | 1 |
| **TOTAL** | **300** | **100** |

#### 4.4.3.6 Religious Belief

The host communities around the proposed rice mill are all Muslims. The survey shows Islam to be 100% while no respondent interviewed indicated Christianity or any other form of religion.

**Table 4.13: Religious Belief of Respondents**

| Marital Status | Number | Percentage (%) |
|---|---|---|
| Islam | 300 | 100 |
| Christianity | - | - |
| Others | - | - |
| TOTAL | 300 | 100 |

### 4.4.5 Education

This section presents the economic characteristics of respondents within the study area. It provides an overview of the main sources of livelihood, household income levels, and expenditure priorities. The analysis is based on responses from 300 households within Nasarawa Kofa Community and surrounding settlements in Bebeji Local Government Area of Kano State.

Understanding the economic structure of the community is important for assessing the potential socioeconomic impacts of the proposed CNG Mother Station project, particularly in relation to employment opportunities, income generation, and local

business development.

#### 4.4.5.1 Main Occupations

The economic activities of the study area are diverse, with agriculture remaining the dominant source of livelihood. Other activities include trading, artisan work, civil service, and informal labour.

The survey results show that farming is the most common occupation, accounting for 50 percent of respondents. This is followed by trading at 25 percent, while civil servants and artisans each account for 10 percent. A small proportion of respondents (5 percent) are engaged in other forms of livelihood activities.

**Table 4.14: Main Occupations of Respondents**

| Occupation | Frequency | Percentage (%) |
|---|---|---|
| Farming | 150 | 50 |
| Trading | 75 | 25 |
| Civil Service | 30 | 10 |
| Artisan | 30 | 10 |
| Others | 15 | 5 |
| **Total** | **300** | **100** |

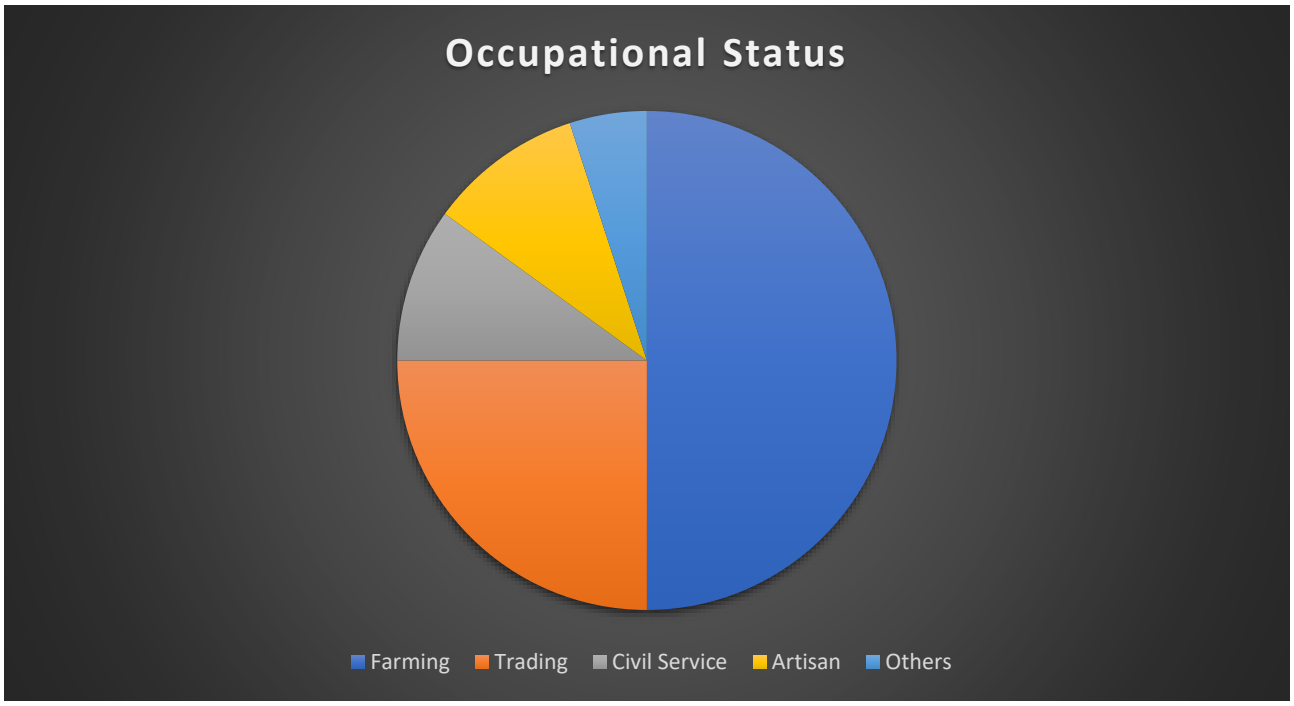


**Figure 4.10: Main Occupations of Respondents**

The findings indicate that the economy of the study area is largely informal and agriculture-based, with limited industrial and large-scale commercial activities. This highlights the importance of any development project that can create employment opportunities and stimulate local economic growth.

#### 4.4.5.2 Monthly Income Levels

Household income levels within the study area are generally low, reflecting the subsistence nature of many economic activities.

The survey shows that 45 percent of respondents earn less than ₦30,000 per month. About 30 percent earn between ₦31,000 and ₦60,000, while 15 percent earn between ₦61,000 and ₦90,000. Only a small proportion of respondents earn above ₦90,000 per month.

**Table 4.14: Monthly Household Income Levels**

| Monthly Income Range | Frequency | Percentage (%) |
|---|---|---|
| Less than ₦30,000 | 135 | 45 |
| ₦31,000 - ₦60,000 | 90 | 30 |
| ₦61,000 - ₦90,000 | 45 | 15 |
| ₦91,000 - ₦120,000 | 21 | 7 |
| Above ₦120,000 | 9 | 3 |
| **Total** | **300** | **100** |

