ENVIRONMENTAL IMPACT ASSESSMENT (EIA) DRAFT REPORT

FOR THE

PROPOSED 100MMSCF/D CNG PLANT AND 40MW POWER PLANT PROJECT AT OGBOLOMA TOWN IN YENAGOA LOCAL GOVERNMENT AREA OF BAYELSA STATE

BY:

OBODOFEI
Integrated Services Limited

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FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

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LIST OF ACRONYMS

ALARP	as low as reasonably practicable
AoI	Area of Influence
APHA	American Public Health Association
ATR	African Traditional Religion
BAT	Best Available Technology
CBOs	community-based organizations
CLO	Community Liaison Officer
CO_2	Carbon Dioxide
CR	Conflict Resolution
DCD	Development Control Department
ECN	Energy Commission of Nigeria
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EPRP	Environmental Protection and Rehabilitation Plan
EPSR	Electric Power Sector Reform
ERMP	Emergency Response Management Plan
ERP	Emergency Response and Preparedness
ESMP	Environmental and Social Management Plan
FMEnv	Federal Ministry of Environment
GPS	Global Positioning System
GRM	Grievance Redress Mechanism
GTG	Gas Turbine Generator
HSE	Health Safety and Environment
IHR	International Health Regulations
ILO	International Labour Organization
ISO	International Organization for Standardization
ITCZ	Inter-Tropical Convergence Zone
LDAR	leak detection and repair
MoU	Memorandum of Understanding
NBS	National Bureau of Statistics
NCE	National Certificate in Education
NEPA	National Electric Power Authority
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGML	Nigerian Gas Infrastructure Company Limited
NiMet	Nigerian Meteorological Agency
NMDPRA	Nigerian Midstream and Downstream Petroleum Regulatory Authority
NNGP	Nigerian National Gas Policy
NPC	National Population Commission
NUPRC	Nigerian Upstream Petroleum Regulatory Commission
OEMs	Original Equipment Manufacturers

OISL	Obodofei Integrated Services Limited
OIW	Ordinary Industrial Waste
OSH	Occupational Safety and Health
PACs	Project Affected Communities
PPE	Personal Protective Equipment
PPPRA	Petroleum Products Pricing Regulatory Agency
PPTA	Petroleum Profit Tax Act
PRMS	Pressure Reduction and Metering Systems
QHSE	Quality, Health, Safety, and Environment
RMU	Ring Main Unit
STI's	sexually transmitted diseases
TCF	trillion cubic feet
TMP	Traffic Management Plan
ToR	Terms of Reference
UNESCO	United Nations Educational, Scientific and Cultural Organization
VAT	Value Added Tax
VOC	Volatile Organic Compounds
WHO	World Health Organisation
WMP	Waste Management Plan

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EXECUTIVE SUMMARY

0.1 INTRODUCTION

Obodofei Integrated Services Limited, a distinguished entity in the energy sector, propose to construct a CNG and Gas Power Plant at Ogboloma Town in Yenagoa Local Government Area of Bayelsa State. The project involves the processing of natural gas to be supplied by the Nigerian National Petroleum Corporation (NNPC) based on agreement reached and signed into Compressed Natural Gas, Liquified Natural Gas and the excess shall be utilized to fire a 40MW Gas Turbine Power plant.

Under the provisions of the Nigerian Environmental Impact Assessment Act No 86 of 1992 codified as EIA Act Cap E12 Law of the Federal Republic of Nigeria (LFN) 2004, an EIA is required prior to the development of the proposed Project. The purpose of the EIA is to identify and assess the potential environmental and social (E&S) risks and impacts of the Project so that they can be appropriately managed.

The EIA covers the entire life cycle of the proposed Project i.e. pre-construction, construction, commissioning, operation and decommissioning and it has been carried out in line with the relevant requirements of the Federal Ministry of Environment (FMEnv), the World Bank's Environmental and Social Framework, the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability.

Legal and Administrative Framework

The EIA has been carried out in line with the applicable legal and administrative framework, including relevant international guidelines and conventions. Some of these include, but not necessarily limited to the following:

- The Nigerian Constitution, 1999;
- Federal Ministry of Environment (FMEnv) Regulations;
- National Policy on Environment (2017);
- Environmental Impact Assessment (EIA) Act, CAP E12 LFN 2004;
- National Guidelines and Standards for Environmental Pollution Control in Nigeria
- 1991;
- Land Use Act 2004;
- Harmful Waste (Special Criminal Provisions) Act CAP H1, LFN 2004;
- Nigerian Urban and Regional Planning Act CAP N138, LFN 2004;
- Factories Act, Cap F1, LFN 2004
- Labour Act Decree No 198 of 1990;
- Employee's Compensation Act, No. 13, 2010;
- National Gas Policy, 2017;
- The Nigerian Oil and Gas Industry Content Development Act 2010;
- Petroleum Act 2021 (Revised);
- Criminal Code Act CAP C38 LFN 2004;
- Labour Act, 1999;
- The National Environmental Standards and Regulations Enforcement Agency (NESREA) Act, 2007;
- Nigerian Upstream Petroleum Regulatory Commission (NUPRC) Nigerian

- Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) (formerly DPR), Established by PIA, 2021
- National Environmental (Surface and Groundwater Quality Control) Regulations (No 22 f 2010);
- National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations (No 20 of 2010);
- National Environmental (Noise Standards and Control) Regulations (No 35 of 2009);
- National Environmental (Ozone Layer Protection) Regulations, (No 32 of 2009);
- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes), S.I.9 of 1991;
- National Health Act, 2014
- Wild Animals Preservation Act Cap 132 LFN 1990;
- Federal Solid and Hazardous Waste Management Regulations (1991);
- National Environmental (Sanitation and Wastes Control) Regulations (No 28 of 2009);
- Associated Gas Re-Injection Act, CAP 20, LFN 2004;
- Guidelines for the Establishment of a Natural Gas Plant Facility in Nigeria, DPR (now NUPRC), 2006;
- National Resources Conservation Council Act, CAP 286, LFN 1990;
- Standards Organization of Nigeria (SON), Act CAP 412 LFN 1990
- Bayelsa State Ministry of Environment
- Bayelsa State Environmental and Sanitation Authority
- Bayelsa State Policy on Environment
- Bayelsa State Ministry of Physical Planning and Urban Development
- Bayelsa State Companies in Large Scale (Industrial and Commercial Operations) Location of Office in Yenagoa Law, 2004
- Bayelsa State Capital Development Authority Law, 2006
- Bayelsa State Physical Planning and Development Act, 2015.
- Local Government Laws on Environmental Protection
- International Conventions

Overview of project proponent

Obodofei Integrated Services Limited is an indigenous Oil & Gas company founded in the year 2000 with Board and Management which includes highly skilled professionals with vast experience in oil and gas sector as well as from a diverse range of industries. The company is a prominent industry located in Bayelsa State. The Group's activities cover the following areas of Natural Gas (NG) downstream:

- Gas Processing.
- CNG wholesale outlets
- Micro distribution outlets and service centres for CNG sales

0.2 PROJECT JUSTIFICATION

Need for the Project

The proposed project addresses a critical need stemming from Nigeria's longstanding challenge of inadequate power & energy supply, which has severely impacted various sectors of the economy and hindered industrial growth. Despite efforts such as the enactment of the Electric Power Sector Reform Act (EPSRA) in 2005 aimed at privatizing and enhancing the power sector, the electricity demand continues to outstrip supply.

Project Benefits

The project is designed to enhance Bayelsa State's development by providing social, economic, and environmental benefits, contributing to regional and national progress:

1. **Reliable Power Supply**: The 40MW Gas Turbine Power Plant will deliver stable electricity, reducing outages and supporting economic activities, industrial growth, and daily life.
2. **Economic and Industrial Growth**: Reliable power will boost industries, create jobs, and attract investments, fostering Bayelsa's industrialization and SME growth.
3. **Job Creation**: Employment will be generated during construction (civil works, engineering) and operation (skilled labor, technical staff), stimulating the local economy.
4. **Improved Quality of Life**: Consistent electricity will enhance living standards by enabling access to modern amenities, improving education, healthcare, and public services.
5. **Energy Diversification**: By using Compressed Natural Gas (CNG), the plant will support a sustainable energy mix, reducing dependency on the national grid.
6. **Environmental Sustainability**: The project promotes cleaner energy with lower emissions compared to coal-fired plants, reducing Bayelsa's carbon footprint and supporting Nigeria's climate goals.
7. **Economic Resilience**: Reliable energy will stabilize critical sectors like agriculture, manufacturing, and services, driving long-term growth.
8. **Social Development**: Improved infrastructure and access to electricity will advance education, healthcare, and public services, uplifting local communities.
9. **Investment Attraction**: Stable energy will make Bayelsa a hub for local and international investments in diverse sectors.
10. **Community Empowerment**: Local communities will benefit from social programs, development initiatives, and stakeholder partnerships, ensuring widespread impact.

Envisaged Sustainability of the Project

Economic Sustainability: The proposed Project shall guarantee economic sustainability due to the accruable revenue from the project. Nigerians shall gain employment and skill acquisition opportunities through direct and indirect involvement of contractors, consultants, suppliers and other professionals during the construction and operational phase of the project. Apart from the direct employment of persons, indirect employment and associated economic effects will be derived from the Project. And also

- Supply chain optimisation by stimulating more economic activities in rural communities, creating more rural employment opportunities, increasing incomes of rural households, and saving or earning foreign exchange through import substitution or more export earnings.
- Economically developed communities tend to pay more attention to allocated resources, improve their environment and foster social stability.

- Equity is encouraged whilst promoting healthy and resilient ecological systems that support economic development and contribute to social resilience.

Environmental Sustainability: The project shall ensure maintenance of high-level performance and adoption of environmental processes. The aim is to ensure that the project does not damage prospects for use by future generations. OISL and partners will enforce compliance with its policy and its own corporate guidelines on HSE and at the same time is committed to performance improvement. The following measures will be taken for sustainable environmental suitability:

- All projects' facilities shall be designed and constructed to keep environmental impacts at the minimum and acceptable limits.
- All operations shall be carried out to conform to all relevant national laws and regulations (e.g FMEnv and Bayelsa State Ministry of Environment).
- Promote the conservation of aquatic biodiversity, enhancement of genetic resources, conservation of natural resources, and ecological resilience.
- Resource-use efficiency to promote a lower carbon footprint when performed in a sustainable manner with renewable energy sources.

Technical Sustainability: The proposed project is technically sustainable because of the proponent's strict adherence to nationally acceptable engineering design and construction standards. Innovative technologies that are economically viable and have minimal environmental, social and health impacts shall be utilized in the execution of the proposed project.
Best Available Technology Not Entailing Excessive Cost (BATNEEC) shall be applied right from the commencement of activities by project initiators and these shall be further enhanced during all production activities. Additionally, the proposed project is considered economically viable and sustainable given the following considerations:

(i) Stringent safety measures would be built into the design and fabrication of facilities. The design and safety considerations that would be employed in this project shall originate from tested specification packages in strict compliance with local Nigerian standards, where applicable.

(ii) OISL management is committed to continuous development and motivation of its human resource base through effective training or re-training, and an attractive remuneration and reward system. Furthermore, to ensure the transfer of relevant technologies, staff training on different aspects of the project would be an integral part of the key contractors' responsibilities.

Social Sustainability: The stakeholder consultation process has been implemented as part of the EIA process to ensure that all stakeholders provide input into the project planning process. OISL will ensure that the consultation, which started with the scoping workshop exercise, shall be sustained throughout the project's lifecycle. This will undoubtedly foster a sustainable social relationship between OISL and the host communities. Among the measures to be adopted to ensure the social sustainability of the project include;

a) Robust and sustained stakeholder engagement: OISL will ensure sustained and effective Stakeholder Engagement in a structured and culturally appropriate manner with the affected communities. The consultation process is tailored to the risks and impacts of the project; the project's phase of development; the language preferences of the affected communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups. In a demonstration of OISL's social policies, a robust community engagement was instituted as part of the EIA work (details are presented in Chapter Four).

b) Establishment of Grievance Redress Mechanism (GRM): GRM will be designed to receive and facilitate the resolution of concerns and grievances about the project's environmental and social performance as part of its Environmental and Social Management System (ESMS). Potential sources of grievances and acts of sabotage could include community youth groups, tribal conflicts, boundary conflicts, etc.

Project Alternatives

The EIA evaluated several alternatives to ensure the most sustainable and efficient implementation:

1. **Location Alternatives**:
   - The project site in Bayelsa State was chosen due to its proximity to the NNPC natural gas line and commitment to local development by the proponent (Ogbodofei Integrated Services Limited), and its potential to boost industrialization and improve infrastructure. Other Niger Delta states were evaluated but deemed less viable due to indigenous factor.
2. **Energy Alternatives**:
   - Coal, Hydropower, Solar, Wind, Geothermal and CNG energy alternatives was considered while Natural Gas was selected since it is readily available and is the most sustainable, efficient, and can be processed into compressed and liquified forms.
3. **Technology Alternatives**:
   - **Gas Turbine Power Plant**: Selected for its high efficiency, scalability, and lower emissions.
   - **Combined Cycle Gas Turbine (CCGT)**: Excluded due to higher costs and space requirements.
   - **Reciprocating Engines**: Excluded for lower efficiency and higher maintenance needs.
   - **Open Cycle Gas Turbine (OCGT)**: Excluded for its lower efficiency compared to the selected Gas Turbine Power Plant.

0.3 PROJECT OVERVIEW

The proposed Project will be situated within Ogboloma Town in Yenagoa Local Government Area, Bayelsa State, Nigeria. The proposed location of the CNG and Gas turbine power plant is on a land take of 16Hectares at Unpina Bush along Etelebou Road, Ogboloma Town in Yenagoa Local Government Area, Bayelsa State.The project area is bounded by the coordinates: 5°01'32."N, 6°20'50.40"E; 5°01'30.001"N, 6°20'54.06"E; 5°01'26.136"N, 6°20'47.751"E; 5°01'23.722"N, 6°20'51.836"E

The proposed scope of activities for the project includes:

- Engineering design
- Procurement activities
- Plant Civil and structural work

- Dismantling and transport of equipment from an existing power plant at Ijora
- Installation work on site
- Excavation, trenching, and drilling
- Pipe hauling, stringing, welding, and coating
- Installation of pipeline and backfilling of trenches
- Site cleanup, reinstatement, and commissioning
- Operation and maintenance
- Decommissioning

The initial phase of the project will establish a 40MW power generating capacity powered by two 20MW gas turbines configured in a 2 x 20MW setup and installation of a 100MMSCF/D CNG Processing Plant. The power plant is designed with an optional future expansion to 60MW in a combined-cycle configuration, which will incorporate a steam turbine to capture and utilize waste heat from the gas turbines, thereby improving efficiency and maximizing output. Fuel gas consumption is projected to be approximately 10MW to sustain plant operations

The Project activities can be categorised as follows:

Preconstruction Phase

The start-up activities in this phase are essentially desktop, involving feasibility studies with environmental, technical and financial considerations. These investigations are aimed at ensuring the viability and sustainability of the project, while having minimal negative impacts on the environment. Other aspects of the pre-construction activities shall be site preparation activities consisting of minimal site clearance and earthworks (top soil removal and site grading). In addition, this phase involves movement and transport of equipment and materials. The phase shall include materials and equipment supply

Construction Phase

This phase involves;

- Civil work activities
- On site fabrication of materials
- Installation of equipment and machinery,
- Installation of ancillary facilities
- Waste generation and disposal

Operational Phase

- Power Generation Activities
- Operation and maintenance of infrastructure and other facilities
- Waste generation and management

Decommissioning and Abandonment

It involves the disengaging and removal of all equipment used in the course of the project's operational life. Decommissioning of the proposed project entails some activities which include:

- Dismantling of the equipment and
- Transfer of all equipment and accessories to other locations where they shall be needed.
- Removal of constructed structures (site office building), etc.

0.4 DESCRIPTION OF THE ENVIRONMENT

Data and information for the environmental description of the study area were based on field data gathering (primary data) as well as a desk-based review of relevant literature (secondary data). Due to the Project exigencies, a one-season sampling approval was obtained from the FMEnv. Field sampling was carried out from 21st to 26th October 2024 and complemented with secondary data such as information obtained from relevant literature (e.g., published articles) on the general environmental and social conditions of the Project area of influence (5km spatial boundary).

The field samples were analyzed for physicochemical and microbial parameters at Ebic Integrated Services Limited laboratory located at 23, Graham Avenue, Off Igbo-Etche Road, Rumukwurushi, Port Harcourt, River State. The Laboratory is accredited by the FMEnv and Nigerian Upstream Petroleum Regulatory Commission (NUPRC). The laboratory analyses were consistent with the approved standard methodologies such as those recommended by ASTM International (formally called American Standards for Testing and Materials) and the American Public Health Association (APHA).

The environmental and social conditions of the Project's AoI are summarized as follows:

Atmospheric Condition:

Climatic and Metrology: The study area (Bayelsa State) which is in the Niger delta region of Nigeria experiences a fluctuating climate which is characterized by two distinct conditions of wet and dry seasons. The wet season occurs between April and October, while the dry season occurs between November and March. Wet (Rainy) season in Bayelsa State extends into early November while the North East trade wind that brings about the dry (harmattan) season is fully felt around late November till early February.

Rainfall: The mean monthly rainfall ranged from 28mm in December to 414mm in September when the peak is experienced. Rainfall is the basis for the classification of season into wet and dry season in the area. Ideally, there are no months without rainfall, but sometimes severe Harmattan conditions may cause droughts of up to one month. The mean annual rainfall for the project area is 2,594mm. The months with the highest rainfall are September (340 mm), July (429), June (340mm) and August (320mm). The months with the lowest rainfall are December(28mm), January (35mm) and February (52mm).

Relative Humidity (RH): Relative humidity is high all the year round for both wet and dry seasons. This is due mainly to the proximity of the area to the ocean, relatively dense vegetation cover, greater cloud cover, the influence of the moisture laden tropical maritime air mass and the associated South West monsoon winds which dominated the region particularly in the wet season. Humidity measurements for this study ranged from a maximum (96%) at dawn (01:00–07:00GMT) to a minimum (72%) in the late afternoon (14:00 – 15:00 GMT). The mean diurnal value for humidity measured on site was 88%. In coastal areas, relative humidity is constantly high because of the regular onshore winds that are moisture laden.

Air Temperature: The project/study area experiences moderately high incidence of solar radiation and long periods of sunshine because of its tropical location. The highest mean maximum temperature is recorded during the months of December through March (32.0°C) while the lowest mean maximum temperature value (24.0°C) is recorded in all months except April and May. The minimum mean annual temperature obtained for Bayelsa was 20°C (August), while the maximum mean annual temperature was 340°C (February).

Wind Direction and Speed: The wind pattern follows the dynamic migratory movements of the ITD. During the wet season, the most dominant wind directions are the South Westerly and Westerly, which are usually moisture bearing. In the harmattan months, the dominant wind direction is mostly North Easterly and Easterly. The mean windspeed for the onsite monitoring period was 1.5m/sec while The average wind speed data obtained for Port Harcourt from NIMET over a period of 1992-2022 is given as 3.0m/s.

Sunshine Hours: The mean annual sunshine hours in the area (synoptic data) is about 1537 hours while the mean monthly value varies from 51.6 and 176.7 hours in the months of July and December respectively. The generally short sunshine hours in July are due to the greater amount of cloudiness and rainfall characteristic of the region. Conversely, the higher December figure is due to the prevalent clear skies when the ITD has once more started its Northward migration.

Air Quality and Ambient Noise Level: The ambient air quality study revealed that key pollutants such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ammonia (NH_3), carbon monoxide (CO), hydrogen sulfide (H_2S), methane (CH_4), and particulate matter (PM2.5 and PM10) were not detected or remained well below regulatory limits across all monitoring stations. Sulfur dioxide and nitrogen dioxide, while undetected, could potentially increase due to combustion activities during project phases. Volatile Organic Compounds (VOCs) were detected at low levels (0.1–0.2 ppm), well within permissible limits. Particulate matter and noise levels were also minimal, indicating a relatively clean and quiet environment. However, increased activities during construction and operations may elevate these levels, necessitating ongoing monitoring and mitigation strategies.

Geology and Hydrogeology of the Project Area

The proposed project location is within the Niger Delta Basin of Nigeria. The Niger Delta occupies a pride of place as one of the world's largest Tertiary delta systems and a highly prolific hydrocarbon province. It is situated on the West African continental margin at the apex of the Gulf of Guinea, which formed the site of a triple junction during continental break-up in the Cretaceous. Throughout the Delta's history, it has been fed by the Niger, Benue and Cross Rivers, which between them drain over 106 km^2 of continental lowland savannah. The delta sequence comprises an upward-coarsening regressive association of Tertiary clastics up to 12 km thick. It is informally divided into three gross lithofacies: (i) marine claystones and shales of unknown thickness, at the base; (ii) alternations of sandstones, siltstones and claystones, in which the sand percentage increases upwards; (iii) alluvial sands, at the top. The area constitutes an extensive plain open to periodic inundation by flood resulting in flood plains and levees at the River banks (Reijers et al., 1997).

Groundwater Quality

Groundwater samples were collected from four (4) different locations within the Project's AoI inclusive of the control point. At each sampling location, groundwater samples were collected into a 2-litre polyethylene bottle for general physicochemical analysis, while samples for Oil & Grease determination were collected in a 1-litre glass bottle and preserved with concentrated sulphuric acid. Samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized 50ml McCartney bottles were used for samples meant for microbial analysis. In-situ measurements of pH, Conductivity, Total Dissolved Solids (TDS), Temperature, and Dissolved Oxygen (DO) were taken at each location using an Extech Digital DO700 meter.

The groundwater analysis revealed clear water (1 TCU) within aesthetic quality standards, though Total Suspended Solids (TSS) exceeded limits, suggesting filtration might be needed. Total alkalinity, hardness, acidity, and organic carbon levels were within acceptable ranges. Hydrocarbon pollutants, including TPH, PAH, BTEX, THC, and TOG, were negligible, indicating no significant contamination. Physiochemical parameters, such as nitrates, sulfates, phosphates, and chlorides, were well within safe limits, with minimal carbonate presence. Exchangeable cations, including sodium, potassium, calcium, and magnesium, were typical and safe. Heavy metals were mostly undetectable or below harmful levels, while biological analysis indicated moderate microbial activity and no fecal contamination

Soil Quality

A total of seventeen (17) soils were sampled using a stainless-steel auger and transferred to an aluminium foil. The soil samples collected were taken for microbial and physicochemical analysis. Sub-samples for microbial analysis were put in sterilized 50ml McCartney bottles. All samples collected were preserved and transported to the laboratory for analysis.

Physically, the soil ranged from sandy loam to clay loam with moderate water retention (moisture: 2.88%–7.33%) and organic carbon content (1.98%–10.34%), supporting fertility. Hydrocarbon analysis showed moderate surface contamination, with Total Petroleum Hydrocarbons (TPH) ranging from 10.319–22.865 mg/kg in topsoil and lower levels in subsoil, while Polycyclic Aromatic Hydrocarbons (PAHs) and BTEX were below detection limits, indicating minimal toxic contamination. Chemically, nitrites, phosphates, and exchangeable cations such as potassium and calcium varied across depths, with higher organic activity in the topsoil. Microbial analysis showed active heterotrophic bacteria and fungi populations, particularly in the topsoil, with moderate levels of hydrocarbon-degrading microbes.

Surface water

Surface water analysis from upstream, midstream, and downstream locations revealed generally good quality, meeting FMEnv standards for aquatic life and recreation. Physical parameters, including pH (7.56–8.59), turbidity, and temperature (27.9°C–29.3°C), were within acceptable ranges, with low salinity and TSS indicating clarity and suitability for use. Hydrocarbons (TPH, PAH, and BTEX) and Total Organic Carbon (TOC) were negligible, suggesting no significant petroleum contamination. Nutrient levels such as nitrate, sulphate, and phosphate were low, minimizing risks of eutrophication. While calcium, sodium, magnesium, and potassium were elevated downstream, they remained characteristic of groundwater-fed systems. Trace heavy metals were mostly undetectable, though elevated copper and manganese levels in midstream and downstream areas warrant monitoring. Biological indicators like COD and microbial counts reflected low organic pollution

Sediment

Sediment samples were collected at three (3) different stations (collocated with surface water samples) from Etelebou creek.