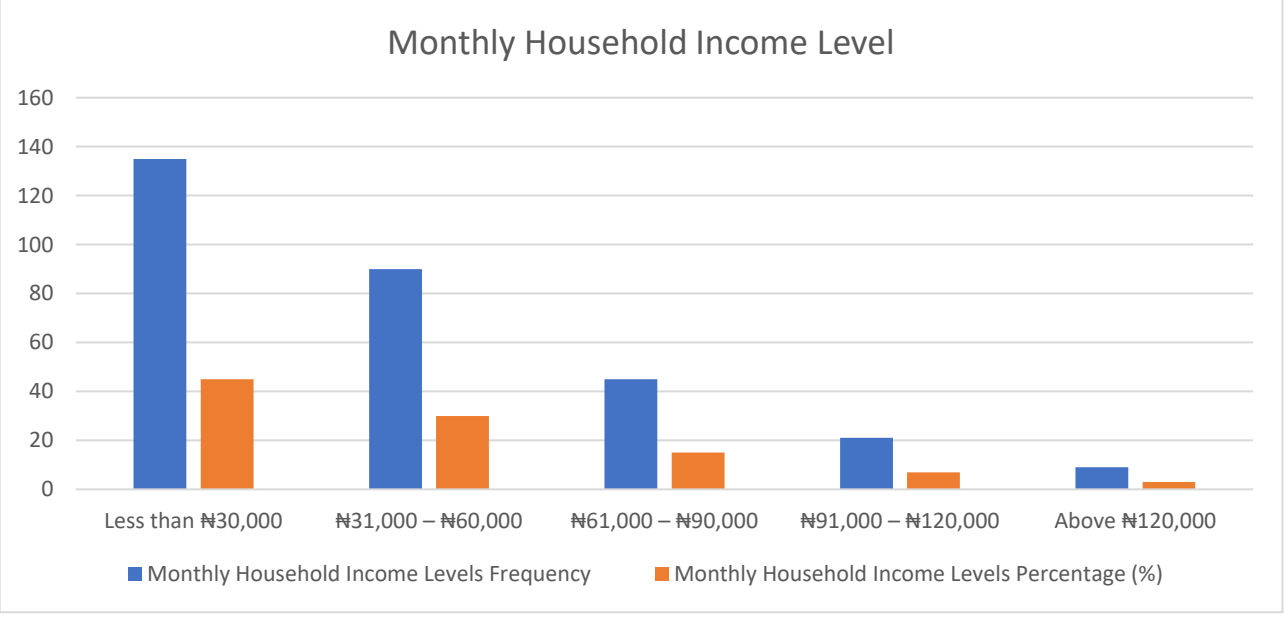


**Figure 4.11: Monthly Household Income Levels**

The income distribution indicates that a significant proportion of households fall within the low-income category. This makes employment generation a key expectation from development projects within the community. The proposed CNG Mother Station is therefore expected to contribute positively through direct and indirect job creation.

#### 4.4.5.3 Household Expenditure Priorities

Household expenditure patterns provide insight into the basic needs and economic pressures faced by residents. The survey results show that food constitutes the highest household expenditure priority, accounting for 55 percent of respondents. This is followed by education and healthcare, each at 15 percent. Transport accounts for 10 percent, while housing accounts for 5 percent.

**Table 4.15: Major Household Expenditure Priorities**

| Expenditure Item | Frequency | Percentage (%) |
|---|---|---|
| Food | 165 | 55 |
| Education | 45 | 15 |
| Healthcare | 45 | 15 |
| Transport | 30 | 10 |
| Housing | 15 | 5 |
| **Total** | **300** | **100** |

The dominance of food expenditure reflects the subsistence level of most households and indicates limited disposable income. The relatively high allocation to education and healthcare also suggests that households place importance on human capital development and well-being despite economic constraints.

### 4.4.6 Education and Health

Education and healthcare are important indicators of the social well-being and development status of any community. This section presents the educational profile of respondents, the availability of healthcare services, common health challenges, and healthcare utilization patterns within the study area.

Information obtained from the household survey, stakeholder consultations, and field observations was used to assess the existing conditions relating to education and health in Afaka Community and surrounding settlements.

#### 4.4.6.1 Educational Institutions and Literacy Levels

Education plays a vital role in improving the quality of life and enhancing socioeconomic development.

The educational attainment of respondents provides an indication of literacy levels within the community. The survey findings reveal that the majority of respondents possess at least a basic level of formal education.

**Table 4.16: Educational Attainment of Respondents**

| Educational Level | Frequency | Percentage (%) |
|---|---|---|
| No Formal Education | 45 | 15 |
| Primary Education | 75 | 25 |
| Secondary Education | 120 | 40 |
| Tertiary Education | 60 | 20 |
| **Total** | **300** | **100** |

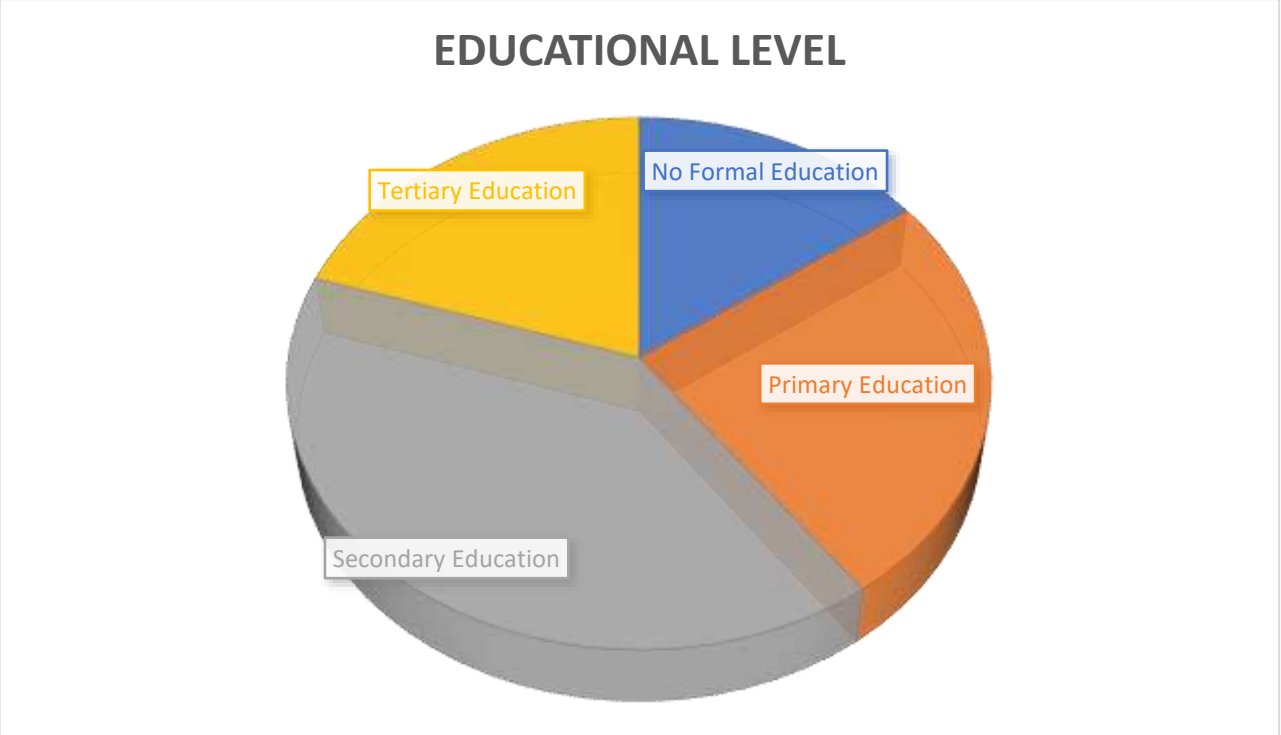


**Figure 4.13: Educational Attainment of Respondents**

The results show that secondary education represents the highest educational attainment among respondents, accounting for 40 percent of the sample. Respondents with primary education account for 25 percent, while those with tertiary education constitute 20 percent. Approximately 15 percent of respondents reported having no formal education.

The findings suggest a moderate literacy level within the study area, which is expected to facilitate effective communication, stakeholder engagement, and participation in project-related activities. However, the presence of residents without formal education highlights the need for community sensitization programmes to be conducted in simple and locally understood languages.

#### 4.4.6.2 Healthcare Facilities and Common Diseases

Access to quality healthcare services is essential for maintaining the health and productivity of community members. The study area is served by a combination of Primary Healthcare Centres (PHCs), private clinics, hospitals, pharmacies, and patent medicine stores.

The survey results indicate that 50 percent of respondents rely primarily on clinics and primary healthcare centres for medical services, while 40 percent access hospitals. However, 10 percent of respondents reported that the nearest healthcare facility is located more than five kilometres from their residence.

**Table 4.16: Nearest Healthcare Facility Accessed by Respondents**

| Healthcare Facility | Frequency | Percentage (%) |
|---|---|---|
| Clinic/Primary Healthcare Centre | 150 | 50 |
| Hospital | 120 | 40 |
| None Within 5 km | 30 | 10 |
| **Total** | **300** | **100** |

Although healthcare facilities are available within the study area, access remains a challenge for some residents, particularly those living farther from established medical centres. The survey also assessed the most common illnesses affecting households within the community.

**Table 4.17: Common Sicknesses in Households**

| Sickness | Frequency | Percentage |
|---|---|---|
| Malaria | 180 | 60 |
| Cough/Respiratory Illnesses | 75 | 25 |
| Diarrhoea | 45 | 15 |
| **Total** | **300** | **100** |

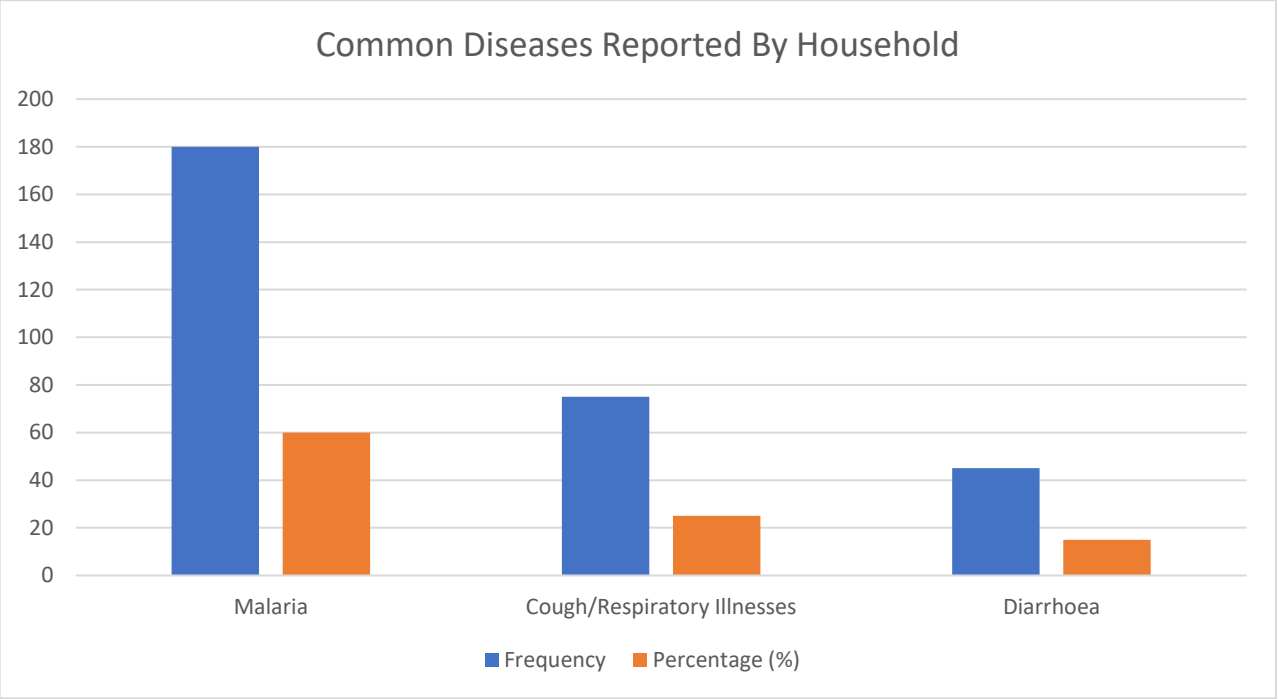


**Figure 4.14: Common Diseases Reported by Households**

Malaria was identified as the most prevalent illness, affecting 60 percent of households. Respiratory illnesses accounted for 25 percent, while diarrhoeal diseases accounted for 15 percent.

The high prevalence of malaria is consistent with the environmental conditions commonly found in many parts of northern Nigeria, where stagnant water, inadequate drainage, and seasonal rainfall contribute to mosquito breeding. Respiratory illnesses may be associated with dust, household air pollution, and seasonal weather conditions.

### 4.4.6.3 Frequency of Hospital Visits

The frequency of hospital visits serves as an indicator of healthcare utilization and the overall health status of the population.

During stakeholder consultations and household interviews, respondents indicated that healthcare facilities are generally visited when family members experience illnesses such as malaria, respiratory infections, fever, diarrhoea, and other common health conditions. Routine medical check-ups were reported to be less common, particularly among low-income households due to financial constraints. Based on field consultations, most households reported visiting healthcare facilities between one and three times within a six-month period, depending on the health condition

of family members and availability of financial resources. Households with children and elderly persons reported more frequent visits due to their greater healthcare needs.

The relatively high incidence of malaria and respiratory illnesses contributes significantly to healthcare utilization within the study area. Consequently, maintaining good environmental sanitation, improving drainage systems, promoting health awareness, and ensuring access to quality healthcare services remain important priorities for community development.

Healthcare services are provided through clinics, primary healthcare centres, and hospitals. However, access remains limited for some residents due to distance and economic constraints. Malaria remains the most common disease affecting households, followed by respiratory illnesses and diarrhoeal diseases.

Overall, the findings indicate the need for continued investment in educational development, healthcare services, disease prevention programmes, and community health awareness initiatives. The proposed project presents an opportunity for corporate social responsibility interventions that can support improvements in education, healthcare infrastructure, and public health within the host community.