Sediment analysis revealed slightly acidic to neutral pH (6.79–8.11), typical of loamy silt soils with high clay content (60.86%–85.24%), influencing porosity, permeability, and bulk density. Moisture content varied, with SED 2 retaining the most water (8.36%). Organic matter, indicated by Total Organic Carbon (TOC), was consistently low (<0.1%). Hydrocarbon contamination was minimal, with negligible TPH, PAH, and BTEX levels, though low THC and TOG levels were present, particularly in SED 1. Nutrient analysis showed variations, with SED 1 exhibiting higher nitrogen and nitrite levels, while SED 3 had the highest phosphate concentration (2.934 mg/kg), likely linked to agricultural runoff. Heavy metals were low, with detectable copper and zinc and elevated iron (up to 1530.267 mg/kg), characteristic of clay-rich sediments. Biological parameters indicated a healthy microbial ecosystem, with consistent heterotrophic bacteria levels and moderate hydrocarbon-degrading microbes. Coliform counts were within environmental norms, with SED 1 showing slightly higher values.

Vegetation

The project area falls within the lowland rainforest ecological zone of Nigeria. As observed during the field survey, the vegetation cover of the project area consists of a forest structure characterised by an open canopy of a few emergent trees, and shrubs as well as undergrowth of herbs, grasses and climbers. Following several anthropogenic activities within and around the project area, the vegetation structure and pattern has undergone a series of transformations from its original ecotone, resulting in its present community of degraded secondary forest with few trees, dominated by shrubs and grasses. Thus the vegetation of the project area could be described as a secondary forest structure. Different habitats such as fallow bush, plantation, subsistent agricultural farm and degraded secondary forest, dominate the landscape of the project area. Plantation agriculture such as palm oil plantation and patches of cassava farm formed the major agricultural activities within the project area. Nevertheless, the different habitats, especially the regenerating fallow areas as observed during the field survey, still support diverse fauna species.

Vegetation sampling was carried out using the line transects method. Transects were laid randomly across the Project site as well as Gas pipeline RoW and distributed across the different habitats. The investigation of the flora composition of the project area was conducted in four (4) different habitats as identified during assessment which include; Secondary forest, plantation, farmland and fallow bush area. Quadrats of 10m x 10m each were systematically laid along each transect for vegetation sampling.

Taxonomic diversity within the study area and is represented by 119 species belonging to 52 plant families. Diversity at the rank of family is dominated by 6 families which account for a total of 56 species. These families in decreasing order of their number of representative species are: Fabaceae (15), Euphorbiaceae (12), Annonaceae (9), Poaceae (7), Rubiaceae (7) and Moraceae (6).

Fauna

The faunal occurrence and distribution in the project area are revealed to be uniform. This is attributable to the fact that the area is nearly homogenous in terms of habitat conditions. The methods adopted for the fauna survey includes direct and indirect methods. The direct method involves recording species based on actual sightings or calls into data sheets along the predetermined transects, while an indirect method is the recording of the significant signs along the same transect lines. Point transect survey was carried out opportunistically, to quickly appraise the fauna species diversity in the project area. Considering time as a limiting factor, fauna species were counted at random point stations along a transect. A transect walk was carried out and ten (10) minutes stop at every 100m interval to observe , listen to calls along the transect and recording of all the species along the transect. Field guides and binoculars were used to aid in the proper identification of the various species of fauna. Indirect methods involved taking note of signs of animal presence in the site such as burrows, faecal droppings, footprints and interviews with the locals. Field-based interviews were conducted to collect wildlife biodiversity data by discussing with local hunters and members of the community. Furthermore, questions relating to poaching activities and the type of games killed further provided a yardstick for confirming the presence or otherwise of some of the wildlife.

The conservation status of some species identified are mammals, reptiles, and birds. Among mammals, species such as the White-throated Guenon are endangered, while others like Sclater's Guenon, Spot-necked Otter, and Sitatunga are vulnerable, and some, like Maxwell's Duiker and Brush-tailed Porcupine, are locally threatened. Reptiles include the vulnerable Dwarf Crocodile and Tree Pangolin, alongside threatened species like the Nile Monitor Lizard and Nile Crocodile, and the locally vulnerable Rock Python. Birds such as the Black Kite and African Harrier Eagle are locally common.

Socio-economic Study

The socio-economic baseline description is focused on local level, i.e. within Yenagoa Local Government Area. This is because it is expected that the proposed project will result in macro-economic benefits at a national level, the primary socioeconomic impacts of the Project will be experienced at the local level within 5-kilometer radius of the project location. In the context of this study, the AoI further includes areas around the site likely to be affected by the Project activities during the pre-construction, construction and operation phases. The effects can be positive or negative, short or long term or permanent, as well as direct and in-direct.

The methods used to carry out the socio-economic and health survey included:

(i) review of available literature,
(ii) site and field visit to the proposed project surrounding areas, for baseline data collection
(iii) discussions (FGDs) with project-affected populations (PAPs) and communities (PACs),
(iv) application of professional knowledge and experience.

The consultation for the study involved institutional engagement with regulatory authorities and relevant ministries, and primary stakeholder consultation with traditional rulers and community members directly impacted by the proposed project, with a stakeholder engagement programme conducted in March 2024 to inform and gather concerns to ensure project acceptability Necessary photographs of the human environment were also taken to aid discussions.

Apart from the field data, the secondary sources of data and information were extensively drawn upon to prepare this report describing the socio-economic baseline conditions of the project-affected persons and communities. Statistical (census data/community profile), models (population projections), and other literature searches complemented the efforts

Key issues raised during stakeholder engagements included concerns about land compensation, waste management, comprehensive engagement of community segments including elders and youth, employment opportunities for youths, and the provision of community support and assured employment based on qualifications.

0.5 ASSOCIATED AND POTENTIAL IMPACT

Potential environmental and social impacts (including health and safety issues) associated with the proposed expansion Project were assessed using a modified Leopold Interaction Matrix. Impact significance was also determined. In determining the significance of impacts, the factors considered included: magnitude of impacts (which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency); value/sensitivity/fragility and importance of relevant environmental and social receptors; legal/regulatory requirements; and public perceptions (based on stakeholders' consultation). The identified potential adverse impacts are summarized in Section 6.0 below along with the recommended mitigation measures.

0.6 MITIGATION MEASURES

In proffering mitigation measures for the identified impacts of the Project, preference was given to avoidance or prevention of adverse impacts and where not feasible, measures which are practicable and cost-effective using best available technology were provided to reduce and/or minimize the impacts while compensation/offset was considered as the last resort, in line with the standard mitigation hierarchy.

The summary of the identified impacts including the recommended mitigation measures is provided as follows:

Pre -construction Phase

The potential impacts associated with the pre-construction phase of the proposed Project include: Community agitation over compensations, land disputes, wrong stakeholder identification and leadership tussles, .Deterioration of ambient air quality from vehicular emissions (SPM, NOx, CO, SOx); increase in noise levels, Lobbying, agitations for jobs, employment and contractual agreement by local workers, Exclusion of vulnerable groups from consultations which may lead to strife, Creation of employment for skilled and unskilled workforce, Employment of both Skilled and Unskilled workers, Business opportunities for local contractors through sub-contracting activities;

The associated impacts of the pre-construction phase activities shall be mitigated through the following measures, amongst others:

OISLshall;

- Ensure relevant stakeholders are identified.
- Ensure that early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed
- Ensure that project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities
- Ensure that early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed.
- Establish and publicize grievance procedures.
- Maintain good cooperative relations with the local community.
- Ensure both skilled and unskilled workers are employed within the project host communities.
- Ensure that noise attenuation measures such as installation of acoustic mufflers on large engines
- Raise public awareness of unusual activity
- Ensure that any Plan activities do not exceed Regulatory limits.
- Use fuel efficient and well-maintained haulage trucks with a proper exhaust system.
- Ensure that vehicles on the site with engines turned off;
- Service vehicles as at when due and stick to manufacturers‟ specifications in use
- Develop and follow a controlled fuelling, maintenance and servicing protocol
- Ensure that covering of vehicles carrying fine grade materials
- Public awareness and education;

Construction Phase

The potential impacts associated with the construction phase of the proposed Project include: reduction in the structural stability and percolative ability of soil resulting from compaction and destabilisation of the geological balance during excavation activities, laying foundations, erection of temporary buildings; The use of heavy machinery and increased traffic during the construction work within the project area is likely to lead to compaction of the soil structure which may lead to reduced soil infiltration capacities and subsequently resulting in increased run-off. The increased runoff may lead to soil erosion and subsequently gully formation. It may also affect soil water balance and the general hydrological cycle.

Surface water contamination due to leaks and spills related to construction wastes and fuel storage, hazardous materials. Increased sediment load in the water body in water turbidity and soil erosion; alteration of hydrological pattern; Emissions (like SO2, CO, NOx, VOC) from construction equipment such as excavation and levelling equipment, lifting cranes, welding, Cutting etc.; Loss of fauna and plant species as a result of increased human activities and Introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site; Removal of vegetation due to pond construction at the demonstration sites; Disruption of family structure and social networks; increase in level of crime and drug and alcohol abuse, increase in incidence of sex workers and casual sexual relations, which may result in STIs and unwanted pregnancies; Road traffic including accidents; Risk of injury and health related issues, rights denial etc.

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

- Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.
- Waste and storage areas for hazardous substances shall be separated on site and waste storage areas shall be located on hard standing (or in a bund wall, where necessary) to prevent potential contamination.
- Regular maintenance and servicing of construction equipment that contribute to air emission shall be implemented.
- Where possible, the clearing of vegetation, particularly of indigenous trees needs to be avoided as much as possible during construction, and the clearing needs to be carried out only where necessary;
- Where clearing is done, land should be landscaped and reclaimed by planting more trees and other forms of vegetation;
- Where erosion may occur due to vegetation loss, erosion control measures need to be put in place.
- Minimise heavy machinery movements and other equipment and away from designated transportation and operational areas; Unnecessary vehicular and machinery movements should be avoided as much as possible;
- Reclaim and re-vegetate excavation sites once work is completed to reduce run off. Proliferation of cages threatening fish resources sustainability:
- Activities associated with high levels of noise shall be limited to daylight hours.
- Construction equipment with lower sound power levels shall be selected and used.
- Acoustic enclosures shall be installed on equipment casing radiating noise.
- OISLshall ensure that engines and other noise making equipment are in good working order and well maintained, and that all have original noise suppression equipment (e.g. mufflers) intact and in working order.
- Project personnel shall use appropriate Personal Protective Equipment (PPE) to reduce exposure to noise impact.
- Soil disturbance and vegetation clearing will be kept to minimum.
- All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimize the introduction of alien species.
- Cleared areas which are not being used shall be re-vegetated using plants or seeds of locally occurring species.
- Regular monitoring shall be undertaken (at least every 6 months) to ensure that alien plants are not increasing as a result of the disturbance that has taken place. All construction related activity shall be restricted to demarcated areas.
- No unauthorized persons shall be allowed into the construction site.
- Hunting or deliberate killing of animals in the Project area by project personnel shall be prohibited.
- The local communities shall be informed of the project activities prior to commencement of work.

- Construction workers camp shall be developed and workforce management protocols that include workforce behaviour and interactions with the local communities shall be implemented and enforced.
- A grievance mechanism procedure (which tracks grievances and responses; and responds in a timely manner with corrective actions identified where appropriate) shall be developed and implemented.
- Development and implementation of a robust Occupational Health and Safety (OHS) Plan and Procedures shall be ensured. The OHS Plan shall be developed in accordance with all relevant national and international standards, including IFC Performance Standards, World Bank EHS Guidelines.

Operation Phase

The potential impacts associated with the construction phase of the proposed Project include: Noxious gas emission, OHS Risk, increase of human interactions leading to diseases/ infections such as transmission of sexually transmitted diseases (STI's) and other communicable diseases, Noise Generation, Pressure on existing infrastructure, Increased social vices.

The associated impacts of the operation phase activities shall be mitigated through the following measures, amongst others

Obodofei Integrated Services shall:

- Install continuous emission monitoring systems (CEMS)
- Optimize combustion processes to ensure efficient fuel utilization.
- Consider adopting advanced combustion technologies such as lean-burn combustion or selective catalytic reduction (SCR) systems.
- Implement effective air inlet filtration systems to prevent the ingress of particulate matter into the gas turbine.
- Conduct regular maintenance and inspections of the gas turbine components to ensure optimal performance.
- Implement efficient cooling systems for various components of the gas turbine to reduce the amount of water vapor released into the atmosphere, which contributes to visible plumes and potential environmental impacts.
- Train and brief workers on safety precaution, their responsibility for their safety and the safety of others;
- Provide adequate instructional and warning HSE signs;
- Ensure compliance with contract General Health, Safety, and Environment code of contract code and relevant regulations. Enhancing education and sensitisation of workers and the local communities on the dangers and prevalence of disease; Regular sensitisation campaigns and monitoring of the spread diseases
- Promote public health and education;
- Develop a traffic management and provide adequate safety and caution signs e.g. speed control, warning signs, etc.

- Ensure that noise attenuation measures such as installation of acoustic mufflers on large engines
- Raise public awareness of unusual activity
- Ensure that any Plan activities does not exceed Regulatory limits.
- Maintain ongoing cordial relationships with the stakeholder communities.
- Sex education and danger of multiple sex partners' awareness shall be created.
- Certify government approved security could engage to coup crime rate.
- When necessary OISL shall activate its emergency response procedure
- Implement effective journey management plan

Decommissioning Phase

The potential impacts associated with the decommissioning phase of the Project include soil, groundwater and surface water contamination due to decommissioning activities; Decrease in ambient air quality, increase in noise level, traffic and road accidents due to transportation of dismantled equipment and materials from site including waste; and workers' health and safety.

The associated impacts of the decommissioning phase activities shall be mitigated through the following measures, amongst others:

- A detailed decommissioning plan shall be developed and submitted to all relevant regulatory authorities for approval prior to the commencement of facility decommissioning.
- OISL shall ensure that dismantled materials (e.g.scrap metals) are taken off site for appropriate recycling.
- OISL shall ensure that all major electrical items are removed from site and recycled appropriately.
- All impacted soil areas shall be re-vegetated with native plant species.
- Public awareness and education on the occurrence of farm related diseases;
- For malaria, smallholder farmers must be encouraged to keep pond waters clean;
- For schistosomiasis, people must be educated to avoid direct contacts such as walking into the ponds;
- Promote public health and education;
- Treatment of farm effluent water by ensuring adequate time for biodegradation of the chemicals used;
- Ensure use of right chemicals and hormones where applicable;
- Minimise regular contacts between such waters and the natural water systems;
- Frequent water monitoring to determine the level of pollution and contamination;
- Ensure internationally accepted good practices of aquaculture and apply the laws of the country where breaches are identified;
- Ensure adequate laboratory tests before new fish fingerlings are introduced into the country and enhance controls and checks at points of entry;
- Ensure screening and treatment prior to introduction of new fingerlings;
- Regular checks and controls of predators and dangerous species;
- Good management of the ecosystems;

- Minimise the proliferation of dangerous fauna and flora through controls.
- Enhancing education and sensitisation of workers and the local communities on the dangers and prevalence of disease; Regular sensitisation campaigns and monitoring of the spread diseases;
- Development of brochures and other materials that will convey information about diseases and infections;
- Regular provision of adequate prevention measures.

0.7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

An Environmental Social Management Plan (ESMP) has been developed to satisfy long term objectives of managing and monitoring the environmental and social impacts of the proposed Project. It covers the pre-construction, construction, operation and decommissioning phase of the Project includes desired outcomes; performance indicators; monitoring (parameters to be monitored and frequency); timing for actions; responsibilities and cost estimates required for implementation of recommended mitigation measures, monitoring of the performance indicators and capacity building.

OISL shall have principal responsibility for all measures outlined in the EMP, but may delegate responsibility to its partners/contractors, where appropriate and monitor the implementation. OISL will provide specifications for environmental compliance and performance (through this ESIA and ESMP and the associated plans) and, as a contractual requirement develop and provide its own specific management plans, incorporating:

- Environmental Management Programs
- Awareness Creation and Training
- Worker Safety and Health Plan
- Manpower Development Guidelines
- Grievance Redress Mechanism (GRM)/Conflict Resolution (CR)
- Social Impact Management Plan
- Emergency Response/Evacuation Plans;
- Traffic Management Plan (TMP)
- Environmental Monitoring Plan
- Waste Management Plan
- Hazardous Materials Management Program;

0.8 DECOMMISSIONING AND ABANDONMENT PLAN

In compliance with National regulatory requirements (FMEnv) and international standards, decommissioning and demobilization of equipment and personnel will be planned and implemented. The programme will include a plan to survey the site for contamination. All materials that could subsequently prove hazardous to the restoration of the site shall be treated. All contaminated material shall be disposed of in a safe and approved manner as stated in the ESMP. The site shall also be restored to meet environmental requirements approved by regulators, and all reusable items will be disconnected and handed over to the appropriate departments, while the non-reusable items will be carefully segregated, containerized, labelled and conveyed to approved disposal sites. Any polluted and contaminated soil will be treated in-situ or removed from the site and treated/disposed of safely. Bioremediation of any contaminated soils shall be considered where applicable. At unit closure, maintenance contracts shall be terminated, e.g. equipment calibrations and equipment preventive maintenance. All automatic deliveries or services shall be stopped.

0.9 CONCLUSION

This EIA study has identified positive and negative impacts of the proposed Project. Associated and potential negative effects on the environmental (biophysical), socioeconomic, and health characteristics of the project area have been evaluated in detail. Mitigation measures have also been prescribed for significant negative impacts.

In line with applicable Nigerian and international regulatory requirements and, widely accepted EIA procedures, the assessment has been based on the standard practices of using the project details and relevant environmental, social and health baseline characteristics.

The few potential negative impacts identified were mitigated through the program implementation design stage. Adherence to these measures and regulatory compliance requirements by OISL shall ensure that impacts assessed as having low significance subsequently remain at tolerable levels. The effects of those impacts identified as having potentially moderate and high significance consequences will also be either eliminated or minimized through the implementation of appropriate mitigation measures as recommended in this report.

ACKNOWLEDGMENT

Obodofei Integrated Services Limited is most grateful to the Government of the Federal Republic of Nigeria, also the Federal Ministry of Environment (FMEnv), Bayelsa State Ministry of Environment, Yenagoa LGA, Bayelsa state for their support, assistance and understanding during the Environmental Impact Assessment (EIA) for the Proposed CNG and Power Plant Project at Ogboloma Town in Yenagoa Local Government Area of Bayelsa State

We would also want to use this opportunity to thank the Environheroes International Limited project team for their diligence and dedication in preparing the EIA report.

CHAPTER ONE
INTRODUCTION

1.1 Background

This report documents the Environmental Impact Assessment (EIA) for the Proposed CNG and Power Plant Project at Ogboloma Town in Yenagoa Local Government Area of Bayelsa State. The project involves the installation of a 100MMSCF/D CNG processing plant from natural gas to be supplied by the Nigerian National Petroleum Corporation (NNPC) gas line based on agreement reached and signed. Produce gas from the facility shall be utilized to fire a 40MW Gas Turbine Power plant.

The proposed Project will result in various positive and negative interactions between planned activities and the environment. In line, therefore, with the statutory requirement for environmental management in Nigeria, Obodofei Integrated Services Limited, has conducted the Environmental Impact Assessment (EIA) of the proposed Project, and the findings are documented in this report. The EIA study has been undertaken in line with statutory requirements for environmental management in Nigeria, which include the National Policy on Environment, the EIA Act CAP E12 LFN 2004, the Federal Ministry of Environment (FMEnv) Sectoral Guidelines for Manufacturing and Infrastructural Development Projects, amongst other State, National Guideline/Regulations, Standards and Regulatory Frameworks.

1.2 Project Proponent

Obodofei Integrated Services Limited is an indigenous Oil & Gas company was founded in the year 2000 with Board and Management which includes highly skilled professionals with vast experience in oil and gas sector as well as from a diverse range of industries. The company is a prominent industry located in Bayelsa State. The Group's activities cover the following areas of Natural Gas (NG) downstream:

- Gas Processing.
- CNG wholesale outlets
- Micro distribution outlets and service centers for CNG sales.

1.3 Environmental Consultant

Obodofei Integrated Services Limited commissioned Environheroes International Limited (an FMEnv and NESREA accredited consultant) to conduct the Environmental Impact Assessment study for the Proposed CNG and Power Plant Project at Ogboloma Town in Yenagoa Local Government Area of Bayelsa State.

1.4 Project Location and Accessibility

The proposed Project will be situated within Ogboloma Town in Yenagoa LGA, Bayelsa State, Nigeria (Figure 1.1 and 1.2). The proposed location of the 100MMSCF/D CNG Plant and 40MW Gas turbine power plant will be located on a land take of 16Hectares at Unpina Bush along Etelebou Road, Ogboloma Town in Yenagoa Local Government Area, Bayelsa State.

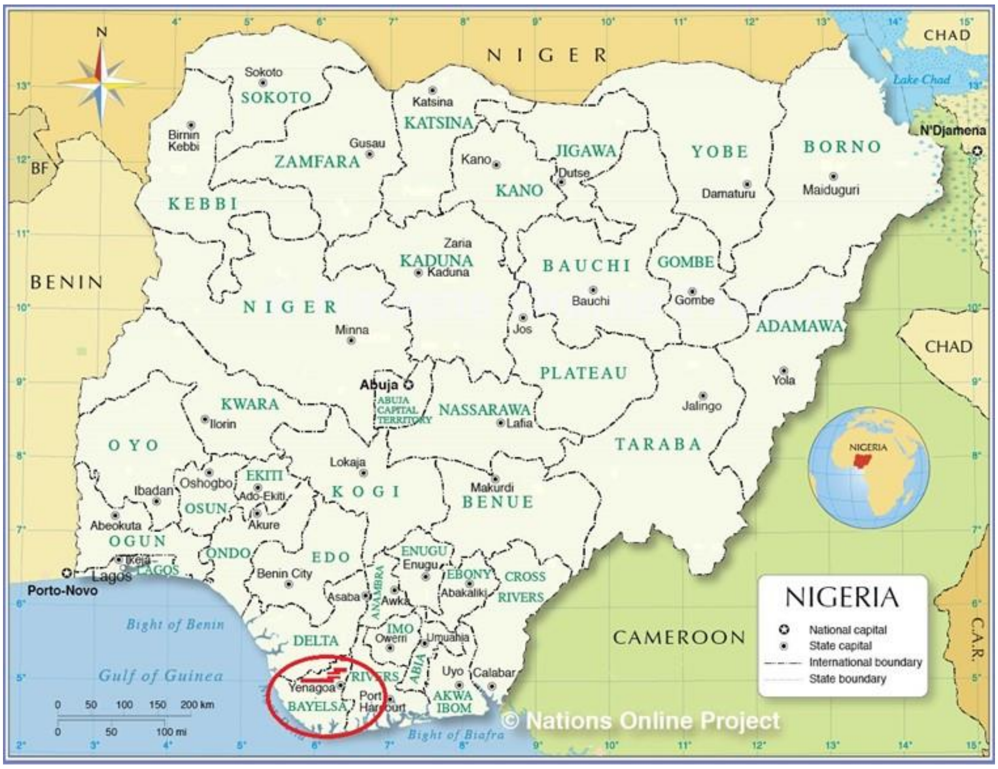

Figure. 1.1: Map of Nigeria highlighting Bayelsa State

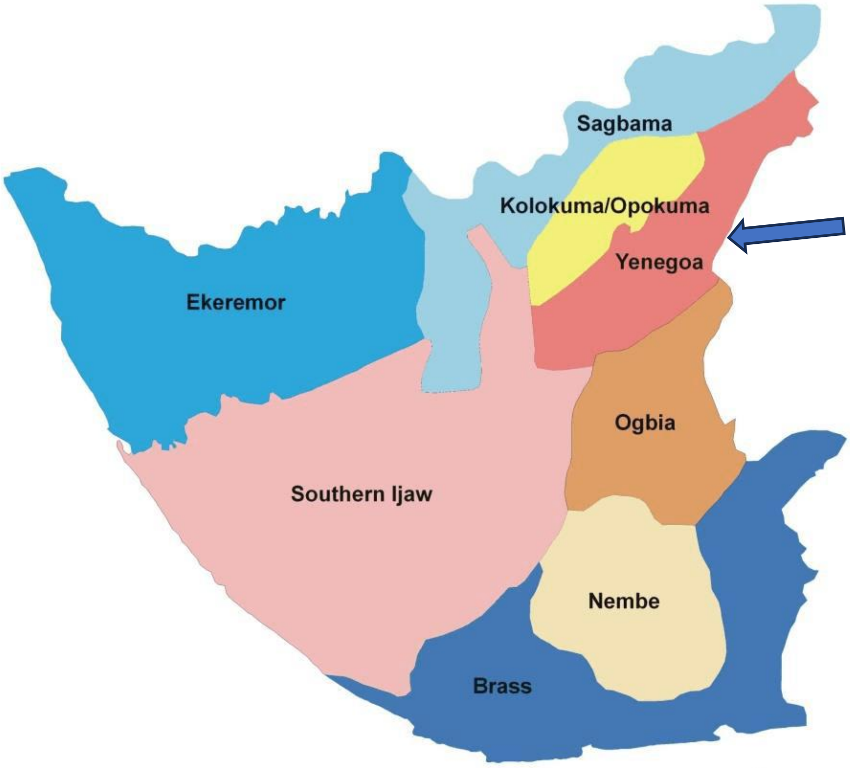

Figure 1.2: Map of Bayelsa state showing Yenagoa LGA

1.5 EIA Objectives

The overall objective of the EIA study is to proactively identify and assess the potential environmental and social (including health and safety) risks and impacts associated with the proposed Project throughout its life cycle and to put in place appropriate mitigation measures and management actions to address and monitor the identified risks and impacts. This is to ensure that the Project is planned, constructed and operated sustainably and to promote its environmental and social performance.