### 4.4.7 Housing and Infrastructure

Housing conditions and access to infrastructure are important indicators of the standard of living within a community. The availability and quality of housing, water supply, sanitation facilities, transportation systems, electricity, and other public infrastructure influence the health, safety, and socioeconomic well-being of residents.

This section presents the findings of the socioeconomic survey relating to housing characteristics and infrastructure within Nasarawa Kofa Community and surrounding settlements in the project area of influence.

#### 4.4.7.1 Housing Types and Materials

The survey assessed the predominant housing construction materials used by residents. The type of housing material provides an indication of household economic status and the level of physical development within a community.

The findings indicate that cement block houses are the dominant housing type within the study area, accounting for 70 percent of respondents. Mud houses account for 30 percent of the housing stock.

**Table 4.17: Housing Types and Wall Materials**

| House Wall Material | Frequency | Percentage (%) |
|---|---|---|
| Mud | 90 | 30 |
| Cement Block | 210 | 70 |
| **Total** | **300** | **100** |

The high proportion of cement block structures suggests gradual urbanization and improvements in housing quality within the study area. However, the presence of mud houses indicates that some households remain economically disadvantaged and may require additional support to improve their living conditions.

Field observations revealed that most residential buildings are constructed using conventional materials such as cement blocks, corrugated roofing sheets, concrete floors, and metal doors. Both owner-occupied and rented residential properties were observed within the community.

#### 4.4.7.2 Land Tenure

Land ownership and tenure arrangements play an important role in determining access to land resources, housing development, agricultural activities, and community stability.

The survey results indicate that 70 percent of respondents own the land they occupy, while 25 percent reported that their land belongs to family or community ownership systems. Only 5 percent indicated that the land is owned by government institutions or private organizations.

**Table 4.18: Land Ownership Pattern**

| Land Ownership Category | Frequency | Percentage (%) |
|---|---|---|
| Government/Company | 15 | 5 |
| Family/Community | 75 | 25 |
| Self-Owned | 210 | 70 |
| **Total** | **300** | **100** |

The predominance of self-owned land suggests a relatively stable settlement pattern and strong attachment of residents to their community. It also indicates that land acquisition issues associated with the proposed project are likely to be minimal provided project activities remain within designated project boundaries.

#### 4.4.7.3 Water Supply

Access to safe and reliable water is essential for domestic use, sanitation, public health, and economic activities.

The survey findings show that boreholes constitute the primary source of water supply for most households, accounting for 60 percent of respondents. Wells serve as the main source of water for 35 percent of respondents, while 5 percent depend on rainwater harvesting and surface water sources.

**Table 4.19: Main Sources of Water Supply**

| Water Source | Frequency | Percentage (%) |
|---|---|---|
| Borehole | 180 | 60 |
| Well | 105 | 35 |
| River/Rainwater | 15 | 5 |
| **Total** | **300** | **100** |

The dominance of borehole usage indicates relatively good access to groundwater resources within the study area. However, households relying on wells and surface water may face challenges relating to water quality, seasonal availability, and public health risks.

Field observations revealed that some households purchase water from commercial vendors during periods of water scarcity.

#### 4.4.7.4 Electricity Access

Electricity is a critical infrastructure requirement for residential, commercial, educational, and healthcare activities.

The study area is connected to the national electricity grid and receives power supply through the public distribution network. However, stakeholders reported that electricity supply is often characterized by interruptions and fluctuations, similar to many communities within Kaduna State.

To supplement public electricity supply, some households and businesses utilize petrol-powered generators, rechargeable power systems, and solar energy installations.

Although electricity access is generally available within the community, stakeholders identified improved power supply as an important requirement for economic growth, small-scale businesses, and household welfare.

#### 4.4.7.5 Transportation

Transportation infrastructure facilitates movement of people, goods, and services and contributes significantly to socioeconomic development.

The survey results indicate that motorcycles are the most common means of transportation within the study area, accounting for 65 percent of respondents. Cars and buses account for 25 percent, while 10 percent of respondents rely primarily on walking.

**Table 4.20: Main Means of Transportation**

| Means of Transportation | Frequency | Percentage (%) |
|---|---|---|
| Motorcycle | 195 | 65 |
| Car/Bus/Tricycle | 75 | 25 |
| Walking | 30 | 10 |
| **Total** | **300** | **100** |

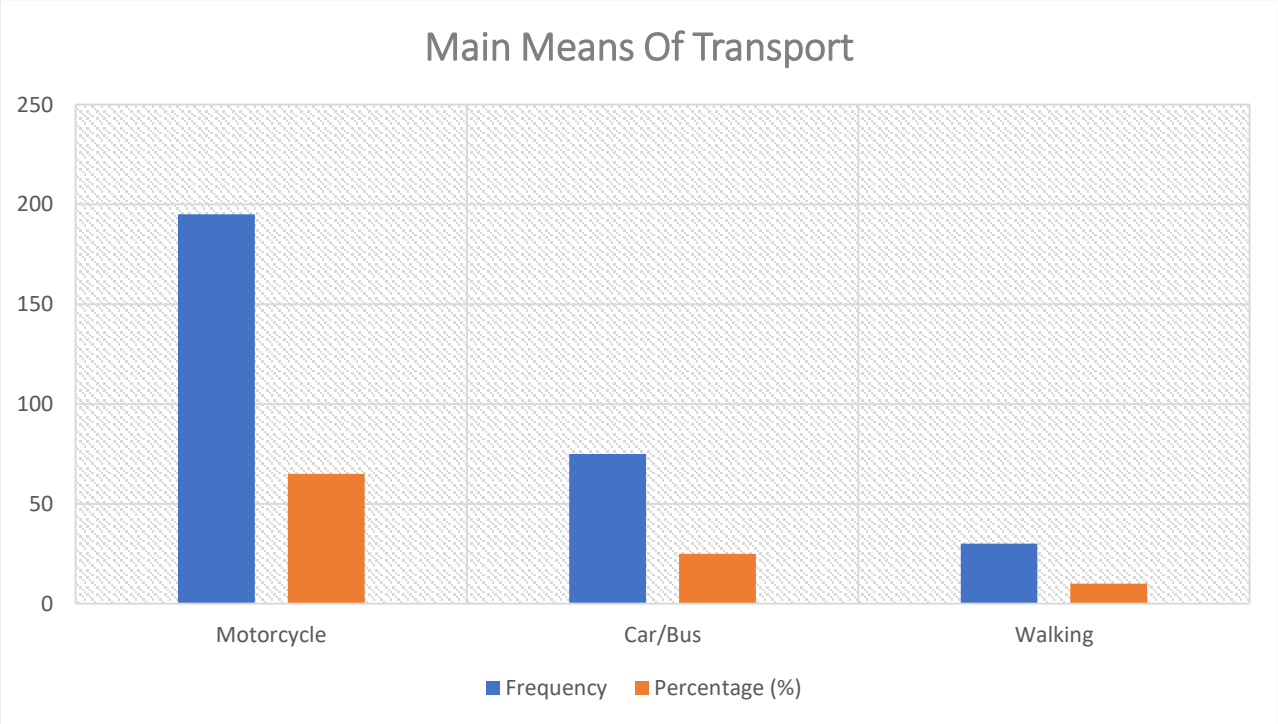


Figure **4.15: Main Means of Transportation**

Motorcycles remain the preferred mode of transportation because of their affordability, flexibility, and ability to navigate both paved and unpaved roads.

#### 4.4.7.6 Sanitation and Waste Management

Proper sanitation and waste management are essential for maintaining environmental quality and protecting public health.

The survey assessed toilet facilities and methods of solid waste disposal within the study area.

**Table 4.21: Household Toilet facilities**

| Toilet Type | Frequency | Percentage (%) |
|---|---|---|
| Flush Toilet | 90 | 30 |
| Pit Latrine | 165 | 55 |
| No Toilet/Open Defecation | 45 | 15 |
| **Total** | **300** | **100** |

The results indicate that pit latrines are the most commonly used sanitation facilities, accounting for 55 percent of respondents. Flush toilets account for 30 percent, while 15 percent of respondents reported having no toilet facility and relying on open defecation practices.

The continued existence of open defecation presents potential environmental and public health concerns that require attention through improved sanitation programmes and community awareness initiatives.

The survey also assessed methods of solid waste disposal.

**Table 4.22: Types of Toilet Facilities**

| Toilet Type | Frequency | Percentage (%) |
|---|---|---|
| Open Dumping/Burning | 180 | 60 |
| Collected by Waste Handlers | 120 | 40 |
| **Total** | **300** | **100** |

The findings reveal that open dumping and open burning remain the predominant waste disposal methods within the study area, accounting for 60 percent of respondents. Approximately 40 percent of households utilize formal waste collection services.

Improper waste disposal practices may contribute to environmental pollution, drainage blockage, unpleasant odours, and increased disease risks. There is therefore a need for improved waste management systems and increased environmental awareness within the community.

On the Summary of Housing and infrastructure condition. The study area is characterized by a mixture of modern and traditional housing structures, with cement block buildings constituting the dominant housing type. Most residents occupy self-owned properties, indicating a stable settlement pattern.

Boreholes are the principal source of domestic water supply, while electricity is available through the national grid despite periodic interruptions. Motorcycles represent the most widely used means of transportation due to their affordability and accessibility.

Sanitation and waste management remain areas requiring improvement, particularly with respect to open dumping, waste burning, and the persistence of open defecation among a segment of the population.

### 4.4.8 Stakeholder Engagement and Perception

Stakeholder engagement is a fundamental requirement of the Environmental and Social Impact Assessment (ESIA) process. It provides an opportunity for affected communities and interested parties to understand the proposed project, express their views, identify concerns, and communicate their expectations to the project proponents.

As part of the socioeconomic assessment, consultations were conducted with community leaders, women groups, youth representatives, residents, business operators, farmers, and other stakeholders within the project area of influence. Information obtained during these engagements was used to assess community perceptions, expectations, concerns, and the level of support for the proposed CNG Mother Station Project.

#### 4.4.8.1 Stakeholders Identified

The stakeholder identification process focused on individuals, groups, and institutions that may be directly or indirectly affected by the proposed project or have an interest in its implementation.

The major stakeholders identified during the study are presented below.

**Table 4.23: Stakeholders Identified During Consultation**

| S/N | Stakeholder Category | Interest in the Project |
|---|---|---|
| 1 | District Head and Traditional Council | Community leadership and representation |
| 2 | Village Head and Community Elders | Community welfare and development |
| 3 | Youth Leaders and Youth Groups | Employment and economic opportunities |
| 4 | Women Leaders and Women's Associations | Family welfare and social development |
| 5 | Farmers | Land use and livelihood protection |
| 6 | Traders and Business Owners | Business opportunities and local patronage |
| 7 | Artisans and Skilled Workers | Employment and contract opportunities |
| 8 | Community Residents | Social and environmental impacts |
| 9 | Local Government Representatives | Regulatory and developmental interests |
| 10 | Project Proponent | Project implementation and sustainability |

The identified stakeholders were considered important because of their influence, interest, or potential exposure to project impacts.

**Plate 4.6: Engagement with community Head**

The project proponent, Greenville LNG, is a key stakeholder, as it is responsible for project implementation and for ensuring that the project meets environmental and

social standards. Environmental consultants are also stakeholders, providing technical expertise to support the ESIA process.

The consultation process ensured that all relevant stakeholder groups were adequately represented during discussions relating to the proposed project.

#### 4.4.8.2 Community Consultation Process

Community consultations were conducted as part of the ESIA field exercise to provide information about the proposed project and obtain feedback from stakeholders.

The consultations involved meetings with traditional leaders, youth representatives, women leaders, community members, and other interested stakeholders. Discussions focused on project awareness, anticipated benefits, concerns, environmental and social issues, and community expectations.

**Table 4.24: Summary of Community Consultation Process**

| Item | Description |
|---|---|
| Project | Proposed CNG Mother Station along AKK Pipeline |
| Host Community | Nasarawa Kofa |
| Local Government Area | Bebeji LGA, Kano State |
| Consultation Period | June 2026 |
| Participants | Traditional leaders, youths, women, farmers, traders, artisans, residents and project stakeholders |
| Method | Community meetings, interviews, focus discussions and questionnaire survey |
| Total Questionnaire Respondents | 300 |
| **Item** | **Description** |

Stakeholders generally welcomed the consultation process and expressed appreciation for being informed and involved in discussions concerning the proposed project. The results indicate a strong level of support for the project. Fifty percent of respondents stated that they support the project provided certain conditions are met, while 40 percent expressed full support. Only 10 percent indicated that they do not support the project.

#### 4.4.8.3 Community Support Level

The household survey conducted as part of this socioeconomic assessment provides quantitative data on community support for the proposed project. The survey found that 30 per cent of respondents fully support the project, 65 per cent support the project with conditions, and 5 per cent do not support the project.

**Table 4.25: Community Support for the Proposed Project**

| Level of Support | Frequency | Percentage (%) |
|---|---|---|
| Yes, Fully Support | 120 | 40 |
| Yes, With Conditions | 150 | 50 |
| No | 30 | 10 |
| **Total** | **300** | **100** |

The findings show that 90 percent of respondents support the project either fully or conditionally. This indicates a generally positive perception of the proposed development within the host community.