Specifically, the objectives of the EIA are to:

- Enhance Project design and planning by identifying those aspects of location, construction, operation and decommissioning which may cause adverse environmental, social, health and safety effects.
- Establish the existing state of the Project environment (biophysical, social, economic and cultural) and identify any sensitive components of the environment.
- Identify existing and expected environmental regulations that will affect the operations and advise on standards, concepts and targets;
- Identify any environmental issues and concerns that may, in the future, affect the successful operation of the Project;

- Recommend appropriate and practicable measures during construction, commissioning, operations and decommissioning to avoid and mitigate adverse effects and enhance beneficial impacts.
- Develop an appropriate Environmental and Social Management Plan (ESMP) for the Project including a monitoring programme.
- Provide the basis for engagement with potentially affected communities and other stakeholders, including the relevant regulatory authorities.

1.6 Scope of the EIA Study

The scope of work for the EIA covers the following:

- Review of relevant local, national and international laws, regulations and industry codes and standards that apply to the proposed Project and the EIA study;
- Description of all actions/activities that will be carried out in the course of the Project;
- Literature review of materials and information pertaining to the environment where the proposed Project will occur;
- Scoping workshop and stakeholder engagement;
- Field data gathering (in accordance with the FMEnv-approved Terms of Reference);
- Laboratory analysis of field samples;
- Analysis of data obtained and description of the study area prior to the proposed project activities, with regards to the significant environmental issues of the proposed project;
- Identification and evaluation of potential environmental and social risks and impacts of the Project;
- Recommendation of appropriate and cost-effective mitigation measures including Environmental and Social Management Plan (ESMP); Preparation of EIA report.

1.7 EIA Terms of Reference

In line with the National EIA Procedural Guidelines, a detailed Terms of Reference (ToR) was prepared and submitted to the FMEnv. The ToR section highlighted the general scope of the EIA including the overall data requirements on the proposed Project environment. The FMEnv-approved ToR for the EIA study is provided in the Appendix.

1.8 Legal, Regulatory and Administrative Framework

The EIA study was conducted in compliance with the legal, regulatory, and administrative framework encompassing international, national, and state/local laws, guidelines, and regulations. Additionally, it adhered to the obligations outlined in international treaties and conventions to which Nigeria is a signatory. The study also considered regulations, guidelines, and standards established by the Federal Ministry of Environment and the Bayelsa State Ministry of Environment.

1.8.1 National Policy, Guidelines and Regulations

- **Constitution of the Federal Republic of Nigeria (1999)**

The constitution, as the national legal order, recognizes the importance of improving and protecting the environment and makes provisions for it. Relevant sections are:

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

- **Federal Ministry of Environment (FMEnv)**

The Federal Ministry of Environment (FMEnv) serves as the principal authority responsible for regulating and enforcing environmental laws in Nigeria. The Ministry's mandate, as outlined in its establishing act, includes ensuring that all development and industrial activities, operations, and emissions adhere to prescribed national guidelines, standards, and relevant regulations for environmental pollution management.

The FMEnv is tasked with overseeing all matters pertaining to the nation's environment and biodiversity. It has developed various intervention instruments, such as policies, standards, guidelines, regulations, and programs, aimed at curbing environmental degradation. Through the implementation of these instruments, the FMEnv enforces compliance among industries and regulated communities, employing compliance promotions as an effective means of ensuring adherence to environmental regulations.

- **Environmental Impact Assessment (EIA) Act CAP E12, LFN 2004**

The EIA Act is the primary Act governing EIA in Nigeria. It was promulgated to enable the prior consideration of an EIA on specified public or private projects. The Act sets out the procedure to be followed and methods to be used in undertaking an EIA. Section 2(2) of the Act requires that where the extent, nature or location of the proposed project or activity is such that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

- **National Policy on Environment, 2017**

Environmental management in Nigeria is based on the National Policy on the Environment 2017. 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 strategic objective of the Policy is to coordinate environmental protection and natural resources conservation for sustainable development.

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

This document was drafted in March 1991 to serve as a basic instrument for monitoring and controlling industrial and urban pollution. These guidelines were initiated sequel to the drafting of the National Environmental Policy in 1989. The guidelines and standards relate to six (6) areas of environmental concern, thus;

- Effluent limitations
- Water quality or industrial water uses at points of intake
- Industrial emission limitations
- Noise exposure limitations.
- Management of solid and Hazardous waste
- Pollution abatement in industries.

- **National Environmental Protection (Effluent Limitation) Regulations, 1991**

The National Effluent Limitation Regulation, S.1.8 of 1991 (No. 42, Vol. 78, August, 1991) makes it mandatory for industries such as waste generating facilities (including research institutes, clinics, hotels etc) to install antipollution 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 specified in the regulation.

- **National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991**

Where and when applicable, the pollution abatement regulation, S.1.9 of 1991 (No. 42, Vol. 78, August, 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 the FMEnv, the requirement of a 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 for existing industries or Environmental Impact Assessment for new industries) and penalty for contravention.

- **National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991**

The management of hazardous and solid waste regulation, S.1.15 of 1991 (No. 102, Vol. 7, August, 1991) defines the requirements for groundwater protection, surface impoundment, land treatment, water piles, landfills, incinerators etc. It also describes the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituents. It also states the requirements and procedure for inspection, enforcement and penalty.

- **National Climate Change Act, 2021**.

Nigeria's 2021 Climate Change Act provides 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 the average increase in global temperature within 2^{o}C and pursuing efforts to limit the temperature increase to 1.5^{o}C 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.

❖ **Revised National Forest Policy, 2020**

The revised 2020 National Forest Policy sets out strategies for growing the sector further and addressing emerging environmental issues like climate change resulting from increased population with its attendant pressure on the forests and their resources.

The objectives of the National Forestry Policy of Nigeria include:

- Protection and conservation of Nigeria's forest resources.
- Sustainable management of forest resources to meet the needs of present and future generations.
- Promotion of community participation in forest management.
- Promotion of forest-based industries and value addition to forest products.
- Promotion of research and development in the forestry sector.
- Strengthening of institutional capacity for effective forest management.
- The policy recognizes the importance of involving local communities in forest management and encourages their participation in decision-making processes. It also promotes the development of alternative livelihoods for communities dependent on forest resources to reduce the pressure on forests. Nigerian Nationally Determined

❖ **Regulations on National Content Development for the Power Sector, 2014**

The Regulations on National Content Development for the Power Sector, 2014 is a set of guidelines established by the Nigerian Electricity Regulatory Commission (NERC) to promote the participation of Nigerian companies and citizens in the power sector value chain. The regulations apply to all stakeholders in the power sector, including generation, transmission, distribution, and ancillary services.

The key objectives of the regulations are to:

- Foster the development of local capacity and capabilities in the power sector by promoting local content and technology transfer.
- Encourage the use of Nigerian goods and services in the power sector value chain, including equipment, materials, and manpower.

- Facilitate the transfer of skills and technology to Nigerians by foreign companies operating in the power sector.
- Promote the employment and training of Nigerian citizens in the power sector.

Some of the key provisions of the regulations include:

Nigerian Content Plan: All licensees in the power sector are required to submit a Nigerian Content Plan to NERC for approval before commencing operations. The plan should outline how the licensee intends to comply with the regulations and promote local content development.

Nigerian Content Development Fund: A Nigerian Content Development Fund has been established to support the development of local capacity and capabilities in the power sector. Licensees are required to contribute a percentage of their annual operating expenditure to the fund.

Local Content Targets: Licensees are required to meet specified local content targets in their operations, including the use of Nigerian goods and services, the employment of Nigerian citizens, and the transfer of skills and technology to Nigerians.

Reporting Requirements: Licensees are required to submit regular reports to NERC on their compliance with the regulations, including their local content development activities.

- **The Consumer Protection Council Act (CPCA), 2019**

The Consumer Protection Council Act (CPCA) is a Nigerian law that was enacted in 1992 to provide for the establishment of a Consumer Protection Council (CPC) with the mandate to protect consumers and promote their interests. The act was later amended in 2019 to strengthen the provisions of the law and enhance the effectiveness of the CPC.

The CPCA empowers the CPC to:

- Protect consumers against hazards to their health and safety arising from products and services.
- Promote and enforce consumer rights and standards.
- Undertake investigations into consumer complaints and take appropriate actions.
- Prosecute any person or company that violates consumer protection laws.
- Conduct research and disseminate information to consumers and businesses.
- Ensure that businesses comply with product and service quality standards.
- Educate consumers on their rights and responsibilities.

The act also establishes the Consumer Protection Fund (CPF) which is to be used by the CPC to finance its activities and to compensate consumers who suffer losses as a result of the violation of their rights.

- **Endangered Species Act, CAP E9, LFN 2004**

The Endangered Species Act (ESA) is a Nigerian law that was enacted in 2004 as CAP E9 of the Laws of the Federation of Nigeria. The act is aimed at protecting endangered species and their habitats, as well as regulating the trade in endangered species and their parts.

The ESA empowers the Federal Government, through the Minister of Environment, to designate and protect endangered species, including plants and animals, as well as their habitats. The act also prohibits the hunting, killing, capturing, or trading of any endangered species, except under special circumstances authorized by the Minister.

The ESA also established the National Endangered Species Committee (NESC) which is responsible for advising the Minister on matters related to endangered species, including the listing of species, the issuance of permits, and the establishment of conservation programs.

The act provides for penalties and fines for violations of its provisions, including imprisonment and fines of up to N500,000. It also allows for the forfeiture of any property used in connection with the commission of an offence under the act.

- **National Gas Policy, 2007**

The Nigerian National Gas Policy (NNGP) was approved in June 2017 as a strategic roadmap to address the challenges faced by the country in the development of its natural gas resources. Nigeria has significant reserves of natural gas, estimated at over 200 trillion cubic feet (TCF), which is the largest in Africa and the ninth largest in the world. However, the country has not fully leveraged this resource due to a lack of infrastructure, inadequate regulatory framework, and limited investment in the sector.

The policy harps on the use of natural gas for power generation, which is a critical component of Nigeria's energy mix. It seeks to increase the contribution of gas to the country's power sector from the current level of about 20% to at least 50%. The NNGP encourages the use of natural gas as a transportation fuel, particularly for heavy-duty vehicles such as trucks and buses. It aims to develop a comprehensive natural gas vehicle policy and infrastructure that will enable the adoption of natural gas as a transportation fuel.

- **The Nigerian Oil and Gas Industry Content Development Act 2010**

The Nigerian Oil and Gas Industry Content Development Act of 2010 is a significant legislative framework aimed at promoting and enhancing the participation of Nigerian businesses and citizens in the country's oil and gas sector. Enacted as a response to the need for indigenous capacity building and economic empowerment, this Act seeks to foster local content development in the oil and gas industry.

Key provisions of the Act include requirements for Nigerian content in oil and gas activities, such as exploration, production, and development. The legislation mandates operators, contractors, and service providers in the industry to prioritize the use of locally manufactured goods, services, and manpower in their operations. This prioritization is intended to create opportunities for Nigerian businesses, promote technology transfer, and contribute to the overall growth of the domestic economy.

Furthermore, the Act establishes the Nigerian Content Development and Monitoring Board (NCDMB) as the regulatory body responsible for overseeing and ensuring compliance with the provisions of the legislation. The NCDMB plays a pivotal role in developing strategies, guidelines, and policies to drive the implementation of Nigerian content in the oil and gas sector.

The Act also encourages joint ventures and strategic alliances between Nigerian and international companies to facilitate knowledge transfer and skill acquisition. It emphasizes the need for capacity development, training, and the transfer of technology to empower Nigerians to actively participate in various aspects of the oil and gas value chain.

- **Petroleum Act, 2021**

The key objective of the Act is to restructure and transform the Nigerian oil and gas industry. The Act provides legal, governance, regulatory and fiscal frameworks for the Nigerian oil and gas industry and the development of petroleum host communities.

The Act repeals the following laws: Associated Gas Reinjection Act; Hydrocarbon Oil Refineries Act; Motor Spirit (Returns) Act; Nigerian National Petroleum Corporation (“NNPC”) (Projects) Act; NNPC Act (when NNPC ceases to exist under section 54(3) of the Act); Petroleum Products Pricing Regulatory (Establishment) Act; Petroleum Equalisation Fund Act; Petroleum Profit Tax Act (“PPTA”); and Deep Offshore and Inland Basin Production Sharing Contract Act. However, while some of the repeals will take effect from the effective date of the Act, others are contingent upon the occurrence of certain events. The provisions of certain laws are saved until the termination or expiration of all existing oil prospecting licenses and oil mining leases.

- **National Environmental Impact Assessment Procedural and Sectoral Guidelines 2013**

In response to the promulgation of the EIA Act, the FMEnv developed National EIA Procedural Guidelines and another set of guidelines on various sectors of the National economy. Applicable to this study is the EIA Guidelines for Infrastructural Sector (2013).

The guidelines have been developed by the FMEnv to assist proponents in conducting a detailed environmental and social assessment with regard to Infrastructural projects in Nigeria.

- **National Environmental Standards and Regulations Enforcement Agency (NESREA) Act, 2007**

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

- **National Environmental (Sanitation and Wastes Control) Regulations, 2009**

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

- **National Environmental (Noise Standards and Control) Regulations, 2009**

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

- **National Environmental (Surface and Groundwater Quality Control) Regulations, 2011**

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

- **National Environmental (Construction Sector) Regulation, 2011**

The purpose of this regulation is to prevent and minimize pollution from construction, decommissioning and demolition activities in the Nigerian environment.

- **Electric Power Sector Reform Act, 2005**

The Electric Power Sector Reform (EPSR) Act 2005 enacted on 11th March 2005 provides a legislative framework for the reform of the Nigerian power sector in accordance with the policies set out in the National Electric Power Policy. The Act removes the operational and regulatory responsibilities of the electricity industry from the Federal Government. It provides the legal backing for the unbundling of NEPA and, the formation of successor companies to take over the various functions, assets, liabilities and staff of NEPA.

This Act repealed the Electricity Act and the National Electric Power Authority Act. It is also the background that will enable the development of a competitive electricity market, the creation of a regulatory body that will license and regulate the generation, transmission and distribution and supply of electricity. In addition, the Act provides for the determination of tariffs and other related matters.

The Act specifies the requirements for issuing licences for power-generating companies. Schedule 1A of the Act requires that an EIA Approval Certificate or Proof of submission and acceptance for processing of the Report on EIA to the Ministry of Environment or details on how effluents and discharges will be managed (if the proposed capacity is less than 10MW)

Subject to this Act, the Commission shall have the following principal objectives;

a) To create, promote, and preserve efficient industry and market structures, and to ensure the optimal utilization of resources for the provision of electricity services.
b) To maximize access to electricity services, by promoting and facilitating consumer connections to distribution systems in both rural and urban areas.
c) To ensure that an adequate supply of electricity is available to consumers.
d) To ensure that the prices charged by licensees are fair to consumers and are sufficient to allow the licensees to finance their activities and to allow for reasonable earnings for efficient operation.
e) To ensure the safety, security, reliability, and quality of service in the production and delivery of electricity to consumers.
f) To ensure that regulation is fair and balanced for licensees, consumers, investors and other stakeholders, and
g) To present quarterly reports to the President and National Assembly on its activities

❖ **Nigerian Electricity Regulatory Commission (NERC)**

NERC was established under the Nigerian Power Sector Reform Act 2005. The commission effectively took off on October 31, 2005, following the inauguration of its full-time commissions. NERC has been set up as an independent and self-funding sector regulator with the following primary functions:

- ✓ Ensure orderly development of a competitive power market;
- ✓ Ensure efficient, safe and adequate production of electricity;
- ✓ Promote competition and private sector participation;
- ✓ Promote consumers and public interest
- ✓ Evolve standards and codes that measure with international best practice
- ✓ Evolve stable and equitable rates – cost reflective + reasonable profit;
- ✓ License and regulate persons engaged in the electricity business
- ✓ Settle disputes amongst industry participants;
- ✓ Ensure expansion of access to rural and urban dwellers and;
- ✓ Establish and administer the power consumer assistance fund for subsidizing underprivileged consumers.

❖ **Renewable Electricity Policy (2006)**

This policy aims to expand the role of renewable electricity in sustainable development through effective promotional and regulatory measures. It is derived on the premise that increased power generation from conventional sources and electricity grid extensions alone are insufficient to achieve electricity targets rapidly and cost-effectively. Renewable energy is a key aspect of the Government's strategy to increase access to electricity in the country. The specific objectives of the Renewable Electricity Policy are to:

- Expand electricity generating capacity to meet national economic and social development goals;
- Encourage the diversification of sources of electricity supply through renewable energy, and as such improve the energy security of the country;
- Increase access to electricity services nationwide, especially in rural areas;
- Stimulate growth in employment generation through an expanded renewable electricity industry;
- Enhance technological development through increased domestic manufacturing of renewable electricity components;
- Stimulate competition in the delivery of renewable electricity;

- Promote rapid expansion of the renewable-based electricity market through cost-reducing supply side and demand side incentives;
- Develop regulator procedures that are sensitive to the peculiarities of renewable energy-based power supply;
- Create a stable and predictable investment climate in renewable electricity markets;
- Provide effective protection to consumers through regulation; and
- Reduce air pollution and greenhouse gas emissions, thus contributing to improved health and overall social development.

❖ **National Electric Power Policy (2001)**

The Policy set the following as critical objectives for Nigeria's electric power sector:

- Ensure that the power sector attracts private investment both from Nigeria and from overseas.
- Develop a transparent and effective regulatory framework for the power sector.
- Develop and enhance indigenous capacity in electric power sector technology.
- Ensure that the Government divests its interest in State-owned entities and entrenches the key principles of restructuring and divestiture in the electric power sector.
- Promote competition to meet growing demand through the full liberalization of the electricity market.
- Review and update electricity laws in conformity with the need to introduce private sector operation and competition.

❖ **Electricity Act (1990)**

The Electricity Act, Cap 106 of 1990 contains regulations pertaining to permits for electrical installations, placement of overhead lines, construction of substations and switching stations, penalties for breaches of licenses and regulations etc. The specific part and sub-parts relevant to the project are Part VI: Regulations appertaining to overhead lines and restrictions to placing electric lines above ground. This section includes the following stipulations:

- Except under and in accordance with the terms of a written authority granted by the Minister, no electric lines (other than service lines) shall be placed above the ground.
- Every support carrying electric lines shall be made of wood, steel reinforced concrete or any other approved materials and shall be protected against decay, corrosion or other deterioration.

- Every support shall be so constructed and placed as to withstand the transverse, horizontal and vertical loads calculated in accordance with Regulation 48 without exceeding the material's strength limits as set out in Regulation 53.
- Every electric line shall be made of copper, aluminium or steel, or any alloy or combination of any of such materials, subject to the approval of the Minister.
- All overhead electric lines shall be attached to suitable insulators carried on cross-arms or brackets of suitable materials and cross-section.
- All lines at angles shall be attached to the insulator so that the insulator and not the binding wire take the strain.
- The foundations shall be so constructed and placed, taking into account the reaction of the soil at times of the year in which they are embedded to the load that they are to carry.
- Every electric line shall have a copper equivalent cross-section area of not less than 16 square millimetres and an ultimate tensile strength of not less than 4 kilo-Newtons.
- Overhead electric line supports, in conjunction with stays and struts, if provided, shall withstand the longitudinal, transverse and vertical loads due to fittings, conductors and wind loadings under the most adverse temperature conditions.

❖ **Energy Commission of Nigeria Regulation, 1988**

The Energy Commission of Nigeria (ECN) was established in 1988 with the statutory mandate for strategic planning and coordination of national policies in the field of energy. It was established in line with the declaration of the Heads of the Economic Community of West African States in 1982 for the establishment of an Agency in each member state charged with the responsibility of coordinating and supervising all energy functions and activities. The functions of the ECN include, but are not limited to, the following:

- serve as a centre for gathering and dissemination of information relating to national policy in the field of energy;
- inquire into and advise the Government of the Federation or the State on adequate funding of the energy sector including research and development, production and distribution;
- monitor the performance of the Energy sector in the execution of government policies on energy; and
- serve as a centre for providing solutions to interrelated technical problems that may arise in the implementation of any policy relating to the field of energy.

- **Nigerian National Energy Policy (2004)**

The National Energy Policy establishes guidelines for the protection of the environment in the exploitation of Nigeria's fossil fuels. It also emphasizes the exploration of renewable and alternative energy sources, primarily solar, wind and biomass.

The overall thrust of the energy policy is the optimal utilization of the nation's energy resources for sustainable development. It addresses diverse issues such as research and development, energy pricing and financing, legislation, energy efficiency, environment etc.

The policy objectives and implementation strategies have been carefully defined with the fundamental guiding premise that energy is crucial to national development goals and that the government has a prime role in meeting the energy challenges facing the nation. The overall energy policy objectives are:

- Ensure the development of the nation's energy resources, with diversified energy resource options, for the achievement of national energy security and an efficient energy delivery system with an optimal energy resource mix;
- Guarantee increased contribution of energy-productive activities to national income;
- Guarantee adequate, reliable and sustainable supply of energy at appropriate costs and in an environmentally friendly manner, to the various sectors of the economy, for national development;
- Guarantee an efficient and cost-effective consumption pattern of energy resources;
- Accelerate the process of acquisition and diffusion of technology and managerial expertise in the energy sector and indigenous participation in energy sector industries, for stability and self-reliance;
- Promote increased investments and development of the energy sector industries with substantial private sector participation;
- Ensure comprehensive, integrated and well-informed energy sector plans and programmes for effective development;
- Foster international cooperation in energy trade and project development in both the African region and the world at large; and
- Successfully use the nation's abundant energy resources to promote international cooperation.

- **Nigerian Upstream Petroleum Regulatory Commission (NUPRC) Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) (formerly DPR), Established by PIA, 2021**

The Nigerian Midstream and Downstream Petroleum Regulatory Authority (Otherwise known as "The Authority") was created in August 2021 in line with the Petroleum Industry Act 2021 which provides legal, governance, regulatory and fiscal framework for the Nigerian Petroleum Industry as well as development of Host Communities.

NMDPRA encompasses a merger of three defunct regulatory agencies: the Petroleum Products Pricing Regulatory Agency (PPPRA), the Petroleum Equalization Fund {Management} Board (PEFMB), and the Midstream and Downstream Divisions of the Department of Petroleum Resources (DPR). This birth has ushered a new dawn for establishing a progressive regulatory framework that encourages investment and full optimization of the midstream and downstream sectors of the petroleum industry in Nigeria.

The Authority is responsible for the regulation of the midstream and downstream petroleum operations in Nigeria which includes technical, operational, and commercial activities The functions of the agency include;

- Regulate and monitor midstream and downstream operations in Nigeria.
- Determine appropriate tariff methodology.
- Set cost benchmarks for midstream and downstream operations.
- Advise the Government and stakeholders on commercial matters relating to tariff and pricing framework.
- Regulate the bulk storage, distribution, marketing, and transportation pipelines of petroleum products.
- Monitor and enforce compliance with the terms and conditions of licenses, permits, and authorizations issued by the authority.
- Set, define, and enforce approved standards and regulations for the design, construction, fabrication, operation, and maintenance of plants, installations, and facilities used or to be used in midstream and downstream petroleum operations.
- Ensure security of supply, development of the market and competition in the natural gas and petroleum products market.
- Establish customer protection measures in accordance with the provisions of the enabling Act.
- Promote competition and private sector participation in midstream and downstream petroleum operations

- **The Nigerian Urban and Regional Planning Act, 2004**

This Act establishes a Development Control Department (DCD) charged with the responsibility for matters relating to development control and implementation of physical development plans at Federal, State and Local Government levels within their respective jurisdiction.

- **Water Resources Act, Cap W2, LFN, 2004**

The Act is aimed at promoting the optimum planning, development and use of Nigeria's water resources; ensuring the co-ordination of activities that are likely to influence the quality, quantity; distribution, use and management of water; ensuring the application of appropriate standards and techniques for the investigation, use, control, protection, management and administration of water resources; and facilitating technical assistance and rehabilitation for water supplies.

- **Harmful Waste (Special Criminal Provisions) Act No 42 of 2004**

This Act prohibits and declares unlawful all activities relating to the purchase, sale, importation, transit, transportation, deposit, and storage of harmful wastes. Appropriate penalties for contravention are prescribed.

- **Criminal Code Act, CAP C38, LFN, 2004**

The Act contains the basic criminal law offences that relate to damage to the environment, public health and natural resources. Some environmental offences include: causing a public nuisance; fouling the water of any spring, stream, well or reservoir of a place; and violating the atmosphere in any place to make it noxious to the health of persons in general in the neighbourhood.

- **Labour Act of 2004**

The Labour Act is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers.

- **Trade Unions (Amendment) Act, 2005**

This Act contains provisions with respect to the formation, registration and organization of trade unions. It includes a stipulation of ‘equal pay for equal workers without discrimination on account of sex or any other ground whatsoever’.

- **Employees Compensation Act, 2010**

In accordance with the provisions of Sections 4(1) & 5(1) of the Employees’ Compensation Act, 2010, employers must report any occurrence of an accident, in which an employee or employees suffer injuries, alleged occupational disease, or death, in his workplace in the manner described hereunder. An employer is obliged to report the accident, injury or death occurring to an employee in the course of his/her work within 14 days after the occurrence of the accident or receipt of information pertaining to the occupational disease.

The objectives of the Act are to:

(a) Provide for an open and fair system of guaranteed and adequate compensation for all employees or their dependants for any death, injury, disease or disability arising out of or in the course of employment;

(b) Provide rehabilitation to employees with work-related disabilities as provided in this act;

(c) Establish and maintain a solvent compensation fund managed in the interest of employees and employers;

(d) Provide for fair and adequate assessments for employers;

(e) Provide an appeal procedure that is simple, fair and accessible, with minimal delays; and

(f) Combine efforts and resources of relevant stakeholders for the prevention of workplace disabilities, including the enforcement of occupational safety and health standards.

Furthermore, the Act provides a guideline for:

- Employer‘s obligation to report death, injury or disease of an employee; and Application for compensation.
- Part III prescribes guidelines for Compensation for Death, Injury or Disease.
- Part IV designates various Scale for Compensation and Payment Schedule

Other national regulations that apply to this project include:

- Electricity (Private Licenses) Regulations, 1965;
- Electricity (Annual Returns) Regulations, 1974;
- Electricity Installation Regulations, 1996;
- Electricity Supply Regulations, 1996;
- Energy Commission of Nigeria Act, Cap 109 LFN 1990;

- Utilities Charges Commission Act No. 104 of 1992;
- Electricity [Amendment] Act No. 28 of 1998

❖ **Factories Act, CAP F1, LFN, 2004**

The Factories Act is the primary law regulating the health, safety and welfare of workers in factories/facilities in the country. The law holds management and staff personally responsible for violations of the provisions of the Act. With respect to safety, there are general provisions as to the securing, fixing, usage, maintenance and storage of machinery, hoists and lifts, chains, ropes and lifting tackle, and other lifting machines. There are in addition to these, standards set for the training of workers, safe access to any workplace, and fire prevention.

❖ **Land Use Act CAP L5, LFN, 2004**

The Land Use Act revised in 2004 under the Constitution of 1999 and the Public Lands Acquisition Laws of the relevant states constitute the governing policy for land acquisition in Nigeria. As is the case with most National and State laws on the acquisition of land in the public interest or for a public purpose, the legislation enables the state to acquire land. The Acts also specify the procedures the state must follow to clear the land and define the compensatory measures the state must implement to compensate the affected people.

❖ **National Policy on Occupational Safety and Health**

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

❖ **The Nigerian Cultural Policy 1996**

The national cultural policy (1996) is generally regarded as an instrument of promoting national identity and Nigerian unity and the protection of cultural heritage.

❖ **Public Participation and Disclosure**

To a large extent, relevant regulatory authorities are required to inform the public of environment-related issues. Section 55 of the EIA Act provides for the maintenance of a Public Registry to facilitate public access to records relating to environmental assessments.

Public hearings to which interested members of the public are invited to provide comments on the EIA of a proposed project are a key part of the approval process by the FMEnv.

1.8.2 State Laws

The proposed Project falls within the jurisdiction of the Bayelsa State Government. The key State administrative authorities and legal instruments that are relevant to the proposed project are briefly described below:

- ❖ **Bayelsa State Ministry of Environment**

The Bayelsa State Ministry of Environment has the responsibility of environmental protection in the State. The former Bayelsa State Environmental Protection Agency (BYSEPA) was established in accordance with the provisions of Section 24 of the FEPA Act 58 of 1988. The Bayelsa State Environment and Development Planning Authority Edict of 1999 has the responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of natural resources in the State.

The applicable State regulations have been taken into cognizance in the execution of the proposed project. Some of the functions of the State Ministries of Environment include:

a) liaising with the Federal Ministry of Environment, FMEnv (formerly FEPA) to achieve the National policy on Environment,
b) co-operating with FMEnv and other National Directorates/Agencies in the performance of environmental functions including environmental education awareness to the citizenry,
c) responsibility for monitoring waste management standards,
d) responsibility for general environmental matters in the State, and
e) monitoring the implementation of EIAs and other environmental studies for all development projects in the State.

- ❖ **Bayelsa State Environmental and Sanitation Authority**

The Bayelsa State Environmental Sanitation Authority was officially established and inaugurated in March 2016. The Authority is primarily responsible for maintaining cleanliness, public health, and environmental sanitation throughout the state. It works to ensure that communities, urban centers, and public spaces are kept clean and free from pollutants, playing a crucial role in promoting public health and a sustainable environment.

Key functions of BESA typically include:

I. Waste Management and Disposal: Overseeing the collection, transportation, and disposal of waste, including household, industrial, and medical waste. The agency works to improve waste management practices, reduce waste accumulation, and prevent illegal dumping.

II. Sanitation and Public Health Campaigns: Conducting awareness programs to educate the public about proper sanitation practices, environmental hygiene, and waste disposal. These campaigns often include community clean-up activities and initiatives to prevent diseases caused by unsanitary conditions.

III. Environmental Monitoring and Enforcement: Ensuring compliance with state sanitation regulations, BESA may monitor pollution levels, enforce cleanliness in public areas, and penalize offenders who engage in unlawful waste disposal practices.

IV. Collaboration with Other Agencies: BESA often works with local government councils, the Ministry of Environment, and other agencies to implement sanitation policies effectively and ensure an integrated approach to environmental management within Bayelsa State.

❖ **Bayelsa State Policy on Environment**

The Bayelsa State Policy on Environment is shaped by a need to address serious environmental challenges posed by oil extraction, pollution, and climate change impacts in the Niger Delta region. This policy framework includes measures to counteract oil spills, gas flaring, deforestation, and water contamination. To enhance local environmental management, the Bayelsa State Oil and Environmental Commission was established to investigate and provide recommendations for mitigating the environmental damage from oil operations.

The Bayelsa State government has worked on several environmental initiatives, including advocacy for cleaner energy practices and restoration projects to support biodiversity and ecosystem health. These efforts align with the broader Sustainable Development Goals, especially in relation to environmental conservation, pollution control, and climate resilienc

❖ **Bayelsa State Ministry of Physical Planning and Urban Development**

The Bayelsa State Ministry of Physical Planning and Urban Development plays a key role in managing and enforcing urban development regulations to ensure sustainable infrastructure growth and address urban planning issues such as flooding and unauthorized building. The state's administration has recently emphasized stricter enforcement of physical planning laws to prevent illegal structures and ensure developments comply with the city's master plan.

- **Bayelsa State Environmental Sanitation Authority (Amendment) Law, 2001**

This law establishes the Bayelsa State Environmental Sanitation Authority and outlines its roles and responsibilities in ensuring environmental sanitation across the state. It empowers the authority to coordinate and enforce sanitation regulations, implement waste management systems, and promote public health through routine sanitation programs and environmental awareness campaigns.

- **Bayelsa State Companies in Large Scale (Industrial and Commercial Operations) Location of Office in Yenagoa Law, 2004**

This law mandates large-scale industrial and commercial companies operating in Bayelsa State to establish their principal offices in Yenagoa, the state capital. The law aims to promote economic growth and ensure the concentration of business operations in Yenagoa to boost its status as the state's commercial hub.

- **Bayelsa State Capital Development Authority Law, 2006**

This law provides for the establishment of the Bayelsa State Capital Development Authority (CDA) tasked with the planning, coordination, and implementation of infrastructural and urban development projects in Yenagoa. The CDA is responsible for enhancing urban aesthetics, developing public facilities, and ensuring orderly growth in the state capital.

- **Bayelsa State Physical Planning and Development Act, 2015.**

This law provides for the establishment of the Bayelsa State Capital Development Authority (CDA) tasked with the planning, coordination, and implementation of infrastructural and urban development projects in Yenagoa. The CDA is responsible for enhancing urban aesthetics, developing public facilities, and ensuring orderly growth in the state capital.

- **Bayelsa State Development and Investment Corporation Law, 2012**

This law establishes the Bayelsa State Development and Investment Corporation (BDIC) to drive investment and economic development in the state. The BDIC is tasked with promoting local and foreign investments, managing public-private partnership projects, and diversifying the state's economy through strategic initiatives in key sectors.

- **Yenagoa Master Plan, 2004**

The Yenagoa Master Plan of 2004 was developed to provide a strategic framework for the urban development of Yenagoa, the capital city of Bayelsa State. The plan focused on addressing the challenges of urbanization by creating a structured layout for residential, commercial, and industrial zones. It aimed to enhance infrastructure development, improve transportation networks, and create sustainable urban spaces to support the city's growing population and economic activities.

❖ **Yenagoa Development Master Plan, 2007**

Building upon the 2004 Master Plan, the Yenagoa Development Master Plan of 2007 introduced updated strategies to accommodate the rapid expansion of Yenagoa. It emphasized modern urban planning principles, including the integration of green spaces, improved drainage systems, and enhanced public utilities. The 2007 plan also aimed to align Yenagoa's growth with international urban development standards, focusing on making the city a regional economic and administrative hub.

❖ **Local Government Laws on Environmental Protection**

The site for the proposed project falls within Yenagoa LGA of Bayelsa State. The LGA has an Environmental Health Department which ensures compliance with environmental sanitation law, which includes maintaining good housekeeping at the proposed Project.

1.8.3 International Conventions

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

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

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

- **Convention Concerning the Protection of the World Cultural and Natural Heritage**

The Convention was adopted in Paris, France on October 17, 1972. The Convention sets aside areas of cultural and natural heritage for protection. It places obligations on each State Party to recognize that the duty of ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage situated on its territory, belongs primarily to that State.

- **Convention on the Conservation of Migratory Species of Wild Animals**

This Convention also known as the Bonn Convention was adopted in 1979 and entered into force in 1983. It stipulates actions for the conservation and management of migratory species including habitat conservation.

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

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

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

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

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

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

- **The United Nations Convention on Biological Diversity**

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

- **The United Nations Framework Convention on Climate Change**

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

- **Convention on the Protection and Promotion of the Diversity of Cultural Expressions**

The United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection and Promotion of the Diversity of Cultural Expression is a binding International legal instrument adopted on October 20, 2005. The Convention recognizes the rights of Parties to take measures to protect and promote the diversity of cultural expressions.

- **International Health Regulations**

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

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

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

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

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

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

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

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

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

- **The Rio Declaration on Environment and Development**

The Declaration was made in 1992 in Rio de Janeiro reaffirming the declaration of the United Nations Conference on Human Environment adopted at Stockholm in 1972. The Principle works towards international agreement which respects the interest of all and protects the integrity of the global environment and development. The relevant principles include:

<u>Principle 4</u>: To achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 17: EIA 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.

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

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

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

1.9 The EIA Process

This EIA study has been carried out in line with the Nigerian (FMEnv) EIA Procedural Guidelines as well as the relevant International Standards and Guidelines. The Nigerian EIA process is summarized in Figure 1.3

The EIA involves a number of key phases carried out in a stepwise manner. These include: scoping; literature review, one-season field data gathering; laboratory analysis; stakeholder engagement; impact identification and evaluation; development of mitigation measures and EMP, report writing and disclosure (in line with the FMEnv guidelines, this EIA report will be displayed for a 21-working day at various centres for public review. The general public will be notified through newspaper advertisements and radio announcements). Each of these phases is explained in detail in the subsequent chapters of this report.

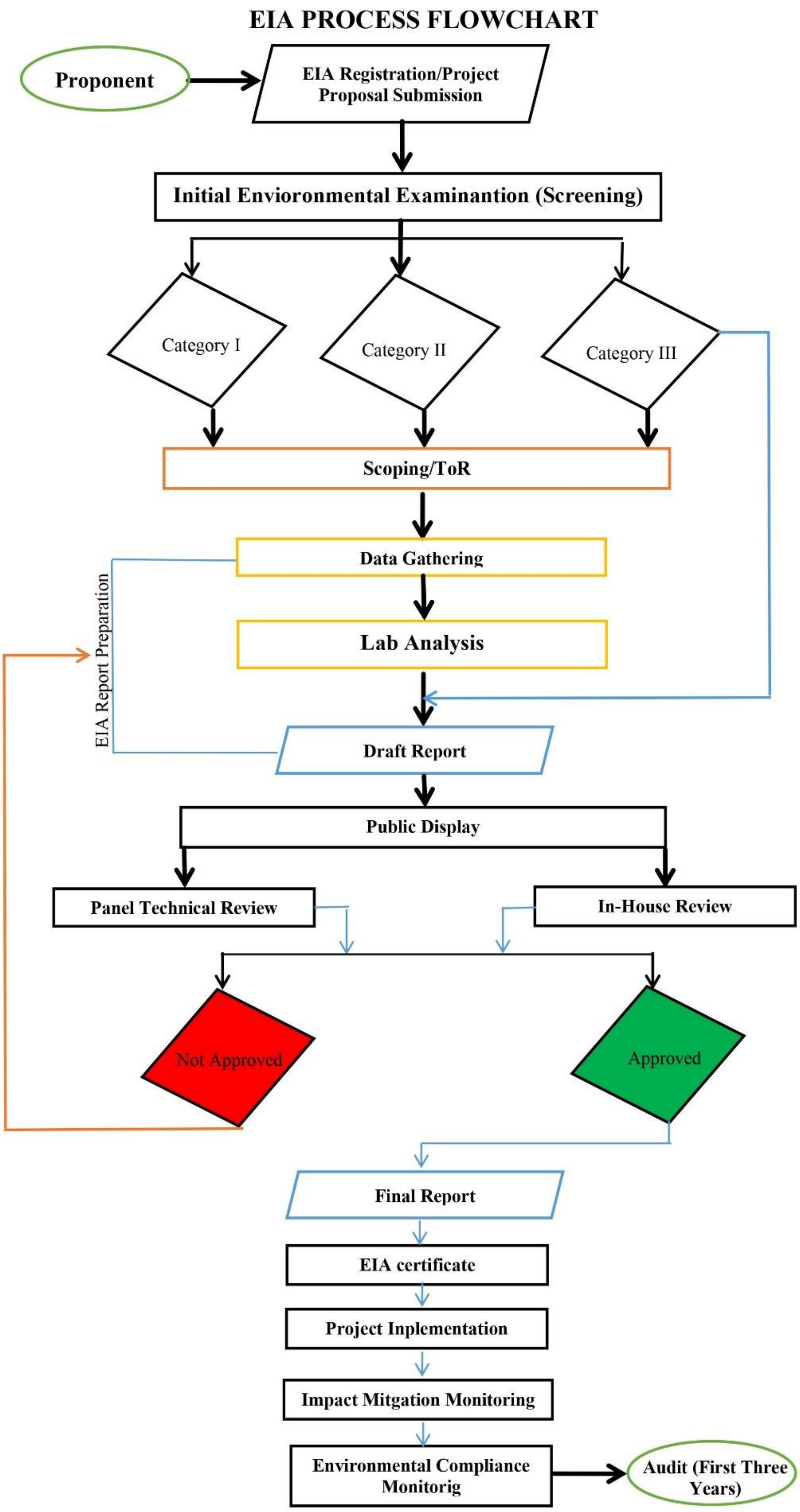

Figure 1.3: Overview of Nigeria EIA Process

1.10 Report Structure

In line with the FMEnv guidelines, this EIA report has been organized into nine (9) chapters. The EIA report is structured as follows:

Preliminary Sections: These include a Table of Contents, a List of Tables, Figures and Plates, and an Executive Summary

Chapter One: Introduction containing an overview of the proposed Project, the EIA objectives and process and applicable legal and institutional framework.

Chapter Two: Project Justification contains a rationale for the proposed Project as well as an analysis of Project alternatives.

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

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

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

Chapter Six: Mitigation measures for the identified environmental and social impacts.

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

Chapter Eight: presents an overview of the remediation plan after decommissioning and project closure.

Chapter Nine: Conclusions and Recommendations

References

Appendices

CHAPTER TWO
PROJECT JUSTIFICATION

2.1 Background

The Nigerian economy has experienced consistent growth, supported by Africa's largest oil production and natural gas reserves. Bayelsa State, a key oil-producing region, holds a significant share of these resources, contributing immensely to Nigeria's energy potential. However, despite this resource wealth, Nigeria faces persistent electricity shortages, which hinder national development. The strong link between socio-economic progress and reliable electricity access highlights the importance of addressing these gaps, especially in regions like Bayelsa that are rich in energy resources.

As Nigeria's industrial sectors expand and its population shifts from agrarian to urban communities, electricity demand continues to rise. Successive government efforts have aimed to expand supply, improve energy access, and encourage investment in the power sector, yet capacity remains insufficient, leading to frequent outages across the country. In response to this demand, Ogbodofei Integrated Services Limited is undertaking a project in Bayelsa to establish a 40MW Gas Turbine Power Plant. This plant will utilize Compressed Natural Gas (CNG) processed from natural gas supplied by the Nigerian National Petroleum Corporation (NNPC) under a formal supply agreement, specifically catering to the power needs of Bayelsa State.

2.2 Need for the Project

The proposed project addresses a critical need stemming from Nigeria's longstanding challenge of inadequate power supply, which has severely impacted various sectors of the economy and hindered industrial growth. Despite efforts such as the enactment of the Electric Power Sector Reform Act (EPSRA) in 2005 aimed at privatizing and enhancing the power sector, the electricity demand continues to outstrip supply.

The Proposed CNG and Power Plant Project is essential to bridge the gap between the growing demand for electricity and the current supply limitations. The 40MW Gas Turbine Power Plant, powered by Compressed Natural Gas (CNG) from the Nigerian National Petroleum Corporation (NNPC), will provide a reliable source of energy to the region, ensuring uninterrupted power supply for industries, businesses, and households. This project will not only address the pressing need for electricity in Bayelsa but also contribute to the overall economic development of the state by boosting industrial activity, creating jobs, and improving living conditions for the local population. Furthermore, the project seeks to achieve the following objectives:

- ✓ Increase the overall power generation capacity in Nigeria, thereby enhancing the reliability of grid electricity supply and meeting a larger portion of the country's electricity demand.
- ✓ Facilitate the utilization of indigenous natural gas reserves for domestic electricity consumption, thereby contributing to the development of national industrial and economic activities.
- ✓ Introduce modern and efficient generating units to the national power generation portfolio, improving the efficiency and sustainability of the energy sector.
- ✓ Generate employment opportunities for qualified individuals in the local community and across Nigeria, thereby contributing to socioeconomic development.

2.3 Project Benefits

The Proposed CNG and Power Plant Project in Bayelsa State is expected to deliver a wide range of social, economic, and environmental benefits, contributing significantly to the region's development and the broader national energy landscape. These benefits include:

I. ***Reliable Power Supply***: One of the primary benefits of the project is the provision of a stable and continuous electricity supply to Bayelsa State. By generating 40MW of power through a Gas Turbine Power Plant, the project will reduce the frequency of power outages, which currently hinder economic activities, industrial growth, and everyday life in the region.

II. ***Support for Industrial and Economic Growth:*** With a steady and reliable power supply, local industries, businesses, and manufacturing sectors in Bayelsa will experience improved operational efficiency. This, in turn, will boost productivity, foster job creation, and promote the growth of small and medium-sized enterprises (SMEs). The availability of power is crucial for attracting new investments and supporting the state’s industrialization goals.

III. ***Job Creation:*** The construction and operation of the power plant will create both direct and indirect employment opportunities. During the construction phase, jobs will be generated in civil works, engineering, and plant setup. Additionally, the ongoing operation of the plant will require skilled labor, including technicians, engineers, and support staff. The influx of workers and the demand for goods and services will stimulate the local economy, creating opportunities for local businesses and communities.

IV. ***Improved Quality of Life:*** A reliable power supply is essential for improving the living conditions of the population. With consistent electricity, households in Bayelsa will benefit from better access to modern amenities such as lighting, refrigeration, telecommunications, and healthcare services. Additionally, uninterrupted power will facilitate the functioning of schools, hospitals, and other public services, thereby enhancing the overall quality of life for the people of Bayelsa.

V. ***Energy Diversification:*** The project will contribute to Nigeria's efforts to diversify its energy sources and reduce reliance on the national grid. By utilizing Compressed Natural Gas (CNG) as a cleaner and more efficient energy source, the plant will help to reduce the environmental impacts associated with conventional fossil fuel-based power generation, promoting a more sustainable energy mix for the region and the country

VI. ***Environmental Sustainability***: Compared to traditional coal-fired power plants, natural gas-powered plants like the proposed project produce lower emissions of pollutants such as carbon dioxide, sulfur dioxide, and nitrogen oxides. As such, the project will support Nigeria's commitment to reducing greenhouse gas emissions and promoting cleaner energy alternatives. Furthermore, the use of CNG, a cleaner fuel, will contribute to reducing the carbon footprint of energy generation in Bayelsa.

VII. ***Economic Resilience:*** By improving the availability of power, the project will strengthen the economic resilience of Bayelsa and Nigeria as a whole. A reliable energy supply is fundamental to supporting critical sectors such as agriculture, manufacturing, and services, thereby fostering long-term economic stability and growth.

VIII. ***Social Development:*** The reliable electricity generated by the plant will enable communities to thrive through enhanced access to education, healthcare, and other essential services. Increased access to power will also facilitate the development of local infrastructure, such as roads and communication networks, further improving the socio-economic conditions of the population.

IX. ***Attraction of Investments:*** With a stable energy supply, Bayelsa will become an attractive location for both local and international investors. The project will create a conducive environment for further investments in sectors like manufacturing, agriculture, and tourism, potentially diversifying the local economy and boosting economic development.

X. ***Local Community Empowerment:*** The project will provide opportunities for local communities through social responsibility programs, community development initiatives, and stakeholder engagement. By actively involving local stakeholders and fostering partnerships with community groups, the project will ensure that its benefits are felt widely across the region.

2.4 Project Value

The envisioned capital cost of the Project is anticipated at around 20 million USD including the cost of preliminary surveys, design, procurement of plants and other equipment, consultancy as well as construction and commissioning. A substantial amount of the financial benefits of the project will be injected into the local, regional, and national economy through the procurement of contracts, engagement of direct and indirect labour as well as payment of taxes, duties, and other revenues to the government.

2.5 Project Sustainability

The sustainability of this project stems from the fact that it will make economic contributions and also satisfy environmental requirements. The sustainable development philosophy of minimizing cost and the impact on the environment has been adopted for this development project. The set goal is, to meet the needs of the present without compromising the ability of future generations to meet their own need.

2.5.1 Economic Sustainability

The proposed Project shall guarantee economic sustainability due to the accruable revenue from the project. Nigerians shall gain employment and skill acquisition opportunities through the direct and indirect involvement of contractors, consultants, suppliers and other professionals during the construction and operational phase of the project. Apart from the direct employment of persons, indirect employment and associated economic effects will be derived from the Project. And also

- Supply chain optimization by stimulating more economic activities in host communities, creating more rural employment opportunities, increasing incomes of rural households, and saving or earning foreign exchange through import substitution or more export earnings.
- Economically developed communities tend to pay more attention to allocated resources, improve their environment and foster social stability.

- Equity is encouraged whilst promoting healthy and resilient ecological systems that support economic development and contribute to social resilience.