### 4.7.4 Perceived Benefits

Respondents were asked to identify the benefit they consider most important from the proposed project.

The survey results indicate that employment creation is the most anticipated benefit, accounting for 60 percent of responses. Business opportunities account for 20 percent, while improved roads and other community development initiatives account for 15 percent. Cleaner and more affordable energy was identified by 5 percent of respondents.

**Table 4.26: Expected Benefits of the Proposed Project**

| Expected Benefit | Frequency | Percentage (%) |
|---|---|---|
| Employment Opportunities | 180 | 60 |
| Business Opportunities | 60 | 20 |
| Better Roads and CSR Projects | 45 | 15 |
| Cleaner and Cheaper Energy | 15 | 5 |
| **Total** | **300** | **100** |

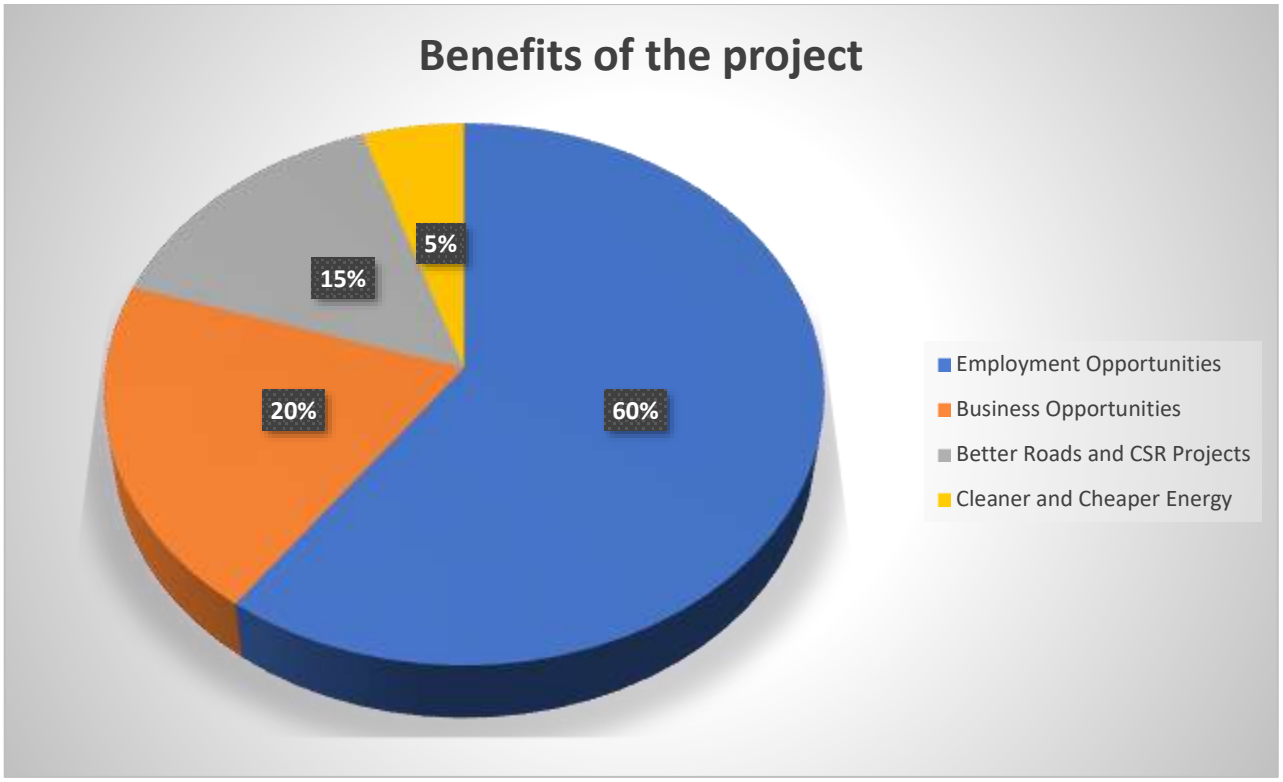


**Figure 4.12: Perceived Benefit of the Project**

The findings demonstrate that employment generation remains the highest priority among residents. Many stakeholders expressed the view that the project should contribute to reducing youth unemployment and improving household income within the community.

Stakeholders also anticipated indirect benefits such as increased commercial activities, skills development, improved infrastructure, and enhanced local economic growth.

#### 4.4.8.5 Concerns and Fears

Although support for the project is high, stakeholders also expressed concerns regarding potential environmental and social impacts.

The survey results show that concerns about pollution and health impacts constitute the highest fear among respondents, accounting for 45 percent. Concerns regarding accidents account for 30 percent, while 15 percent expressed fears about possible increases in the cost of living. Ten percent of respondents reported having no significant concerns.

**Table 4.27: Community Concerns Regarding the Proposed Project**

| Concern | Frequency | Percentage (%) |
|---|---|---|
| Pollution and Health Effects | 135 | 45 |
| Accidents and Safety Risks | 90 | 30 |
| Increase in Cost of Living | 45 | 15 |
| No Major Concern | 30 | 10 |
| **Total** | **300** | **100** |

Stakeholders emphasized the need for strict adherence to environmental, health, and safety standards during project implementation. Community members requested regular environmental monitoring, emergency preparedness measures, and effective communication throughout the project lifecycle.

#### 4.4.8.6 Community Demands and Expectations

Stakeholders were asked to identify the most important action they expect from the project proponent.

The survey findings reveal that local employment is the most significant expectation, accounting for 55 percent of responses. Construction of schools, healthcare facilities, and other community development projects account for 25 percent. Formal community agreements account for 15 percent, while monthly stipends account for 5 percent.

**Table 4.28: Community Expectations from the Project**

| Community Expectation | Frequency | Percentage (%) |
|---|---|---|
| Employment for Local Residents | 165 | 55 |
| Construction of Schools/Clinics | 75 | 25 |
| Formal Memorandum of Understanding (MoU) | 45 | 15 |
| Monthly Stipends | 15 | 5 |
| **Total** | **300** | **100** |

The survey also assessed stakeholder views regarding local contractor participation.

**Table 4.29: Preference for Local Contractor Participation**

| Response | Frequency | Percentage (%) |
|---|---|---|
| Yes | 120 | 40 |
| Only if Qualified | 150 | 50 |
| No | 30 | 10 |
| **Total** | **300** | **100** |
| Yes | 120 | 40 |

The results indicate that 90 percent of respondents support the involvement of local contractors either directly or based on competence and qualification.

Furthermore, respondents were asked to identify the most pressing challenge facing the community.