2.5.2 Environmental Sustainability

The project shall ensure the maintenance of high-level performance and the adoption of environmental processes by adequately addressing environmental issues. The findings of the Environmental Impact Assessment (EIA) and the recommendations in the Environmental and Social Management Plan (ESMP) shall be integrated into all phases of the project and implemented throughout its lifetime. The aim is to ensure that the project does not damage prospects for use by future generations. Ogbodofei Integrated Services Limited will enforce its policy of compliance with statutory regulations and its own corporate guidelines on HSE and at the same time is committed to performance improvement. The following measures will be taken for sustainable environmental suitability:

- All projects' facilities shall be designed and constructed to keep environmental impacts at the minimum and acceptable limits.
- All operations shall be carried out to conform to all relevant national laws and regulations (e.g. FMEnv and Bayelsa State Ministry of Environment).
- Resource-use efficiency to promote a lower carbon footprint when performed in a sustainable manner with renewable energy sources.

2.5.3 Technical Sustainability

The proposed project is technically sustainable because of the proponent's strict adherence to nationally acceptable engineering design and construction standards. Innovative technologies that are economically viable and have minimal environmental, social and health impacts shall be utilized in the execution of the proposed project.

Best Available Technology (BAT) shall be applied right from the commencement of activities by project initiators and these shall be further enhanced during all production activities. Additionally, the proposed project is considered economically viable and sustainable given the following considerations:

(i) Stringent safety measures would be built into the design and fabrication of facilities. The design and safety considerations that would be employed in this project shall originate from tested specification packages in strict compliance with with local Nigerian standards, where applicable.

(ii) Ogbodofei Integrated Services Limited's management is committed to continuous development and motivation of its human resource base through effective training or re-training, and an attractive remuneration and reward system. Furthermore, to ensure the transfer of relevant technologies, staff training on different aspects of the project would be an integral part of the key contractors' responsibilities.

2.5.4 Social Sustainability

The stakeholder consultation process has been implemented as part of the EIA process to ensure that all stakeholders provide input into the project planning process. OISL will ensure that the consultation, which started with the scoping workshop exercise, shall be sustained throughout the project's lifecycle. This will undoubtedly foster a sustainable social relationship between OISL and the host communities. Among the measures to be adopted to ensure the social sustainability of the project include;

a) *Robust and sustained stakeholder engagement:* Ogbodofei Integrated Services Limited will ensure sustained and effective Stakeholder Engagement in a structured and culturally appropriate manner with the affected communities. The consultation process is tailored to the risks and impacts of the project; the project's phase of development; the language preferences of the affected communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups. In a demonstration of Ogbodofei Integrated Services Limited's social policies, a robust community engagement was instituted as part of the ESIA work (details are presented in Chapter Four).
b) *Establishment of Grievance Redress Mechanism (GRM):* GRM will be designed to receive and facilitate the resolution of concerns and grievances about the project's environmental and social performance as part of its Environmental and Social Management System (ESMS). Potential sources of grievances and acts of sabotage could include community youth groups, tribal conflicts, boundary conflicts, etc.

2.6 Project Options

Having considered and identified the electric power supply gap in Nigeria and concluding that there is an urgent need to supply some of the identified gaps, it is now necessary to decide on the best way to meet this need. Decisions have to be made on the optimum way to meet these needs. Project Options represent possible lines of attack to be taken against the problem the project is designed to solve. Thus efforts should be geared towards evaluating the relative attractiveness by comparing to various selection criteria. The options selected are ultimately characterized by different project variables. Thus after having decided on an action option, we then analyze and select the type of work to be required for the project. Thus the following options were considered with respect to the power plant project in Nigeria:

Option 1 - No - project Option

Option 2 - Do - project Option

Option 3 - Delayed - Project Option

2.6.1 No-Project Option

The No-Project Option addresses the effects of not implementing the proposed power generation project. Adopting this option renders all the resources used at the planning stage wasted. In addition, a "business-as-usual" scenario, which involves poor electricity supply, reluctance of investors to establish industries and other developments in Nigeria, poor living conditions and unemployment among the host communities. Therefore, this option is not desirable and is not considered.

2.6.2 Do-Project Option

This option involves the execution of the proposed power generation project. This option will lead to the expansion of electricity generating capacity to meet national economic and social development goals as well as other rippling benefits of the project. The option was accepted based on the overwhelming benefits to be derived from the project.

2.6.3 Delayed Project Alternative

This option (delayed project option) entails that the Power Plant project be 'put on hold'. This will mean that the much-desired benefits and development that the project seeks to bring forth will be delayed or indirectly forfeited. The Proponent has mapped out a 'Project Implementation Schedule' after planning the execution of the project. The project has been carefully planned to commence at a time when the optimal benefits of the project can be maximized. This option was rejected because delaying the project indirectly implies non-implementation of the project.

2.7 Project Alternatives

The Environmental and Social Impact Assessment (ESIA) study sought to consider possible alternatives to the proposed project. The study has therefore sought to identify and assess alternatives to the proposed developments to have the best working models that may have the least or minimal negative effects. two alternatives were considered.

2.7.1 Location Alternative

The proposed location for the CNG and Power Plant project was carefully considered, with all states in the Niger Delta region evaluated as potential sites. However, Bayelsa State was ultimately selected as the preferred location for the following key reasons:

- ***Indigenous Company Commitment:*** Ogbodofei Integrated Services Limited, the proponent of the project, is an indigenous company with deep-rooted ties to Bayelsa State. As part of its corporate social responsibility and commitment to the development of the region, the company aims to contribute directly to the socio-economic growth and welfare of the people of Bayelsa. The decision to locate the project in Bayelsa aligns with the company's mission to improve local infrastructure, create job opportunities, and enhance the quality of life for the residents of the state.
- ***Resource Availability:*** Bayelsa State, being a major oil and gas-producing region in the Niger Delta, offers abundant natural resources, including natural gas, which is the primary fuel for the proposed power plant. The close proximity to these resources reduces transportation costs and ensures a reliable, consistent fuel supply, making Bayelsa an ideal location for such a project.
- ***Economic Development and Industrialization:*** Bayelsa State has significant potential for economic development, particularly in the energy sector, where there is a growing demand for reliable and sustainable power. The establishment of a power plant in the state will contribute to the development of local industries, support economic diversification, and create employment opportunities, helping to drive the state's industrialization efforts.
- ***Improvement of Local Infrastructure:*** The project will lead to the development of critical infrastructure in the region, including power distribution networks, roads, and support services. These infrastructure improvements will benefit the local communities and facilitate other economic activities in the state. Furthermore, the project will enhance the capacity of the state to attract further investments in other sectors.

Consequently, while other states in the Niger Delta were considered for the project, Bayelsa's strategic advantages, the company's local roots, and the potential for social and economic impact made it the most suitable choice. although alternative locations are reasonable, they are not financially feasible options. Moreover, from an environmental and social (E&S) perspective, there are no environmental or social fatal flaws or red flags associated with the location of the project. As such, location alternatives will not be considered any further in this EIA.

2.7.2 Energy Alternatives

Several energy sources were considered as alternatives to Compressed Natural Gas (CNG) for powering the Proposed Power Plant. The evaluation of these alternatives was based on factors such as availability, sustainability, environmental impact, and suitability for the region's energy needs. Below are the primary energy alternatives that were considered:

I. **Coal**

Coal, a conventional fossil fuel, was considered as an alternative energy source due to its availability and historical use in power generation.

Reasons for Exclusion:

- **Environmental Impact**: Coal combustion generates significant amounts of carbon dioxide (CO_2), sulfur dioxide (SO_2), and other pollutants, contributing to air pollution and climate change. The environmental consequences of coal-fired power plants would not align with modern efforts to reduce emissions and transition to cleaner energy sources.
- **Lack of Local Availability**: Bayelsa State does not have significant coal reserves, making coal a less viable option due to high transportation costs and logistical challenges in sourcing the fuel.

II. **Hydropower**

Hydropower is another alternative energy source that could potentially be harnessed for power generation in Bayelsa, given the region's access to water resources.

Reasons for Exclusion:

- **Environmental and Social Impacts**: Large-scale hydropower projects require significant alterations to natural water bodies, including the construction of dams, which can lead to displacement of local communities and adverse ecological impacts such as biodiversity loss and water quality degradation.

- **Suitability and Scale**: While small-scale hydropower could be feasible, the required infrastructure for large-scale hydropower would not be suitable for the region at this time, given the environmental concerns and the limited availability of suitable sites.

III. **Solar Energy**

Solar energy is a renewable resource with abundant potential in Nigeria, especially in areas with high sunlight exposure. Solar power generation was considered as a clean, sustainable energy alternative.

Reasons for Exclusion:

- **Intermittency and Reliability**: Solar energy is intermittent and depends on weather conditions and time of day. This limits its ability to provide a consistent, reliable power supply for industrial and commercial use, which requires a stable base-load energy source.
- **Land and Infrastructure Requirements**: Large-scale solar power plants require large tracts of land and significant upfront investment in infrastructure, such as solar panels, inverters, and storage systems. Given the scale of the energy demand, solar alone would not be sufficient to meet the energy needs of Bayelsa.

IV. **Wind Energy**

Wind energy was also considered as a renewable alternative, especially given the increasing global shift toward sustainable energy sources.

Reasons for Exclusion:

- **Inconsistent Wind Patterns**: Bayelsa State does not experience the consistent wind patterns required for efficient wind energy generation. Wind energy is most effective in coastal and open areas where wind speeds are steady and reliable, which is not the case in the specific location considered for the power plant.
- **Infrastructure Costs**: Wind farms require significant investment in wind turbines and related infrastructure, and the maintenance of turbines in coastal regions can be costly due to corrosion from salty air.

V. **Geothermal Energy**

Geothermal energy, which uses heat from the Earth's core for power generation, was also briefly considered as an alternative.

Reasons for Exclusion:

- **Lack of Geothermal Resources**: Bayelsa State does not have the geothermal resources necessary to support large-scale geothermal power plants. The absence of active geothermal zones in the region makes this energy source unsuitable for the project.

After considering various energy sources, **Compressed Natural Gas (CNG)** was selected as the most viable and sustainable option for the power plant. CNG is a cleaner alternative to coal and provides a more reliable and consistent energy supply compared to intermittent renewable energy sources such as solar and wind. Additionally, Bayelsa's proximity to natural gas reserves makes CNG an ideal fuel source, offering logistical and cost advantages for the proposed project.

2.7.3 Technology Alternatives

The selection of technology for power generation is a critical factor in determining the efficiency, environmental impact, and overall success of the project. Several technological alternatives were evaluated for the proposed CNG and Power Plant Project. Below are the key technology options considered:

I. **Gas Turbine Power Plant**

The proposed project utilizes a **Gas Turbine Power Plant**, which is the most efficient and suitable technology for natural gas-fired power generation.

Reasons for Selection:

- **Efficiency**: Gas turbines are highly efficient in converting natural gas into electricity, offering a reliable and cost-effective solution for meeting base-load energy demand.
- **Environmental Performance**: Gas turbines produce lower emissions compared to other fossil-fuel-based technologies such as coal-fired plants. They generate significantly fewer particulate emissions and produce lower carbon emissions, aligning with the project's environmental sustainability goals.
- **Modular Design**: Gas turbines are scalable and can be expanded as demand for power increases, providing flexibility for future growth.

II. **Combined Cycle Gas Turbine (CCGT)**

A **Combined Cycle Gas Turbine (CCGT)**, which integrates both gas turbines and steam turbines to generate electricity more efficiently, was considered.

Reasons for Exclusion:

- **Complexity and Cost**: CCGT systems require more complex infrastructure and higher capital investment than simple gas turbine plants. Although CCGT offers higher efficiency, the cost of implementation and maintenance would be higher, and the scale of the project did not warrant the use of this more complex technology at this stage.
- **Space Requirements**: CCGT systems also require more land and space for installation, which may not be ideal for the proposed location in Bayelsa.

III. **Reciprocating Engine Power Plants**

Reciprocating engine power plants, using internal combustion engines powered by natural gas, were also considered as a technology option.

Reasons for Exclusion:

- **Lower Efficiency**: While reciprocating engines are generally more cost-effective for small-scale power generation, they have lower efficiency compared to gas turbines.
- **Maintenance Challenges**: Reciprocating engines typically require higher maintenance compared to gas turbines, which could lead to increased downtime and operational costs.

IV. **Open Cycle Gas Turbine (OCGT)**

The Open Cycle Gas Turbine (OCGT), a simpler form of gas turbine technology, was another option evaluated for the project.

Reasons for Exclusion:

- **Lower Efficiency**: OCGT systems are less efficient than Combined Cycle Gas Turbines and cannot take full advantage of the waste heat produced during electricity generation. This makes them less suitable for large-scale power generation compared to more advanced technologies like combined-cycle systems.

After evaluating the various technological options, the **Gas Turbine Power Plant** was selected as the optimal solution. This technology offers a good balance of efficiency, environmental performance, and cost-effectiveness, making it the ideal choice for the proposed project in

Bayelsa. The gas turbine technology provides reliable power generation while minimizing the environmental impact, aligning with the project's sustainability and efficiency objectives.

CHAPTER THREE

PROCESS AND PROJECT DESCRIPTION

3.1 General

This chapter highlights in detail the features of the Project's basic activities, project components, location, layout plan and implementation schedule.

3.2 Project Location

The proposed Project will be situated within Ogboloma Town in Yenagoa LGA, Bayelsa State, Nigeria. The proposed location of the 100MMSCF/D CNG and 40MW Gas turbine power plant will be located on a land take of 16Hectares at along Etelebou Road, Ogboloma Town in Yenagoa Local Government Area, Bayelsa State.The project area is bounded by the coordinates: 5°01'32."N, 6°20'50.40"E; 5°01'30.001"N, 6°20'54.06"E; 5°01'26.136"N, 6°20'47.751"E; 5°01'23.722"N, 6°20'51.836"E The survey plan of the proposed project is presented in Figure 3.1.

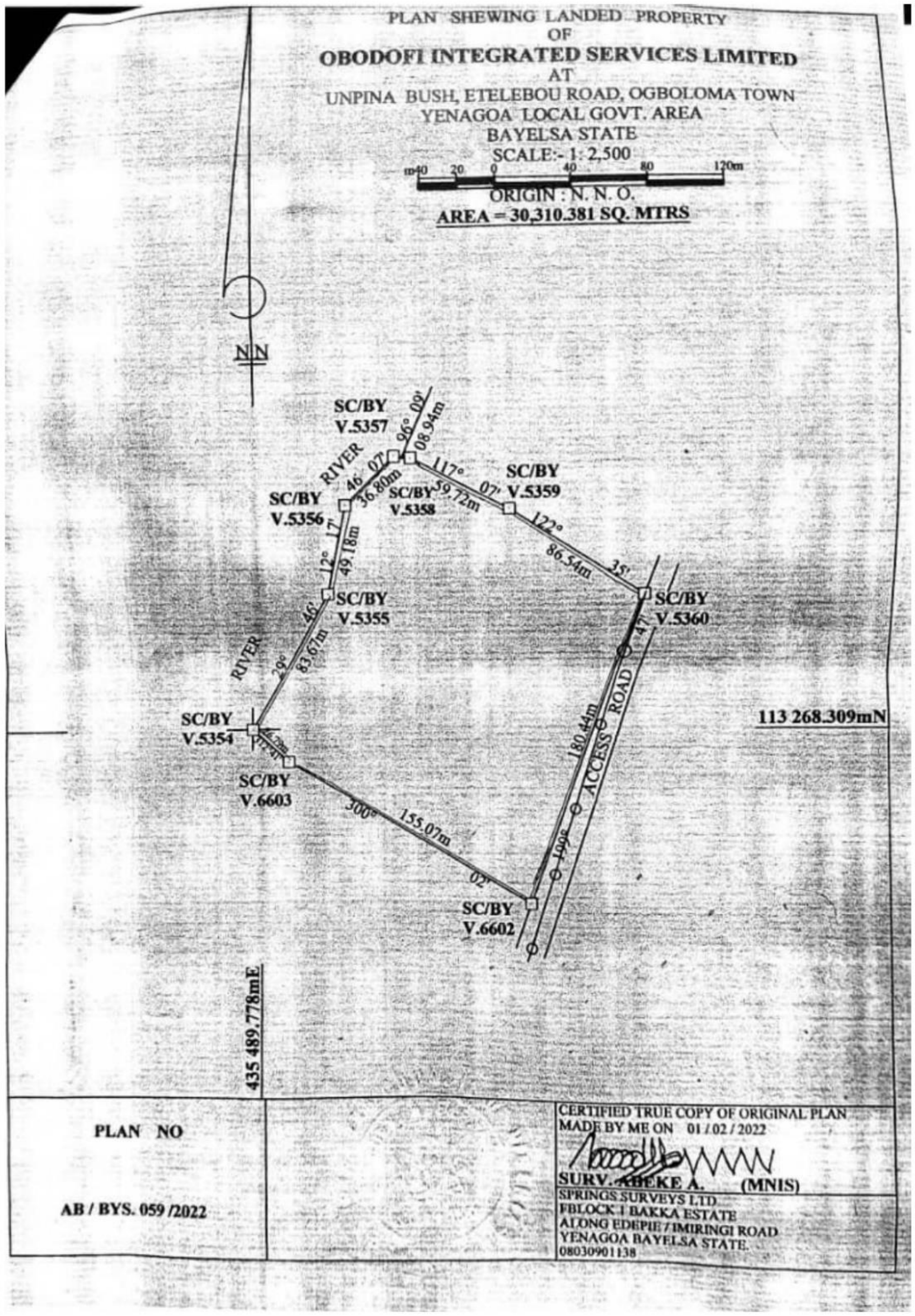

Figure 3.1: Proposed Project Survey Plan

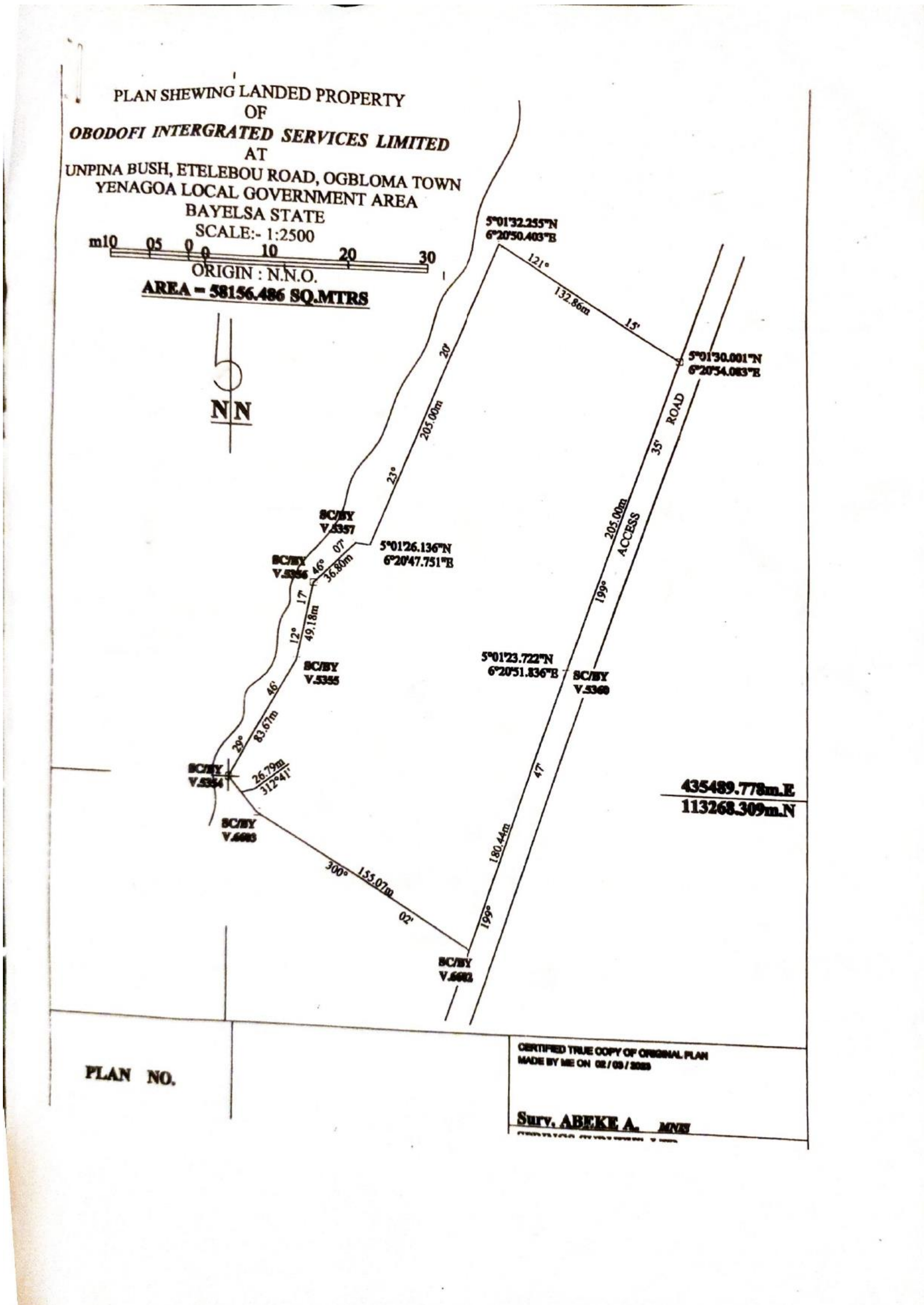

Figure 3.1b: Proposed Project Survey Plan

3.3 Project Scope

The project entails the processing of Natural Gas supplied from NNPC Gas Marketing Limited into Compressed Natural Gas which would also serve as feed stock to the proposed 40MW Gas Fired Power Plant as described in the flow diagram on figure 3.1

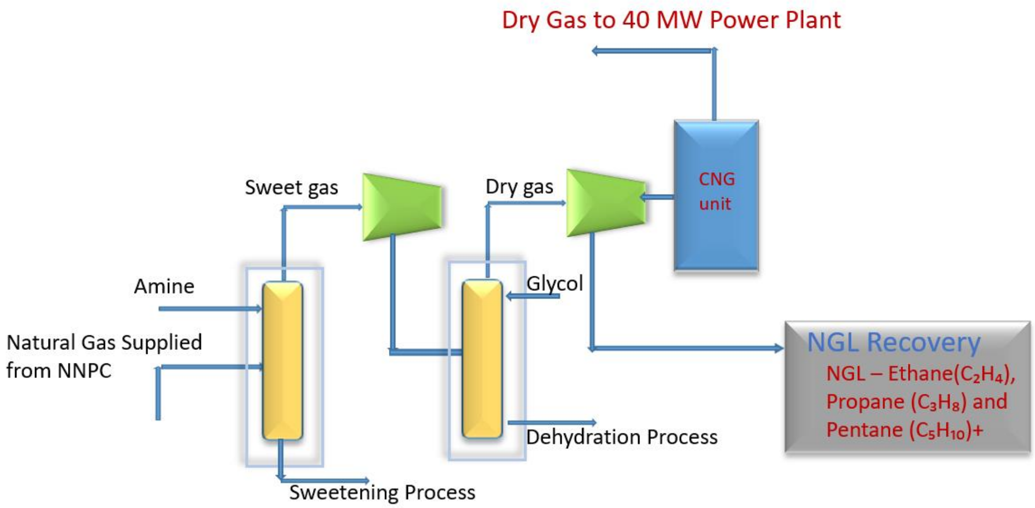

Figure 3.2: Flow diagram for CNG & Power Plant

The initial phase of the project will establish a 40MW production capacity for both CNG and electricity, powered by two 20MW gas turbines configured in a 2 x 20MW setup. The plant is designed with an optional future expansion to 60MW in a combined-cycle configuration, which will incorporate a steam turbine to capture and utilize waste heat from the gas turbines, thereby improving efficiency and maximizing output. Fuel gas consumption is projected to be approximately 10MW to sustain plant operations.

In the current configuration, the two 20MW gas turbines will support both CNG production and power generation. For the planned 60MW expansion, the project includes infrastructure provisions for combined-cycle generation, enabling the capture of exhaust heat from the gas turbines to power a steam turbine, which will significantly increase overall plant efficiency and reduce emissions. Aligned with modern environmental standards, the plant will use low-emission gas turbines to reduce greenhouse gas output, with the combined-cycle system expected to enhance efficiency by 50-60% over the initial open-cycle setup.

3.4 Project Components

The Project core components comprises the following:

- Administrative facilities
  - Office and Rest room
  - Panel control room
  - Conference Room
  - Training Rooms
  - First Aid Room
  - Security Office
  - Maintenance Room
  - Storage Rooms
- Power generation facilities
  - 2 x 20 MW Gas Turbines
  - Black Start/ Emergency Diesel Generator
  - Modular Substation (11kV Switchboard LV Switch board/Motor control center, AC UPS / DC UPS and distribution board)
  - Transformers (11kV/400V 2500kVA ONAN 11Kv/33kV 35/37.5MVA ONAN/ONAF)
  - Piping and fittings
- Fuel storage facilities
  - Diesel tanks.
  - liquid fuel booster pumps
- Gas Supply facilities
  - Pressure reduction and metering system (PRMS)
  - 2 Gas booster compressors and panel
  - Internal Gas pipeline System
- Fire protection system
- Water supply and distribution network
  - Borehole point
  - Water pump

    - Water cooler
    - Pipes for internal water supply system
    - Fire water tank
- Septic tank

3.4.1 Power Plant Overview

The proposed power plant project involves the phased installation of a 40 MW Open Cycle Power Plant (OCPP), with the initial phase deploying two 20 MW gas turbines configured as a 2 x 20 MW system. The plant is designed to operate on Compressed Natural Gas (CNG) sourced directly from a dedicated CNG production facility. This strategic setup ensures a reliable fuel supply while leveraging clean-burning natural gas for efficient power generation. The first phase will deliver 40 MW of electricity to meet immediate energy demands, with a fuel consumption of approximately 10 MW to sustain plant operations. The project aligns with modern energy practices by prioritizing efficiency, environmental compliance, and scalability.

In anticipation of future energy demands, the power plant is designed with provisions for an optional expansion to a 60 MW combined-cycle configuration. This upgrade will include the addition of a steam turbine, enabling the capture and utilization of waste heat from the gas turbines to enhance efficiency and maximize output. The combined-cycle configuration offers a sustainable pathway for increasing capacity while reducing carbon intensity, underscoring the project's commitment to long-term energy solutions. This forward-thinking approach ensures the plant's operational flexibility and resilience, positioning it as a critical asset for meeting growing electricity needs in the region.

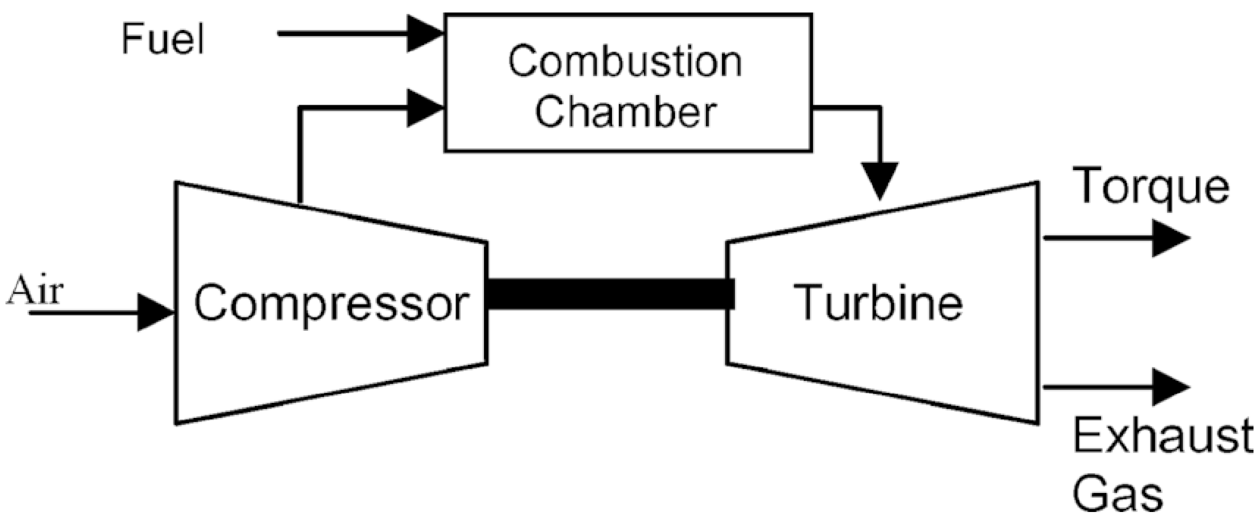

Figure 3.3: Open Cycle Power Plant Flow Diagram

3.4.2 CNG Processing Plant Overview

The 100MMSCF/Day CNG plant is designed to efficiently process raw natural gas into high-quality compressed natural gas (CNG) for storage, distribution, power generation and various applications. The process begins with Gas Receiving and Metering, where natural gas supplied by NNPC Gas Marketing Limited is measured to ensure accurate monitoring and process control. During Pre-Treatment, the gas undergoes filtration to remove particles, dehydration to reduce moisture levels below 0.1 ppm, and acid gas removal to eliminate contaminants like CO_2 and H_2S, ensuring compliance with quality standards and protecting downstream equipment. These steps are essential for maintaining gas purity and preventing issues such as hydrate formation and corrosion.

The Compression stage utilizes a two-stage process to increase gas pressure for efficient storage and delivery. The first stage employs a centrifugal compressor to boost pressure to approximately 120 bar, supported by intercooling for thermal efficiency, while the second stage uses a reciprocating compressor to achieve a final pressure of 250 bar. Together, these stages require 20–25 MW of power. The compressed gas is stored in high-pressure vessels designed to hold 1–2 days of production, ensuring a continuous supply for both dispensing and power generation. The Dispensing and Loading process includes high-capacity dispensers with flow rates of up to

1,500 Nm^3/hour, reducing pressure to 200 bar for safe and rapid filling into transportation systems or distribution networks.

Advanced technologies ensure the plant's efficiency and reliability. Membrane Separation or Pressure Swing Adsorption (PSA) systems are used for removing impurities like CO_2 and water vapor, producing high-purity CNG. These methods are energy-efficient and suitable for processing large gas volumes. For dehydration, the plant employs either Molecular Sieve Dehydration to reduce moisture content to extremely low levels or Glycol Dehydration, which uses triethylene glycol (TEG) in a continuous process to handle variable gas flow rates. These technologies are essential for ensuring the gas remains safe and non-corrosive, especially under high-pressure conditions.

The plant also integrates Advanced Control Systems driven by AI and machine learning to monitor and optimize operations. These systems predict maintenance needs, reduce energy consumption, and enhance equipment longevity by analyzing historical and real-time data to adjust process parameters dynamically. Additionally, Continuous Quality Monitoring Systems track key gas quality metrics such as CO_2, H_2S, moisture, and hydrocarbon levels throughout the production process. This proactive quality management guarantees compliance with environmental and safety standards, delivering consistent and high-quality CNG for all applications.

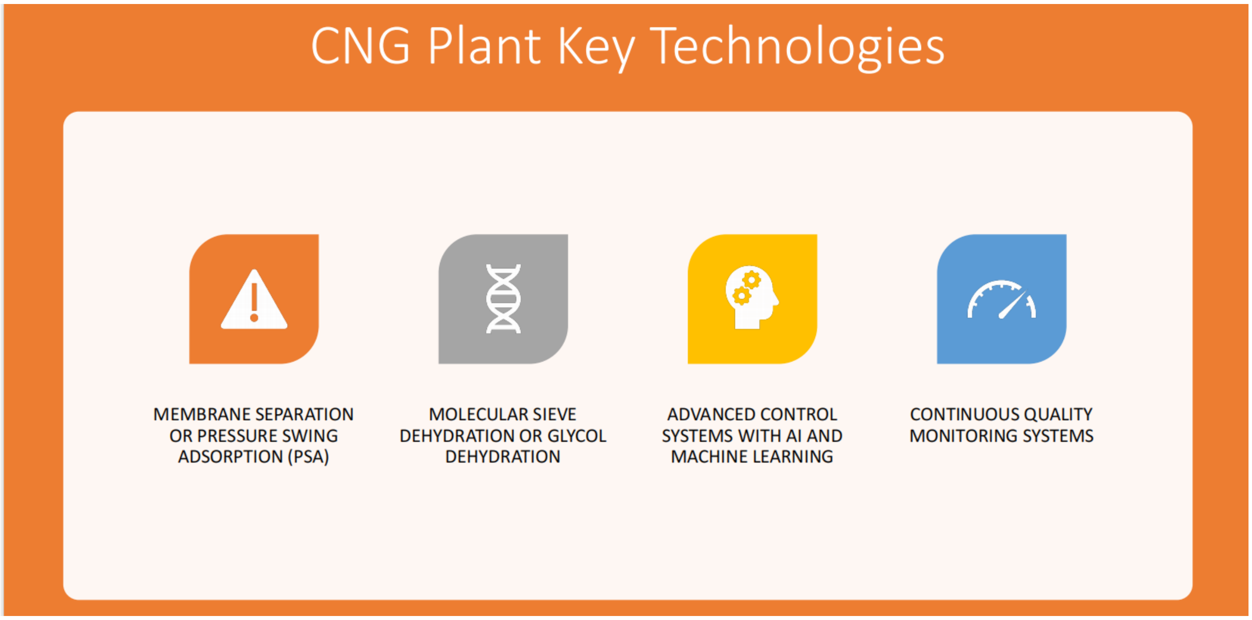

Figure 3.4: Proposed CNG Plant Key Technology
Source: Obodofei Integrated Services, 2024

3.4.3 Environmental and Safety Considerations

To meet regulatory requirements and uphold Obodofei Integrated Services Limited Environmental and Safety Standards, the plant incorporates advanced systems and technologies designed to minimize environmental impact and ensure the safety of personnel and surrounding communities. Key include:

1. **Emissions Control Technologies**
   - The plant is equipped with low-emission gas turbines and additional emissions control systems to reduce greenhouse gases and pollutants. Technologies such as selective catalytic reduction (SCR) and oxidation catalysts are employed to minimize nitrogen oxides (NOx), carbon monoxide (CO), and other harmful emissions, aligning with environmental standards and minimizing the plant's carbon footprint.
2. **Waste Management Systems**
   - Effective waste management systems are in place to handle both solid and liquid waste generated by the plant. Hazardous waste is carefully separated and treated according to environmental guidelines, while recycling initiatives help manage

non-hazardous waste. Wastewater from operations undergoes treatment before discharge or reuse, ensuring minimal environmental contamination.

3. **Noise Reduction Measures**
   - Noise reduction is essential to minimize impact on nearby communities and maintain a safe working environment. The plant utilizes soundproofing materials around compressors and turbines, along with acoustic barriers and silencers to limit noise emissions. Regular noise monitoring is conducted to ensure compliance with regulatory noise limits and to protect worker health.
4. **Emergency Shutdown System (ESD)**
   - A robust Emergency Shutdown System (ESD) is in place to safely halt operations in case of equipment failure, process upsets, or external hazards. The ESD is designed to quickly isolate critical plant areas, preventing incidents and ensuring personnel safety. The system is integrated with alarms and automated responses to initiate rapid shutdown and containment measures.
5. **Methane Leak Detection and Repair (LDAR)**
   - Methane leak detection and repair (LDAR) protocols are implemented to monitor and address potential methane leaks. Advanced sensors and regular inspections ensure early detection, reducing emissions and mitigating environmental impact. Prompt repair of leaks is prioritized to maintain plant safety and comply with methane emissions regulations.
6. **Fire Detection and Suppression Systems**
   - Comprehensive fire detection and suppression systems are installed throughout the facility to mitigate fire risks. The system includes smoke and heat detectors, automatic sprinklers, and foam suppression in high-risk areas. Regular fire drills and safety training for personnel further ensure preparedness in case of fire-related incidents, protecting both the plant and its surroundings.

3.5 Project Phases

The proposed project will be developed in the following set of phases:

- Pre-construction/Design Phase
- Construction/Installation Phase
- Operation/Maintenance Phase; and
- Decommissioning Phase

Each of these four phases has a different combination of activities and the commencement of each phase is dependent on the outcome and success of its predecessor. It must be noted that the scope of the proposed Project, and the associated Project Environmental Impact Assessment (EIA), relates to all four phases.

3.5.1 Pre-construction/Design Phase

The preconstruction phase of the project primarily entails desktop activities, which include feasibility studies integrating environmental, technical, and financial considerations. These investigations are geared towards ensuring the project's viability and long-term sustainability while minimizing adverse environmental impacts.

This phase encompasses a range of tasks, including:

- Procurement of materials and equipment,
- Front End Engineering Designs
- Site preparation
- and excavation for foundation laying.

Furthermore, preparations will be made for the pre-mobilization of equipment, tools, and personnel, followed by the mobilization of resources to the project site, including equipment, personnel, and construction materials.

3.5.2 Construction Phase

3.5.2.1 Construction activities

Activities during the construction phase will include:

- Excavation and preparation of the ground for the foundation and other structures.

- Civil foundations.
- Establishing the interconnecting spur line to facilitate fluid transfer between different parts of the plant.
- Building the plinths and platforms for the gas turbines, and other major equipment.
- Conducting various civil works necessary for the plant's infrastructure.
- Installing the gas turbines, and other modular components.
- Installing pipelines and flowlines to connect different sections of the power plant.
- Filling excavated areas with suitable materials, ensuring stability and support.
- Dismantling and removing temporary construction facilities and equipment.

Table 3.1: Estimated type of heavy duty vehicles to be used during project construction

Item	**Operational Use**	**Quantity**	
Excavators	Would be used for site preparation, excavation, trenching, and grading	3	
Bulldozers	Used for clearing land, levelling terrain, and pushing soil.	2	

Item	**Operational Use**	**Quantity**	
Dump trucks	Used for hauling materials such as soil, gravel, and construction debris.	5	
Crane	Used for lifting heavy equipment and materials during construction.	1	
Rollers	Used for compacting soil	1	

Item	Operational Use	Quantity	
Transportation vehicles	This Includes flatbed trucks, low loaders, and trailers for transporting heavy equipment to and from the site.	3	

3.5.2.2 Construction Utilities

Power Supply: The power requirements for the CNG plant are projected to range between 25–30 MW, with a significant portion supplied by the on-site power generation facility. This ensures a reliable and sustainable energy source to meet the operational demands of critical systems such as gas compression, control systems, and auxiliary equipment. Additional temporary power during construction will be provided by diesel-powered generators, with diesel consumption incorporated into the overall estimate for the project.

Cooling water: This is essential for various processes, with an estimated demand of 500–1,000 m^3/hour to support equipment such as compressors and heat exchangers. Instrument air requirements are expected to be 100–150 Nm^3/hour, delivered at a pressure of 7–8 bar. These utilities are critical for ensuring safe and efficient operations, providing cooling, pressure control, and automation capabilities necessary for the plant's systems.

During the construction phase, approximately 500,000 liters of water will be needed for activities such as concrete curing, dust suppression, and other site works. Daily water requirements will vary based on the schedule of activities, but adequate provisions will be made to ensure a continuous supply. Additionally, compressed air will be generated using portable compressors to support construction needs, such as powering pneumatic tools and systems.

Diesel consumption: during construction is estimated at approximately 60,000 liters, accounting for fuel requirements for generators and construction equipment. This includes power generation for temporary site facilities, lighting, and equipment operation. Careful management of fuel and energy resources will ensure that construction progresses efficiently while minimizing environmental impact.

3.5.3 Operational Phase

3.5.3.1 Power Plant Operation and Maintenance

Routine Operations: The operation of the proposed power plant will involve a meticulous blend of automated and manual processes to ensure continuous and efficient electricity generation. Automated systems will optimize efficiency and responsiveness, while manual operations will provide essential human oversight, decision-making, and hands-on maintenance to uphold the reliability, safety, and performance of the facility.

Planned maintenance: A proactive and systematic maintenance approach will be implemented to ensure the longevity and optimal functioning of plant equipment. This approach will encompass regular checks, inspections, and preventive measures to identify and address wear and tear, mitigate potential issues, and extend the lifespan of critical components.

Transmission Line Maintenance: Regular inspections and maintenance of the transmission lines will be conducted to ensure their integrity and reliability. This will include routine patrols to identify and address any signs of wear, damage, or vegetation encroachment that may affect the performance or safety of the transmission infrastructure.

Gas Pipeline Maintenance: Similarly, the gas pipeline associated with the power plant will undergo routine maintenance to ensure its efficient operation and prevent leaks or other hazards. Inspections, integrity assessments, and corrosion monitoring will be conducted regularly to identify and address any issues that may compromise the integrity or safety of the pipeline.

Emergency Response and Preparedness (ERP): Emergency response and preparedness will be a cornerstone of the power plant's operational strategy, aiming to effectively manage and mitigate the impact of unforeseen events. Protocols will be established to ensure the safety of personnel, protect the environment, and minimize disruptions to power generation.

Emergency equipment and facilities: The power plant will be equipped with essential emergency equipment, including fire extinguishers, first aid kits, and emergency exits. Designated emergency assembly points and facilities will be established to support evacuation and response activities during emergencies, ensuring a comprehensive and organized approach to crisis management.

3.5.3.2 Waste Management;

The waste streams generated during the plant's operation will include both liquid and solid wastes Liquid waste will primarily consist of used oils, lubricants, and other hydrocarbons from equipment maintenance. These will be collected in designated containers to prevent leaks and spills, stored in compliance with environmental regulations, and handed over to licensed waste disposal contractors for safe recycling or disposal. Runoff water from cleaning and operational processes will be monitored for contaminants, treated as necessary, and discharged in line with statutory water quality standards.

Solid waste will encompass a variety of materials, including scrap metals, plastics, wood, machine spares, parts of electrical and armored cables, empty paint containers, and domestic waste from personnel. These waste streams will be segregated at source into recyclable, non-recyclable, and hazardous categories. Recyclable materials such as metals and plastics will be sent to authorized recycling facilities, while hazardous waste, including empty chemical containers, will be disposed of through certified hazardous waste handlers. Domestic waste will be collected in bins and transported to designated municipal waste disposal sites. The implementation of a Waste Management Plan (WMP) will ensure all waste is managed responsibly, in compliance with statutory guidelines, to minimize environmental impact and support sustainability efforts.
Generic waste streams that can be generated at the power plan site and their treatment and disposal routes can be categorized as presented in Table 3.5.

Table 3.2: Expected Waste Types/Management Strategy during the Operation Phase

Waste Type	Classification	Management Strategy
Empty metal/plastics containers	GEN/REC	Decontamination Recycling via accredited contractors
Metal Scraps Electric cables	GEN/REC	Recycling via accredited contractors
Spent Oil/Lube oil	HAZ	Recycling via accredited contractors
Alkaline based Chemical cleaning	HAZ	Neutralization Pit
Food waste, used cleaning fabrics	GEN/REC	Composting at approved dumpsite by accredited Waste vendor
Paper waste	GEN/REC	Recycling via accredited contractors
Plastic bottles and sachets	GEN/REC	Recycling via accredited contractors

GEN – General Wastes; REC – Recyclable Wastes; HAZ – Hazardous Wastes

The first step of the strategy is to reduce the amount of waste generated. This will be accomplished by:

- Reducing material consumption at all levels (including packaging),
- Reducing the volume of waste and using non-hazardous materials rather than hazardous ones where practicable. While not affecting the amount of waste, these measures facilitate the management of waste and reduce the risk of impact at disposal.

Wastes will be handled by trained personnel, who will be in charge of the different activities:

- Identification;
- Labelling: waste containers will be clearly labelled to facilitate the safe and appropriate handling of waste. Unidentified wastes will be treated as hazardous.
- Handling;
- Segregation and storage:
    - Different wastes will be segregated, thus requiring segregation areas and appropriate containers (depending on the volume and the typology of the collected waste), designated by a colour coding system and protected from the direct effects

of sunlight, wind or rain. This area will be identified taking into account site access and drainage.

  - Hazardous wastes will not be mixed, to avoid potential chemical reactions. Hazardous liquid wastes will be stored in bunded areas with a secondary containment capability of no less than 110% of the entire volume of waste stored to reduce the risk of pollution resulting from spillage.
  - All storage areas will be marked to indicate the hazards of the stored waste. Hazardous waste areas will be made secure to prevent unauthorized intrusions. Toxic or very toxic products will be separated from other products and stored in a room or a locked cabinet. Access to these areas will be limited to trained employees.
  - The volume of wastes stored will be kept to a minimum where practicable. Waste will be kept on-site for the minimum amount of time possible given logistical constraints and stored in a way to prevent scavenging by animals and pests. When containers are ¾ full, the environmental representative must be notified to initiate the collection procedure.
  - All waste collection points should have fire-fighting equipment as appropriate. Certain waste collection points may also have areas for washing. Designated areas may be required for storage of non-compliant waste, or waste with special handling requirements.

- Transport: only approved contractors (responsible for holding the appropriate operating licenses and regularly monitored) will be used to transport wastes from the collection points to the final disposal site. Additionally, Obodofei Integrated Services Limited will require contractors to:
  - Transport wastes in an environmentally safe and responsible manner, using the appropriate level of protection and containment for the wastes concerned.
  - Use appropriate vehicles for transportation with suitable specifications including compartments or undercover storage to prevent loss of waste.
  - Use designated routes to minimize impact.
  - Use safe loading and unloading procedures to protect the workforce and prevent loss of waste.
  - Provide means for emergency response and train employees in spill procedures.

- Ensure wastes and vehicles are labelled accordingly.

3.5.3.2 Green House Gas Emission

The greenhouse gas (GHG) emission potential of the CNG plant and associated power generation facility arises primarily from the combustion of natural gas, energy consumption in compression processes, and construction-related activities. These emissions consist mainly of carbon dioxide (CO_2), with smaller contributions from methane (CH_4) and nitrous oxide (N_2O), each varying in its global warming potential.

Operational Emissions

Power Plant Emissions: The on-site power generation plant, fueled by natural gas, emits CO_2 as a byproduct of combustion. While natural gas is a cleaner-burning fossil fuel compared to coal or oil, it still contributes to CO_2 emissions. The magnitude of emissions depends on the plant's operational efficiency, fuel consumption (~10 MW for operations), and potential energy losses in open-cycle mode. An open-cycle configuration generally emits more CO_2 per unit of electricity than a combined-cycle configuration due to lower thermal efficiency.

CNG Compression and Processing: The compression stages (raising pressures to ~250 bar) and gas pre-treatment processes (e.g., acid gas removal and dehydration) require significant energy, mainly from electricity generated on-site. This energy demand contributes indirectly to CO_2 emissions. Methane leakage during compression or storage could also occur, though modern technologies aim to minimize such losses.

3.5.3.3 Employee Requirement

The operation of the CNG plant and power generation facility will require a skilled and diverse workforce to ensure seamless operations and maintenance. Key personnel will include engineers specializing in mechanical, electrical, and process systems, as well as technicians for equipment monitoring, repairs, and routine maintenance. Operators trained in gas compression, power plant management, and advanced control systems will be essential for day-to-day activities. Environmental and safety officers will oversee compliance with regulatory standards and the implementation of safety protocols. Administrative staff will support operations by managing logistics, documentation, and reporting. During the construction phase, additional roles will include site supervisors, skilled laborers, and contractors. Training programs will be provided to ensure all employees are well-equipped to handle the plant's operational and safety requirements.

3.5.4 Decommissioning Phase

Activities during the decommissioning phase will involve demolition and site clean-up, disposal of waste, demobilization of the workers, and a final site review. It involves the disengaging and removal of all equipment used in the course of the project's operational life. Decommissioning of the proposed project entails some activities which include:

- Dismantling of the equipment and
- Transfer of all equipment and accessories to other locations where they shall be needed.
- Removal of constructed structures (site office building), etc.

Demolition

The main activity under the demolition is the dismantling of the operational and ancillary equipment. The remediation measures that need to be undertaken therefore will check the resultant negative impacts of this phase of the project on the environment. The likely impacts will be:

- Physical disturbance arising from equipment removal techniques
- Waste management problems

Clean-Up and Waste Disposal

The clean-up process shall involve the removal of the wastes resulting from the demolition of the site at the end of the plant's life. The clean-up process shall be done in compliance with relevant Waste Disposal Guidelines.

Site Remediation Plan After Closure/Decommissioning

- ✓ The following measures shall be planned for implementation after de-commissioning/closure:
- ✓ All equipment and debris shall be removed from the environment to other locations for use and/or proper disposal as guided by existing regulations.
- ✓ Good waste management plan

- ✓ Buildings used for administration and residences shall be leased out or used for other purposes

Post Abandonment Site Review

A post-impact site survey shall be carried out to ensure that no waste or contaminant is left behind and that the negative impacts on the site are highly minimized.