**Table 4.30: Summary of Stakeholder Engagement and Perception Findings**

| Community Challenge | Frequency | Percentage (%) |
|---|---|---|
| Youth Unemployment | 120 | 40 |
| Poor Road Infrastructure | 60 | 20 |
| Inadequate Water Supply | 45 | 15 |
| Lack of Industries and Businesses | 30 | 10 |
| Inadequate Healthcare Facilities | 24 | 8 |
| Other Issues (Security, Electricity, etc.) | 21 | 7 |
| **Total** | **300** | **100** |

The findings indicate that unemployment remains the most pressing challenge confronting the community. Other concerns include poor road infrastructure, inadequate water supply, limited industrial development, and insufficient healthcare facilities.

**Summary of Stakeholder Engagement and Community Perception**

Stakeholder engagement activities revealed a high level of awareness and acceptance of the proposed CNG Mother Station Project. Most respondents expressed support for the project because of the anticipated employment opportunities, business growth, and community development benefits.

Despite the positive perception, stakeholders emphasized the need for environmental protection, occupational and community safety, local employment opportunities, and meaningful corporate social responsibility initiatives.

The key expectations expressed by stakeholders include prioritization of local labour, engagement of qualified local contractors, support for education and healthcare infrastructure, implementation of community development programmes, and establishment of effective communication channels between the project proponent and host communities.

Overall, the consultations indicate that the project enjoys strong social acceptance and has the potential to contribute positively to socioeconomic development within Nasarawa Kofa Community, provided stakeholder concerns are adequately addressed throughout project implementation.

# 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 Nasarawa Kofa, Bebeji Local Government Area, Kano State 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;<br>• 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;<br>• Maintenance of engines and exhaust gas check;<br>• Adoption of engine off policy at construction site.<br>• 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;<br>• When not in use, schedule activities to daytime only;<br>• Use of noise muffs | Low |
| | Mobilization of workforce | Population in the vicinity of activity | Social and cultural interaction issues;<br>Health and security issues;<br>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.<br>• 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;<br>• 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.<br>• 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.<br>• 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;<br>• 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;<br>• Regular visual monitoring to identify equipment producing excessive visible emissions.<br>• Equipment observed to be creating excessive air quality emissions will be replaced or serviced within 48 hours.<br>• 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;<br>• Adoption of engine off policy at construction site;<br>• Schedule activities during daytime | Low |
| | | Soil quality | Disruption of the topography of the soil | 9 | • Best available technology shall be used;<br>• 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).<br>• All plant / equipment operators will be appropriately trained and certified<br>• 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.<br>• 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.<br>• 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.<br>• 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.<br>• 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;<br>• 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<br>- Limit clearing and earthworks<br>- Vegetation will be replanted as part of the landscaping works<br>- 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;<br>- Provide signage; train drivers;<br>- 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;<br>- Maintain spill kits;<br>- Train personnel;<br>- Implement spill response procedures | Low |
| | Equipment installation and commissioning | Workers | Occupational injuries and accidents (-) | 9 | - Enforce HSE procedures;<br>- Provide PPE;<br>- Conduct toolbox talks and<br>- 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;<br>- Continual drills in emergency procedures;<br>- 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;<br>- 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);<br>- Install gas monitoring systems; maintain compressors | Low |
| | Compressor operations | Nearby neighbours/ communities | Noise from compressors and associated equipment (-) | 9 | - Install acoustic enclosures;<br>- maintain equipment;<br>- 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<br>- 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;<br>- Gas detection systems; fire protection systems;<br>- Comply with applicable design codes;<br>- 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;<br>- use pressure relief devices;<br>- conduct competency training;<br>- implement permit-to-work system | Medium |
| | Transportation of CNG trailers | Communities, road users | Traffic accidents and gas release incidents (-) | 12 | - Use certified transport vehicles;<br>- implement journey management plans;<br>- Train drivers; perform vehicle inspections | Medium |
| **Operations** | Trailer unloading (Daughter Station) | Workers | Gas leakage during unloading operations (-) | 12 | - Use standardized unloading procedures;<br>- Install emergency isolation valves;<br>- Conduct operator training | Medium |
| | Routine maintenance activities | Workers | Exposure to operational and maintenance hazards (-) | 9 | - Implement lockout/tagout procedures;<br>- Provide PPE;<br>- Conduct regular safety audits | Low |
| | Routine operations and maintenance | Workforce | Long-term employment opportunities (+) | 9 | - Maintain fair employment<br>- Practices and workforce development programs | Medium (Positive) |
| | Emergency situations (fire/explosio n) | Workers, communities, infrastructure | Injury, fatality, and property damage () | 11 | - Emergency response plan;<br>- Firefighting systems;<br>- Emergency drills;<br>- Mutual aid agreements;<br>- 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<br>- Engine to comply with international standards for exhaust gases;<br>- Maintenance of engines and use of gas filters on exhaust to minimize emission;<br>- Adoption of engine off policy at docking premises.<br>- Regular inspection, servicing and maintenance of plant / equipment will be scheduled and carried out to ensure good performance and reduced emissions.<br>- Equipment will be subject to periodic performance reviews - the scope of which includes environmental performance indicators<br>- 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;<br>- 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.<br>- Provide consistent, clear direction on waste and resource handling, storage, stockpiling, use and re-use management measures.<br>- Waste collection and storage areas shall be established and maintained.<br>- Waste will be segregated at source, stored and transported to disposal sites by appropriate third-party contactor.<br>- 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<br>- Operations will be conducted such that noise generation will be managed within regulatory requirements<br>- 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.<br>- 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<br>- Job hazard identification and analysis is conducted<br>- Perform regular workplace inspections. Hazards identified must be addressed immediately, or as soon as reasonably possible.<br>- Risk assess activities involving hazardous substances<br>- Safety signage is provided at strategic locations.<br>- Toolbox talks shall be held before any site work commences<br>- 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.<br>- Cooperative and open working relations shall be established early with local communities and maintained throughout the life of the project;<br>- Show commitments with respect to local and national content of workforce and<br>- 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.<br>- Induction for workers on health risks of illicit sex and communicable diseases.<br>- Workers will be informed that prostitution is illegal and information on the health risks of prostitution will also be provided;<br>- 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.<br>- This will minimize pollutant gases concentration at level close to workers.<br>- This also enhances wind dispersion effect on the pollutant gases;<br>- 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;<br>- Ensure the implementation of emergency response plan for the location;<br>- Firefighting material should be available on location at all times;<br>- Material safety data sheets (MSDS) should be available for all chemicals and hazardous substances to be used on location;<br>- Staff handling hazardous substances/materials must be aware of their potential impact and take appropriate safety measures;<br>- 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;<br>- 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<br>- 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;<br>- activation of emergency procedures;<br>- 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;<br>- 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;<br>- Provide notice and retraining opportunities | Low |
| | Equipment dismantling and demolition | Workers | Occupational health and safety risks (-) | 9 | - Prepare decommissioning HSE plan;<br>- use trained contractors;<br>- enforce PPE requirements | Low |
| | Demolition activities | Nearby communities | Dust, noise and vibration generation (-) | 9 | - Water suppression; noise control measures;<br>- Controlled demolition practices | Low |
| | Removal of pipelines and storage vessels | Soil and groundwater | Residual contamination from hydrocarbons or chemicals (-) | 9 | - Conduct contamination assessment;<br>- Remove contaminated soils;<br>- 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;<br>- revegetate with native species;<br>- 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.<br>- Operators of equipment will be mandated to wear PPE (earplugs, noise mask, coverall etc,<br>- 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.<br>- Regular consultation will be made with stakeholders (Govt., Community, NGOs, CBOs etc.) to understand community perceptions, issues and concerns.<br>- Effective liaison/ communication channels with communities (via Community interface coordinators/ community relations officers [CIC/CROs]) will be maintained.<br>- 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.<br>- 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 Nasarawa Kofa Community, Bebeji Local Government Area, Kano State.