3.7 Project Schedule

The overall conceptual project implementation schedule for the Pre-construction, Construction and commissioning Phase of the Project is illustrated in Table 3.3:

Table 3.3: Project Schedule Timeline

S/N	**Activity**	**2024**		**2025**				**2026**				**2027**			
		Q3	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
1.	Feasibility study EIA Approval and other regulatory permits														
1.	Preconstruction Phase: • Pre-mobilization/Project design • Clearing of vegetation and other debris • Construction of workers' camp • Mobilization of equipment and men to site • Transportation of materials														
2.	Construction Phase: • Civil work activities include construction of power plant and its ancillary facilities • Construction of access roads and public utilities (sewage, power, water system) • On site fabrication of materials • Installation of equipment and machinery • installation of ancillary facilities • Waste generation and disposal														
3.	Commissioning														
4.	Operation and Maintenance Phase • Power Generation • Operation and maintenance of infrastructure and other facilities.														

CHAPTER FOUR
DESCRIPTION OF THE PROJECT ENVIRONMENT

4.1 Introduction

This chapter provides a description of the existing environmental and socio-economic conditions of the Project area against which the potential and associated impacts of the proposed Project have been assessed.

Data and information for the environmental description of the study area were based on field data gathering (primary data) as well as a desk-based review of relevant literature (secondary data). Due to the Project exigencies, a one-season sampling approval was obtained from the FMEnv. Field sampling was carried out from 21st to 26th October 2024 which falls within the raining season and complemented with secondary data such as information obtained from relevant literature (e.g., published articles) on the general environmental and social conditions of the Project area of influence (5km spatial boundary). Section 4.2 provides detailed information on the baseline data gathering approach and methodology.

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

- Climate and meteorology;
- Geology and hydrogeology;
- Hydrology;
- Air quality and noise;
- Soil;
- Groundwater
- Surface water and sediment;
- Terrestrial flora and fauna;
- Land use;
- Socio-economic and health.

4.2 Baseline Data Collection

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

The baseline data-gathering approach includes the following:

- Review of secondary data relevant to the Project environment (e.g., published articles on the Project area);
- Designing and developing field sampling strategies to meet the scope of the EIA and regulatory requirements;
- Pre-mobilization activities (including calibration/pre-testing of field equipment);
- Mobilization to site and fieldwork sampling (sample collection, in-situ measurement; sample handling, documentation, and storage);
- Demobilization from the field; and
- Transfer of field samples to the laboratory for analysis.

4.2.1 Desktop Studies/Literature Review

Desktop studies involved the acquisition of relevant background information on the bio-physical and socio-economic environment of the study area. Information was sourced from the relevant government authorities (such as the Nigerian Meteorological Agency (NiMet), the National Bureau of Statistics (NBS), and the Federal Ministry of Environment (FMEnv), relevant publications, textbooks, articles, maps as well as online sources. Secondary information obtained includes demographic data, geology and hydrogeology, etc.

4.2.2 Field Sampling and Laboratory Analysis

4.2.2.1 Field Sampling

To effectively characterize the environment of the study area, field sampling was conducted from 21st to 26th October 2024 and witnessed by FMEnv representatives. The objective of the field exercise was to obtain the baseline data of the Project's AoI and describe the integrated environmental context of the area. Sampling locations were identified using recent satellite imagery of the study area. The basis of the sampling design was informed by a preliminary characterization of the study area through desktop research and nearby sensitive receptors, to ensure representativeness of the field samples collected, the sampling approach employed included simple random and systematic sampling, based on the environmental components to be surveyed.

Sampling locations were selected to cover as much as possible the land area for the proposed Project as well as the existing sensitive receptors that could be indirectly or directly affected by the proposed Project. All sampling locations were geo-referenced using Garmin Map-62 series Global Positioning System (GPS) handsets.

The field sampling activities were carried out in line with the FMEnv-approved ToR for the ESIA study, and appropriate quality assurance and quality control (QA/QC) procedures were implemented to maintain the integrity of the field samples. Samples (e.g., soil, surface water and groundwater samples) collected during the field sampling were appropriately preserved and transported to the laboratory for analysis.

Figure 4.1 summarizes the management program put in place to safeguard the integrity of the field samples collected during the baseline data gathering. While plate 4.1 shows some equipment used during the field data gathering exercise.

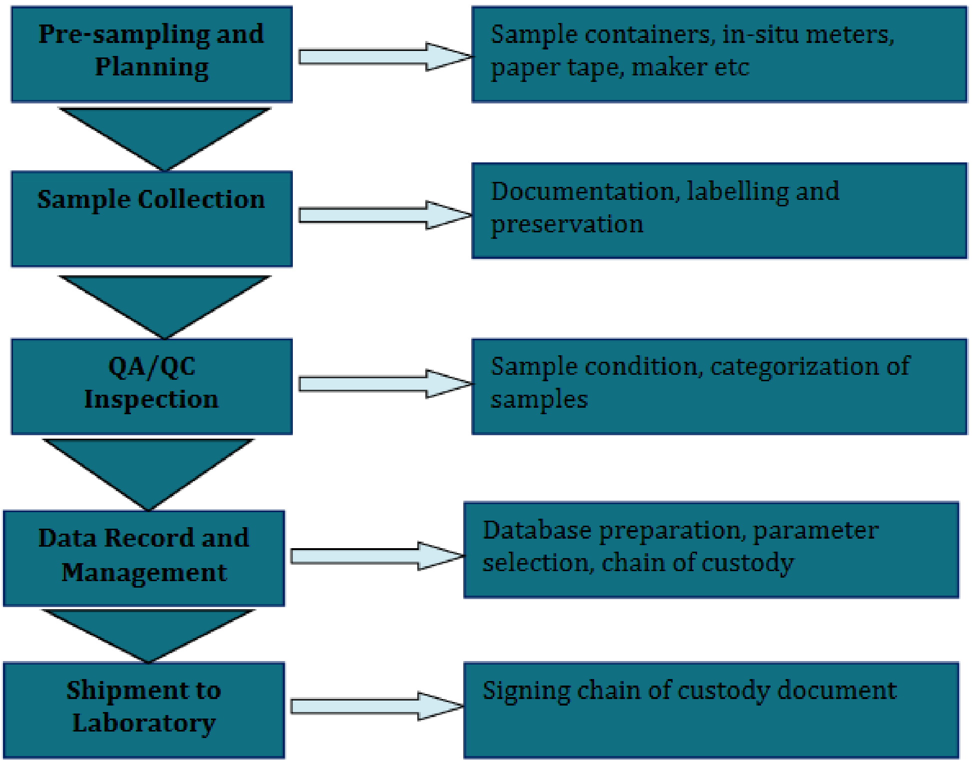

Figure 4.1: Management program employed for field sampling

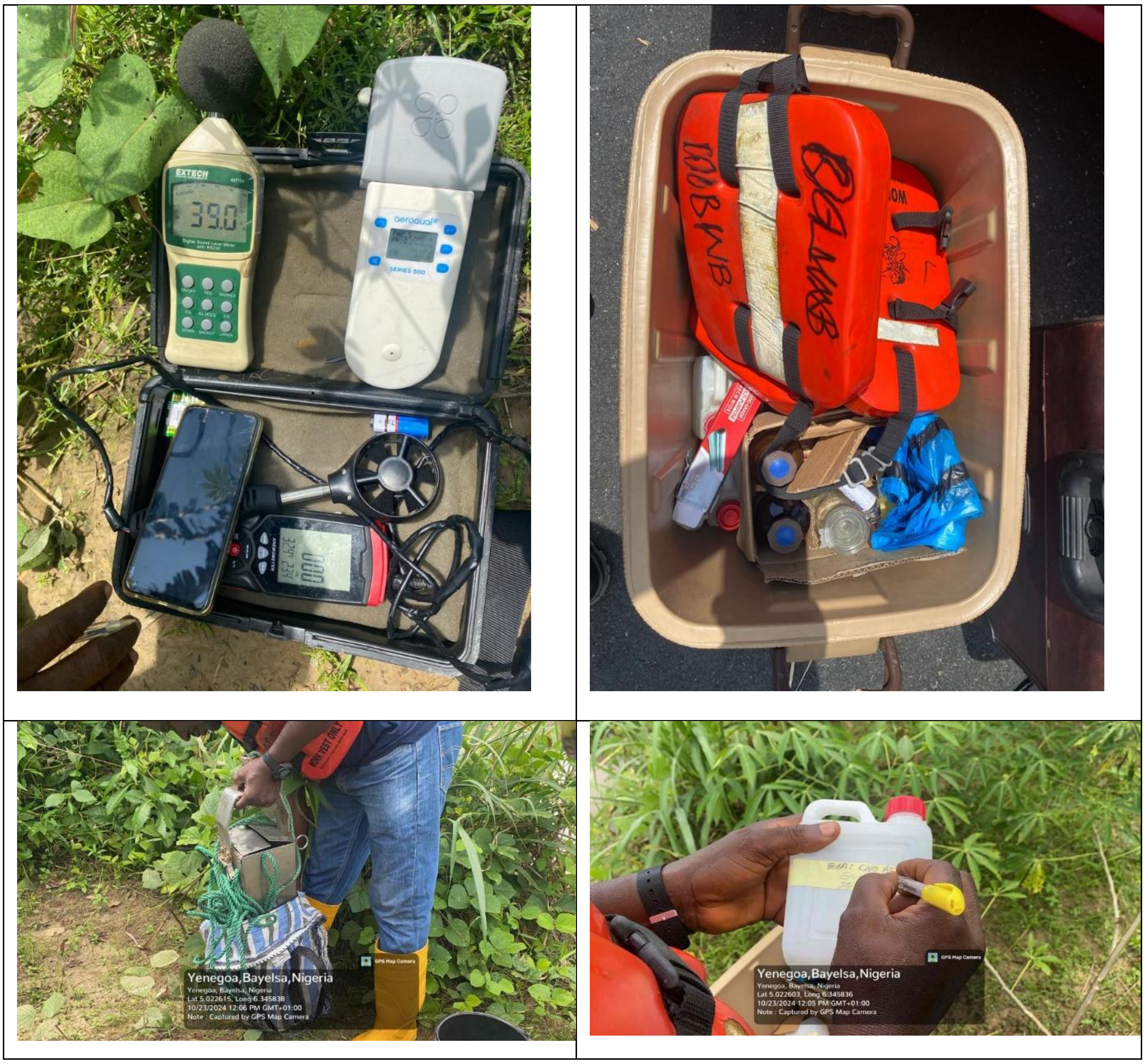

Plate 4.1: Some Equipment used during the field sampling exercise

4.2.2.2 Laboratory Analysis of Field Samples

The field samples were analysed for physicochemical and microbial parameters at Ebic Integrated Services Ltd Laboratory located at 23, Graham Avenue, Off Igbo-Etche Road, Rumukwurushi, Port Harcourt, River State. The Laboratory is accredited by the FMEnv and Nigerian Upstream Petroleum Regulatory Commission (NUPRC). The laboratory analyses were consistent with the approved standard methodologies such as those recommended by ASTM International (formally called American Standards for Testing and Materials) and the American Public Health Association (APHA). Some of the analytical methods used are highlighted in Table 4.1.

Table 4.1: Analytical methods employed for field samples analysis

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

Source: EnvironHeroes field survey, 2024

A list of field equipment used during the field sampling is presented in Table 4.2.

Table 4.2: Field Equipment for Sampling

	Environmental Component	Equipment/Tool
1.	Ambient Air Quality (pollutant gases)	▪ Aeroqual series 500 (with the following gas sensors: CO; CO_2; SO_2; H_2S; NH_3; CH_4; NO_2; and VOC).
2.	Ambient Air Quality (particulate matter)	▪ Aeroqual series 500
3.	Soil	Stainless Steel Augers
4.	Ground and surface water (in-situ water testing for parameters with short holding time namely pH, electrical conductivity, DO, Salinity, TDS, and temperature)	▪ Bante 900P Multiparameter water quality meter
5.	Ambient Noise Levels	Extech Integrating Sound Level Meter (Model No: 407780)
6.	Vegetation (Flora) and Wildlife (Fauna)	Binocular; hand lens, camera, etc.
7.	Sediment	Van Veen grab

Source: EnvironHeroes field survey, 2024

The data-gathering approach is summarized below:

Climate and Meteorology

The regional long-term climatic data of the Project area was sourced from the NiMet and spanned from 1990 – 2022.

Air Quality and Noise

Sixteen (16) *in-situ* air quality measurements were conducted with the use of pre- calibrated digital hand-held monitoring equipment for the following parameters: Sulphur (IV) Oxide (SO_2), Nitrogen (IV) Oxide (NO_2), Carbon Monoxide (CO), Carbon (IV) Oxide (CO_2), Volatile Organic Compounds (VOC), Hydrogen Sulphide (H_2S), Ozone gas (O_3) and Suspended Particulate Matter (SPM).

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

Groundwater Sampling

Groundwater samples were collected from four (4) different locations (control station inclusive) within the Project's AoI inclusive of the control point. At each sampling location, groundwater samples were collected into a 2-litre polyethylene bottle for general physicochemical analysis, while samples for Oil & Grease determination were collected in a 1-litre glass bottle and preserved with concentrated sulphuric acid. Samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized 50ml McCartney bottles were used for samples meant for microbial analysis. In-situ measurements of pH, Conductivity, Total Dissolved Solids (TDS), Temperature, and Dissolved Oxygen (DO) were taken at each location using an Extech Digital DO700 meter.

Soil Sampling

A total of fifteen (17) soils were sampled (control station inclusive) using a stainless-steel auger and transferred to an aluminium foil. The soil samples collected were taken for microbial and physicochemical analysis. Sub-samples for microbial analysis were put in sterilized 50ml McCartney bottles. All samples collected were preserved and transported to the laboratory for analysis.

Surface water Sampling

Surface water samples were collected from three (3) different locations (upstream and downstream) at Etebou Creek. At each sampling location, samples were collected into a 2-litre polyethylene bottle for general physicochemical analysis, while samples for Oil & Grease determination were collected in a 1-litre glass bottle and preserved with concentrated sulphuric acid. Samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized 50ml McCartney bottles were used for samples meant for microbial analysis. In-situ measurements of pH, Conductivity, Total Dissolved Solids (TDS), Temperature, and Dissolved Oxygen (DO) were taken at each location using Extech Digital DO700 meter.

Terrestrial Flora and Fauna

A flora assessment of the Project's AoI was undertaken to provide information on the following: vegetation types, floristic composition, species diversity, inventory of economic/medicinal plants and general biodiversity assessment. The survey was conducted in accordance with the standard botanical field sampling procedures. Plant species encountered were identified to species level both in-situ and ex-situ in the herbarium using appropriate references, manuals and monographs. The ecological status of the species was evaluated and classified appropriately according to the International Union for Conservation of Nature (IUCN).

Sampling techniques for terrestrial fauna assessment include footprint, nest type feeding site, voice, physical appearance, faecal samples, and shell types.

Socio-economic and Health Survey

The study methodologies employed for socio-economic and health baseline data gathering include questionnaire administration, key informants' interviews, focus group discussions, field observations and literature review. A detailed description of these methodologies is presented in Section 4.4 of this chapter.

4.3 Description of Environmental Characteristics of the Project Area

4.3.1 Climatic and Weather Conditions

Climate comprises statistics of temperature, humidity, atmospheric pressure, wind, rainfall, atmospheric particle count and other meteorological elements in a given region over long periods of time. The climate of a location is affected by its latitude, terrain, altitude, as well as nearby water body and their currents.

Nigeria's climate is basically tropical, characterized by two regimes-the dry season and the wet season. The study area (Bayelsa State) which is in the Niger delta region of Nigeria experiences a fluctuating climate which is characterized by two distinct conditions of wet and dry seasons. The wet season occurs between April and October with a brief break in August, while the dry season occurs between November and March. Wet (Rainy)season in Bayelsa State extends into mid-November while the North East trade wind that brings about the dry (harmattan) season is fully felt around late November till early February.

Rainfall

Secondary rainfall data spanning the period of 1992 to 2023 was obtained from NiMET to describe the study area. The mean monthly rainfall ranged from 57mm in December to 504m in July when the peak is experienced. Rainfall is the basis for the classification of season into wet and dry season in the area. Ideally, there are no months without rainfall, but sometimes severe *Harmattan* conditions may cause droughts of up to one month. The mean annual rainfall for the project area is 2,594mm. The months with the highest rainfall are July (504mm), September (478), June (425mm) and August (245mm). The months with the lowest rainfall are December (57mm), January (72mm) and February (92mm). The dip in rainfall in August gives rise to the phenomenon of "August break" first described by Ireland (1962) as the little dry season. As a result, rainfall in the project area for August is highly variable. It was only 232mm and 245 mm in 1998 and 2001, respectively.

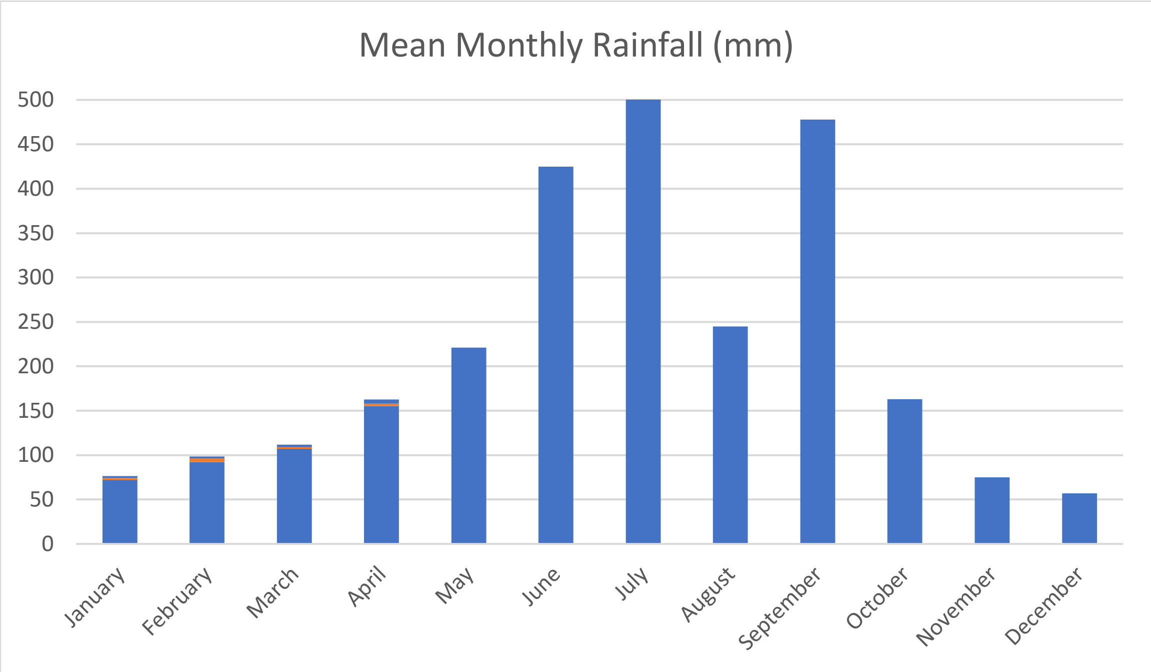

Figure 4.2: Average Monthly rainfall

Relative Humidity

Relative humidity measures water vapour present in the atmosphere, through vapour concentration (Danielson*etal*.,1998). Onsite humidity measurements for this study ranged from a maximum (96%) at dawn (01:00–07:00GMT) to a minimum (72%), 80% between 8:00 hours to 13:00 Hours in the late afternoon (14:00 – 18:00 GMT) 60%. The mean diurnal value for humidity measured on site was 88%. In coastal areas, relative humidity is constantly high because of the regular onshore winds that are moisture laden. The Gulf of Guinea is the source of the water vapour transported over the continent close to the surface (Cadet and Nnoli,1989).A diurnal and annual fluctuation of relative humidity plot oscillates in the opposite direction of air temperature changes. As air temperature rises, relative humidity falls because of expansion in the volume of the atmosphere. In this study it was observed that the dryer months (November–March) had the lowest relative humidity while the wet months (June – October) has the highest.

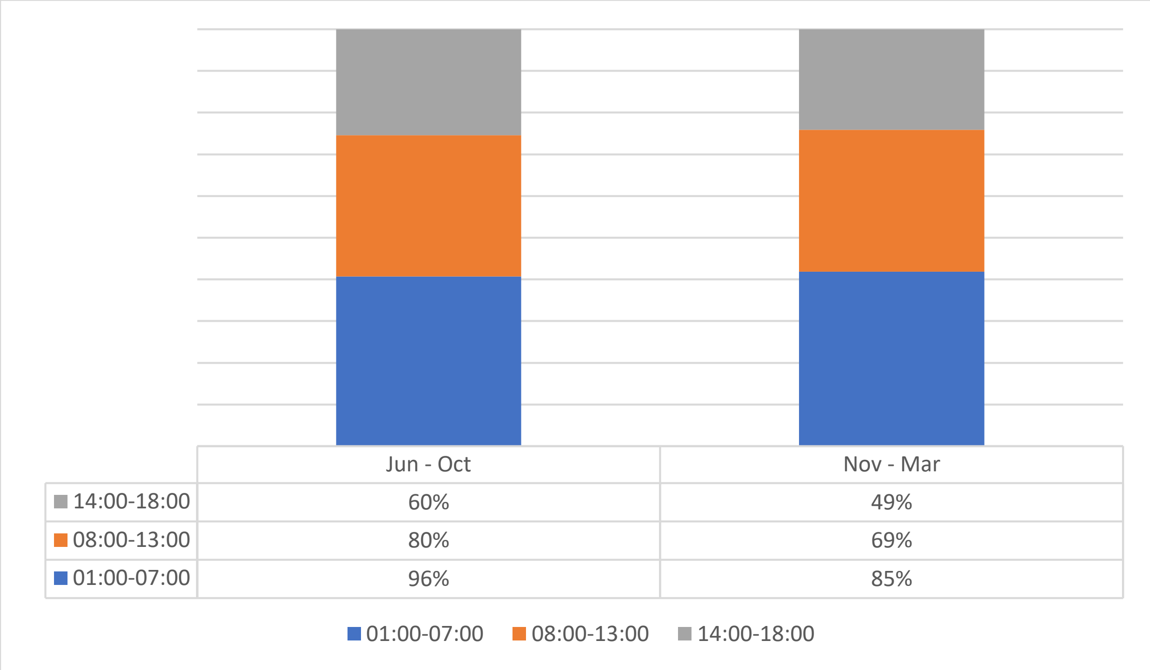

Figure 4.3: Mean Monthly Relative Humidity
Source: NiMET 1992 - 2023

Air Temperature

Temperature is a dominant climate factor that varies from place to place over a period of time at a given location. The spatial distribution of temperature over the earth is influenced by; amount of insulation received, nature of surface, distance from water bodies, relief, nature of the prevailing winds and ocean current. The highest mean maximum temperature is recorded during the months of December through March (32.0°C) while the lowest mean maximum temperature value (24.0°C) is recorded in all months except April and May. The minimum mean annual temperature obtained for Bayelsa was 22°C (August), while the maximum mean annual temperature was 34°C (February). Figure 4.3 presents values from NIMET (1992-2023) Bayelsa station.

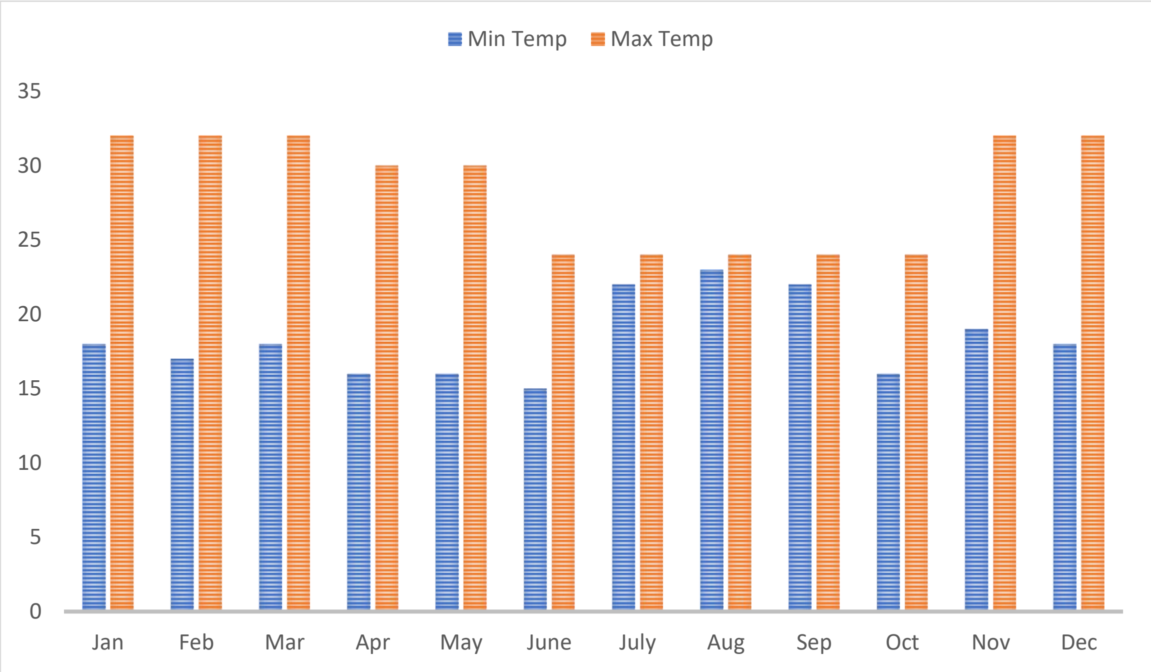

Figure 4.4: Minimum and Maximum Temperature
Source: NIMET, 1992-2023

Wind Direction and Speed

The mean wind speed for the onsite monitoring period was1.5m/sec. Wind analysis is important to environmental studies because it forms the platform for the dispersion of emissions and in the determination of receptor locations. Winds from the general directions of the south, that is, south westerly, south easterly and southerly comprised 78% of the total wind run. The remainder were north westerly winds (8%) and periods of calm(12%).All the calms were recorded at dawn when wind speed in the study area is generally low. The diurnal wind runs are usually maximum during the day with a peak at about noon and minimum by night (Rosemberg,1974). Due to the position of the study near the equatorial belt, average wind speeds are generally low. Nevertheless, the equatorial low pressure system that dominate also support moderate dispersion. If emission points are not very close to the surface, and if the periods of emission do not coincide with inversion situations, emissions are not likely to lead to fumigation. The areas near the Equator has been described by Lockwood (1982) as having trade winds of extreme consistency and where the equatorial trough covers provide good convection otherwise restricted in the trade wind. These conditions go a long way in reinforcing the dispersive potentials of the project area.