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 KASEPPA 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.<br>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<br>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.<br>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.

# REFERENCES

Allen, J. R. L (1965) Late Quaternary Niger Delta and Adjacent Areas: Sedimentary Environments and Lithofacies

APHA, AWWA and APCF (1980) *Standard Methods for the Examination of Water and Waste Water*. New York

Australia Department of the Environment and Heritage (2001). CSIRO Publishing. 106p

Asseez, O. L. (1989). Review of the Stratigraphy, Sedimentation and Structure of the Niger Delta *In* Geology of Nigeria 2nd. Ed. Kogbe, C. A. Rock View Nigeria Limited: Jos, Nigeria 311-324pp

Canter L. W. (1996): Environmental Impact Assessment. Second Edition. New York, USA McGraw Hill

Cedar Lake Ventures Incorporated (2018) Average Weather in Warri. Available from <https://weatherspark.com/y/52948/Average-Weather-In-Warri-Nigeria-Year/Rand&hl=en-NG&tg=129&tk=12131094950315978 7>

Contran, E and Rubin, N. N (1969) Annual Survey of African Law (1969) pp34.

Department of Petroleum Resources; Environmental Guidelines and Standards for the Petroleum Industry in Nigeria; 2002 (EGASPIN)

Doust, H., and Omatsola, E., (1990). Niger Delta *in* Edwards, J. D., and Santogrossi, P.A., eds., Divergent/passive Margin Basins, AAPG Memoir 48: Tulsa, American Association of Petroleum Geologists, pp. 239-248.

Ekwueme, B. N., Nyong, E. E., Petters, S. W. (1995) Geological Excursion Guidebook to Oban Massif, Calabar Flank and Mamfe Embayment, Southeastern Nigeria. 1st Ed, Dechord Press, Calabar, ISBN -10:9783235427.

European Commission (2001): Impact Assessment of European Commission Policies: Achievement and Prospectus

Evergreen Fountain Energy Limited (2017) Preliminary Impact Assessment Report of the Proposed Tank farm Development in Calabar, Delta State.

FEPA (1991). Guidelines and standards for Environmental Pollution Control in Nigeria

GreenFacts (2005) Scientific facts on Air Pollution: Ozone. Available from < http://www.greenfacts.org/en/ozone-o3/index.htm> assessed 28th July 2011. Updated 24th July, 2011.

Golterman H.L, Clymo R. S. and Ohnstad, M.A.M. (1978) Methods for Physical and Chemical Analysis of Freshwater. IBP Handbook No. 8. Blackwell Scientific Publications. Oxford

Government of Delta State (2013) Environmental Impact Assessment of Calabar Energy City Project. Final Report. August 2013.

Government of Delta State (2016) Environmental Impact Assessment of Calabar – Ikom – Katsina Ala Superhighway Project. Draft Report. March 2016.

Hackett, R (1989) *Religion in Calabar. The Religious Life and History of a Nigerian Town*. Mouton de Gruyter

Hem, J.D. (1985) Study and Interpretation of the Chemical Characteristics of Natural Water. *U.S. Geological Survey Water Supply Paper* 2254.

Leopold, Clarke, L.B., Henshaw, B.B. and Balsley, J.R. (1971): A procedure for evaluating Environmental Impacts. *Geological Survey Circular* 645. Government Printing Office, Washington D.C. p13

Lohani, B. N., Evans, J.W. Evereti, R.R. Ludwig, Carpenter, R. A. and Tu, S.L. (1997): Environmental Impact Assessment for Developing Countries in Asia. Manila, Asian Development Bank.

NiMET (2016) Nigerian Meteorological Agency Report.

NPC (1991) Population Census of the Federal Republic of Nigeria

NPDC 2017) Environmental Evaluation Report of Oredo-8 Well Waste Pit at Oredo Flowstation, Edo State.

Nyong E.E and Ramanthan, R.M. (1985). A record of oxygen deficient paleoenvironments in the Cretaceous of the Calabar Flank, SE Nigeria. Journal of African Earth Sciences, 3(4), pp 445-460.

Olaniyan, C.I.O. (1975). *An introduction to West African Ecology*. Heinemann Education Books Ltd., London. 170pp.

Olaniyan C. I. O. (1978). *An Introduction to West African Animal Ecology*. (Second Edition) Heinemann Educational Books Ltd. Ibadan 170p.

Scott-Samuel A, Birley M, and Andern K (1998): The Merseyside Guidelines for Health Impact Assessment. Liverpool. Merseyside Health Impact Assessment Steering Group.

SEPLAT (2014) Environmental Impact assessment of Exploration Drilling in Ogegere Field.

SIEP; 1985 Environmental Assessment, EP 95 – 070; HSE Manual Vol. 3 Hazards and Effects Management Tools and Techniques.

Short, K. C. & Stauble, A. J. (1967) Outline of Geology of Niger Delta. *Am. Assoc. Petroleum Geologists Bull.* Vol 51, 761-779pp

Strady, E, Dang, V.B.H. Némery, J, Guédron, S, Dinh, Q.T. and Guyen P.D (2017) Baseline seasonal investigation of nutrients and trace metals in surface waters and sediments along the Saigon River basin impacted by the megacity of Ho Chi Minh (Vietnam). *Environmental Science and Pollution Research* 24 *(4)*, pp. 3226-3243, 10.1007/s11356-016-7660-7

UNEP, (1996): Environmental Impact Assessment Training Resource Manual. Case Studies from Developing Countries United Nations Environmental Programme (UNEP).

USEPA, (1989); United States Environmental Protection Agency

Wathern (1998): Environmental Impact Assessment. Theory and Practice. London. Rouledge