The average wind speed data obtained for Bayelsa from NIMET over a period of 1992-2023 is given as 3.0m/s. Predominant wind speed directions obtained for the Bayelsa area from 2013 to 2021 is Table 4.3.

Table 4.3: Bayelsa Wind Direction (2013-2021)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2013	W	S	S	S	S	S	S	S	S	S	S	S
2014	S	S	S	S	S	S	SW	SW	SW	S	S	NW
2015	NW	S	S	S	S	S	S	SW	W	S	S	NW
2016	NW	S	S	S	S	S	S	SW	SW	S	S	SW
2017	S	S	S	S	S	S	S	S	W	W	S	S
2018	S	N	S	S	S	S	S	W	W	S	S	W
2019	W	W	S	S	S	S	S	W	S	S	S	W
2020	W	S	S	S	S	S	S	S	S	S	S	S
2021	S	S	S	S	S	S	SW	SW	SW	S	S	NW

Source: Nigerian Meteorological Agency (NIMET)

Table 4.4: Measured Microclimatic Parameters in the Proposed Project Site

Code	Temp (°C)	Wind Speed (m/s)	Wind Direction	Relative Humidity (%)	Noise (dB)
AQ1	32.2	3.14	SW	64.5	43.7
AQ 2	30.9	2.18	SW	63.4	43.2
AQ 3	30.7	2.34	SW	67.4	44.8
AQ 4	33.2	1.71	SW	59.8	37.3
AQ 5	30.0	1.43	NE	68.3	51.0
AQ 6	30.7	3.27	SW	67.2	34.7
AQ 7	32.7	1.62	NE	61.8	36.4
AQ 8	33.4	1.20	SW	59.7	42.1
AQ 9	33.6	1.51	SW	59.3	33.1
AQ 10	33.4	2.10	SW	59.9	37.3
AQ 11	33.6	1.71	SW	59.6	33.6
AQ 12	33.4	2.52	SW	61.7	38.2
AQ 13	33.7	2.76	SW	64.7	38.7
AQ 14	32.9	2.10	SW	69.8	41.2
AQ 15	32.4	1.69	SW	62.4	42.3
AQ Control	32.8	2.41	SW	61.8	34.5

Source: *EnvironHeroes Field Survey, 2024*

4.3.2 Geology, Stratigraphy and Geomorphology

The proposed project location is within the Niger Delta Basin of Nigeria. The Niger Delta occupies a pride of place as one of the world's largest Tertiary delta systems and a highly prolific hydrocarbon province. It is situated on the West African continental margin at the apex of the Gulf of Guinea, which formed the site of a triple junction during continental break-up in the Cretaceous.

Throughout the Delta's history, it has been fed by the Niger, Benue and Cross Rivers, which between them drain over 106 km^2 of continental lowland savannah. The delta sequence comprises an upward-coarsening regressive association of Tertiary clastics up to 12 km thick. It is informally divided into three gross lithofacies: (i) marine claystones and shales of unknown thickness, at the base; (ii) alternations of sandstones, siltstones and claystones, in which the sand percentage increases upwards; (iii) alluvial sands, at the top. The area constitutes an extensive plain open to periodic inundation by flood resulting in flood plains and levees at the River banks(Reijers *et al*., 1997).

Regional Geology and Stratigraphy of the Area

The Niger Delta coastal sedimentary basin has undergone three depositional cycles. The first began with a marine incursion in the middle Cretaceous and was terminated by a mild folding phase in Santonian time. The second included the growth of a proto-Niger delta during the late Cretaceous and ended in a major Paleocene marine transgression. The third cycle, from Eocene to Recent, marked the continuous growth of the main Niger delta. The delta structure and stratigraphy are intimately related, the development of each being dependent on the interplay between sediment supply and subsidence rates. The dominant subsurface structures are syn- and post- sedimentary listric normal faults which affect the main delta sequence. They die out upwards into the alluvial sands and sole out at depth near the top of the marine claystones. Major growth-fault trends cross the delta from northwest to southeast, dividing it into a number of structural and stratigraphic belts, called depobelts, which become younger towards the south. The deltaic sequence in each of these depobelts is distinct in age, so that they actually represent successive phases in the delta's history.

Hydrocarbons have been located in all of the depobelts of the Niger Delta, in good quality sandstone reservoirs belonging to the main deltaic sequence (the 'paralic sequence' of common usage). Most of the larger accumulations occur in roll-over anticlines in the hanging-walls of growth faults, where they may be trapped in either dip or fault closures. The Niger Delta province is the twelfth richest in petroleum resources, with 2.2% of the world's discovered oil and 1.4% of the world's discovered gas (Petroconsultants, Inc. 1996a). Most of the petroleum is sourced from the Akata Formation with smaller amounts generated from the mature shale beds in the lower Agbada Formation (Evamy *et al*., 1978). The hydrocarbons are found in multiple pay sands of The Agbada Formation which have relatively short columns, and adjacent fault blocks with independent accumulations (Doust and Omatsola, 1990).

Geomorphology

The geomorphology of the Niger Delta is that of a wave-dominated delta, with a smoothly seaward-convex coastline crisscrossed by distributary channels. From apex to coast, the sub aerial portion stretches more than 300 km, covering an area of 75 000 km^2. Below the Gulf of Guinea, two enormous lobes protrude a further 250 km into deeper waters. The area has a mostly low-lying elevation (usually not exceeding 20m above sea level). It constitutes an extensive plain open to periodic inundation by flood. Prominent features of rivers and creeks in the area is occurrence of natural levees on banks behind which are vast areas of back swamps and lagoon lakes where surface floor is negligible. In all the area can be subdivided into five major geomorphological units, namely:

- coastal beaches
- saltwater mangrove swamps
- freshwater swamps, backswamps deltaic plain alluvium and meander belt
- dry deltaic plain
- dry flat land and plain

Local Geology of the Area

The Niger Delta consists of three diachronous geologic units, namely: (1) Akata Formation (oldest) consisting of marine claystones and shales of unknown thickness, at the base (ii) Agbada Formation (intermediate), made up of alternations of sandstones, silstones and claystones, in which the sand percentage increases upwards and (iii) Benin Formation (youngest) , of about 2100 m thickness consisting majorly of alluvial sands, at the top (Tables 4.6a and 4.6b). The Agbada Formation is the major hydrocarbon bearing unit in the Niger Delta Basin.

Table 4.5a: Stratigraphic units of the Niger Delta basin

Outcropping Units	Subsurface Units	Present-day Equivalents
Benin Formation	Benin Formation	Continental (fluviatile) deposits mainly sandstones
Ogwashi –Asaba Formation Ameki Formation	Agbada Formation	Mixed continental brackish water and marine deposits, sandstones and clays
Imo Shales	Akata Formation	Marine deposits, mainly clays

Table 4.5b: Geologic units of the Niger Delta

Geologic Unit	Lithology
Alluvium	Gravel, sand, clay and silt
Freshwater swamp	Sand, clay, silt and gravel
Mangrove/saltwater swamps	Fine-medium grained sand, clay and silt
Active/Abandoned beach ridges	Sand, clay and silt
Sombeiro-Warri Deltaic plain	Sand, clay and silt
Benin Formation (Coastal plain-sand)	Medium-coarse grained sand, clay lenses
Agbada Formation	Intercalation of sand, clay and silt
Akata Formation	Clay and Shale

Hydrogeology

Groundwater in the area occurs in shallow aquifers belonging to the coastal plain sand, comprising of sand, gravel and clay intercalations. Borehole yields are generally very good, with production rates of about 20,010 l/h and borehole success rate is usually high. The Benin Formation is the most prolific aquifer in the region. Overlying this Formation are the Quaternary deposits (Table 4.5c), an unconfined aquifer sequence made up of rapidly alternating sequence of sand, silt and clay with the silt and clay becoming very prominent seawards. Recharge to aquifers is by direct infiltration of rainfall and from surface water bodies. The base flow of the surface water bodies influences the ground water recharge rate especially during the dry season when the water table level drops.

Aquifer Characteristics

Boreholes were drilled within the study area using Auger rotary drilling method. Drill cores were sampled at intervals of 2m for lithologic analysis. These boreholes were cased using PVC pipes, gravel packed and cemented. The depths to water levels of all the boreholes were obtained using an electronic dip meter. Some chemical parameters of the borehole water samples were measured insitu before they were dispatched for further labouratory analysis. GPS coordinates were recorded for all sample locations.

Lithostratigraphy

The lithostratigraphy of this axis is characterized by sandy clay material of grey color at the surface in Borehole 1, which transitions to clayey sand at a depth of about 0.4 meters. This clayey sand gives way to silty clay materials that extend to a depth of 3.8 meters. Beneath this, the formation is predominantly fine sandy material, whitish in color, stretching down to a depth of 6.5 meters. The water-bearing lithology is encountered at approximately 0.5 meters from the surface.

In Borehole 2, the surface material is composed of dark brownish clayey fine sand, which extends to a depth of about 0.7 meters. This is followed by grey silty fine sand that stretches to a depth of 2.3 meters. Below this lies a thicker layer of whitish silty fine sand that continues down to a depth of 6.0 meters. The aquifer is intercepted at about 0.8 meters from the surface.

In Borehole 3, the surface layer is a brownish silt fine sand extending to a depth of about 1.7 meters. This is underlain by a significant layer of whitish fine sand that stretches continuously down to a depth of 16.2 meters. The aquifer is encountered at approximately 1.5 meters depth.

Across the three boreholes, the lithology transitions from finer-grained, clay-rich materials near the surface to coarser sandy materials with increasing depth, with the formation materials becoming lighter in color and joining the aquifer at varying depths.

Table 4.5c: Stratigraphic sequence of the Niger Delta Basin with aquifer properties

	Stratigraphic Units	**Lithologic Description**	**Aquifer Prospect**
QUATERNARY	Alluvium	Gravely sands, sands, silt and clays	Good
	Meander Belt Deposit	Gravely sands, sands with thin clay units.	Good
	Wooded Back Swamps & Freshwater Swamps Deposits	Mainly silt and silty clays with clayey intercalations	Poor
	Mangrove Swamps Deposit	Fine sands to silt and silty clays and clays with organic matter	Poor (Saline water)
	Sombreiro-Deltaic Plain Sediments	Coarse to fine grained sands, silts and clays	Medium
Miocene To Recent	Benin Formation	Mainly coarse-medium grained sands, lenticular with clay and shaly lens	Prolific Aquifer

(Source: Olobaniyi *et al*., 2006)

Ground Water Movement

On a regional scale, groundwater movement and flow direction is controlled by hydraulic gradient (flow direction is usually from areas of higher gradient, i.e, water level, to areas of lower gradient). However in areas near saline water/ fresh water boundaries, hydraulic gradient alone may not be sufficient to determine flow direction as there is a tendency for saltwater to flow towards fresh water against hydraulic gradient. This is referred to as salt water intrusion, a phenomenon that hampers groundwater quality. This reversal of flow direction may be made worse by excessive freshwater abstraction via boreholes or hand-dug wells. Groundwater flow direction in the area was determined using the data from 3 boreholes each from two axes of the study area. The data show that the groundwater flow direction in the area is from North to South. This is in conformity with the regional groundwater flow direction in Nigeria and the Niger Delta, which is from Northeast towards the coast in the south. Thus if there is any pollution of groundwater in the area, those south of the point of pollution are most likely to be affected.

4.3.3 Air Quality and Noise Level Standards

Due to the dangers of excessive release of air pollutants into the atmosphere from anthropogenic activities, particularly the disturbance of the dynamic equilibrium in the atmosphere, which ultimately affects man and his interest, attempts have been made to limit the volume of noxious gases and particulates, which are discharged indiscriminately into the atmosphere. In present times, air quality is being judged increasingly against legally adopted standards.

The concentrations of air quality parameters recorded in the study area were compared to the Nigerian Ambient Air Quality Standards (NAAQS). The summary of these limits is provided in Table 4.4. The noise levels recorded in the study area were compared to the FMEnv Noise Exposure Limits (Table 4.5). while the sampling photograph is presented in Plate 4.2.

Plate 4.2: Metrology, Air quality/Noise sampling

Source: EnvironHeroes Field Survey, 2024

Table 4.6: Ambient Air Quality Standards

Parameter	**Averaging Time**	**Nigeria Standards**
		FMEnv Limit
		(µg/m^3)
CO	1-hour	11, 400
NO_2	1-hour	75-113
SO_2	1-hour	26
TSP	1-hour	250

Source: FMEnv, 1991

Table 4.7: Noise Exposure Limits for Nigeria

Duration per Day, Hour	**Permissible Exposure Limit dB(A)**
8	90
6	92
4	95
3	97
2	100
1	105

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

4.3.3.1 Air Quality and Noise Level of the Project Area

The air quality baseline study aims to obtain the spatial coverage of the current atmospheric pollutants in the study area as may be needed in establishing the potential impact of the proposed Project on the air quality of the environment. The geographical coordinates of the air sampling points are presented in Table 4.8

Table 4.8: Air Quality Sampling Locations

	Coordinates	
Code	**Latitude (N)**	**Longitude (E)**
AQ1	05° 01' 16.73"	006° 20' 52.08"
AQ2	05° 01' 29.6"	006° 20' 56.50"
AQ3	05° 01' 41.94"	006° 21' 01.18"
AQ4	05° 01' 42.08"	006° 21' 09.39"
AQ5	05° 01' 31.90"	006° 21' 15.31"
AQ6	05° 01' 01.80"	006° 20' 49.94"
AQ7	05° 01' 44.63"	006° 20' 50.63"
AQ8	05° 00' 42.46"	006° 21' 01.33"
AQ9	05° 00' 40.18"	006° 21' 22.02"
AQ10	05° 00' 37.28"	006° 20' 48.04"
AQ11	05° 00' 27.24"	006° 20'.36.98"
AQ12	05° 00' 33.34"	006° 20' 44.3"
AQ13	05° 00' 37.04"	006° 21' 09.34"
AQ14	05° 02' 07.79"	006° 20' 59.49"
AQ15	05° 02 12.07"	006° 21' 04.13"
AQ (Control)	05° 02 23.36"	006° 20' 53.55"

The results of air quality study conducted in the Project's AoI are presented below in Table 4.9

Table 4.9: Concentration of ambient air quality and noise level in the Project area

Code	SO_2 (ppm)	NO_2 (ppm)	NH_3 (ppm)	CO (ppm)	H_2S (ppm)	VOCs (ppm)	CH_4 (ppm)	SPM (μg/m³)		Noise dBA
								$PM_{2.5}$	PM_{10}	
AQ_{1-}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.001	0.001	43.7
AQ_2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.003	0.001	43.2
AQ_3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.004	44.8
AQ_4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.001	0.004	37.3
AQ_5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.001	0.003	51.0
AQ_6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.001	0.001	34.7
AQ_7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.003	36.4
AQ_8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.001	42.1
AQ_9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.003	0.003	33.1
AQ_{10}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.003	37.3
AQ_{11}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.001	0.001	33.6
AQ_{12}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.001	38.2
AQ_{13}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.003	38.7
AQ_{14}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.001	0.001	41.2
AQ_{15}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.003	42.3
AQ_{15} (Control)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.002	0.001	34.5
FMEnv Limit	0.01	0.06	NS	10	0.008	5		250	NS	80
NESREA Limit	0.10	0.085	NS	10	0.008	NS		NS	150	90

NS – Not Stated

Source: *EnvironHeroes Field Survey, 2024*

Going by the results of the air quality study it can be safely deduced that the air quality in the area at the time of assessment is free from pollution. Proposed project activities may however generate emissions. Gaseous pollutants may also be generated from the exhaust of diesel engines of heavy-duty vehicles and earthmoving equipment during construction. The air pollutants that are likely to be generated during the different phases of the project and their effects and applicability are discussed below.

Sulphur dioxide (SO_2): Sulphur dioxide (SO_2) is a colourless, pungent, irritating, water-soluble and reactive gas produced from the combustion of sulphur-containing fuels and incineration of refuse amongst others. In combination with NO_2, SO_2 is involved in the formation of acids in the atmosphere and can acidify soil and rivers and may lead to loss of plant and animal life. This acid can readily attack buildings and other materials including objects of cultural heritage. The gas is known to be a harsh irritant and is capable of aggravating asthma, reduce lung function and inflame the respiratory tract. It can also cause headaches, general discomfort and anxiety.

Sulphur dioxide was not detected in the ambient air in any of the monitoring locations during the study. The ambient concentration of this gas in the study area may increase from the use of combustion engines during construction and operational activities.

Nitrogen dioxide (NO_2): Nitrogen dioxide (NO_2) is a member of the family of highly reactive gases called oxides of nitrogen (NO_x) which are formed during combustion processes. The main oxide of nitrogen emitted from vehicles is nitric oxide (NO), which at normal concentrations has no adverse effect on plants or humans. However, NO oxidizes to NO_2 as it is dispersed in the atmosphere, and this may adversely affect the human respiratory system and plant growth. In conjunction with SO_2, NO_x plays a major role in the formation of acid in the atmosphere. It also reacts with hydrocarbons in the presence of sunlight to produce photochemical smog.

At the time of the study, NO_2 was not detected in the ambient air in any of the monitoring locations during the study. The ambient concentration of this gas in the study area may increase from the use of heavy-duty vehicles, earth-moving machinery, and Power plant machinery during the different phases of the project.

Ammonia: Ammonia (NH_3) is a colorless gas with a strong, pungent odor commonly found in agricultural and industrial emissions. While essential in low concentrations for various biological processes, higher levels can irritate the eyes, respiratory tract, and skin. Prolonged or high exposure may lead to coughing, throat irritation, or, in severe cases, respiratory distress, making it crucial to monitor in environments with human and ecological presence.

At the time of study NH_3 was not detected in the ambient air in any of the monitoring locations during the study.

Carbon Monoxide (CO): Carbon monoxide is a colourless, odorless and tasteless gas that is slightly less dense than air. It is produced from the partial oxidation of carbon-containing compounds. CO can be harmful when inhaled in large amounts. CO is released when something is burned. The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels.

The CO concentration was not detected across all monitoring stations. The ambient concentration of this gas in the study area may increase from the use of combustion engines during construction and operational activities.

Hydrogen sulfide (H_2S); Hydrogen sulfide (H_2S) is a colorless gas with a characteristic odor of rotten eggs, commonly produced by the breakdown of organic materials. Even at low concentrations, it can cause eye and respiratory irritation, while higher exposure levels can lead to dizziness, headaches, and in extreme cases, respiratory distress or unconsciousness. Therefore, monitoring H_2S is essential to protect both human health and the environment.

The H_2S levels across 16 sampling stations mostly fall below detectable limits (<0.1 ppm).

Methane (CH_4): Methane (CH_4) is a colorless, odorless, and highly flammable gas, primarily released through natural gas production, agriculture, and waste management. Although it is non-toxic, high concentrations can displace oxygen in enclosed spaces, leading to potential suffocation risks. Methane is also a potent greenhouse gas, contributing to global warming, making its monitoring essential for environmental and safety reasons.

The methne levels across 16 sampling stations mostly fall below detectable limits (<0.1 ppm).

Volatile Organic Compounds: Volatile Organic Compounds (VOCs) are a class of chemical compounds that under normal conditions are gaseous or can vaporize and enter the atmosphere. They are a wide range of carbon-based molecules (hence 'organic') that are considered VOCs. These include aldehydes, ketones and hydrocarbons. VOCs excluding methane (CH_4) are emitted by the use of solvents in products and industry, road vehicles and power generation. Some members of this group are significantly toxic and exposure to high concentrations in the atmosphere can cause headaches, dizziness, visual disorders and memory impairment. Some VOCs are carcinogenic.

At the time of the study, the VOC concentrations across 61 sampling stations range from 0.1 ppm to 0.2 ppm, all within the FMEnv limit of 5 ppm. The ambient concentration of VOCs in the study area may increase from the use of heavy-duty vehicles, power generating machinery during construction and operations of the power plant.

Particulates: Particulates are finely divided air borne particles which can be of anthropogenic and/or natural origin. They are secondary air pollutants formed in the atmosphere from SO_2, NO_x NH_3 and VOC. Particulates may have short and long-term adverse effects on humans, animals and plants. The health effects of particulates on man depend on particle size and concentration. They include acute effects such as eye irritation, bronchitis and asthma as well as chronic respiratory diseases such as cancer. Particles that are less than 10µm in aerodynamic diameter are of most concern because of their ability to get inhaled into the lungs to cause respiratory problems. Plants can be affected by particulates which when they settle on leaves can interfere with pollination and photosynthetic functions (if accumulation is significant) and thereby reduce the growth of plants. Particulates can also cause cardiovascular and respiratory problems in animals.

The particulate matter concentrations across 16 sampling stations range from 0.000 to 0.004 µg/m³ for both PM2.5 and PM10, which are well below the FMEnv limit of 250 µg/m³ for PM2.5 and the NESREA limit of 150 µg/m³ for PM10, indicating minimal particulate pollution The project activities may increase the SPM levels of the area during the different phases.

Ambient Noise Level: The noise levels across 16 sampling stations range from 33.1 dBA to 51.0 dBA, with all values well below the FMEnv limit of 80 dBA and the NESREA limit of 90 dBA, indicating a relatively quiet environment

Plate 4.2b: FMEnv & SMEnv Regulator and Others during Data Gathering

4.3.4 Soil Quality

Soil is an important component of the ecosystem that serves as a footprint of impacts. The critical properties of soil that usually form the basis for impact evaluation include physical properties, fertility indices, and chemical and microbial composition. A total of seventeen (17) locations were sampled for soil quality studies and analysed appropriately, Plate 4.3 shows the soil sampling activities. Table 4.10. Shows the sampling coordinates for soils.

Plate 4.3: Soil sampling

Source: EnvironHeroes Field Survey, 2024

Table 4.10: Soil Sampling Locations

Code	Coordinates	
	Latitude (N)	**Longitude (E)**
SS1	05° 01' 19.72"	006° 20' 51.08"
SS 2	05° 01' 33.01"	006° 20' 55.04"
SS 3	05° 01' 45.14"	006° 21' 01.60"
SS 4	05° 01' 42.26"	006° 21' 09.95"
SS 5	05° 01' 36.74"	006° 21' 15.05"
SS 6	05° 01' 02.87"	006° 20' 51.18"
SS 7	05° 00' 44.69"	006° 20' 48.79"
SS 8	05° 00' 43.40"	006° 21' 01.32"
SS 9	05° 00' 39.54"	006° 21' 22.30"
SS 10	05° 00' 38.36"	006° 20' 46.49"
SS 11	05° 00' 27.32"	006° 20'.38.14"
SS 12	05° 00' 33.16"	006° 20' 43.26"
SS 13	05° 00' 42.57"	006° 21' 09.65"
SS 14	05° 02' 05.05"	006° 21' 06.96"
SS 15	05° 02 18.07"	006° 20' 58.13"
SS Control	05° 02 18.07"	006° 20' 58.13"
AQ (Control)	05° 02 23.16"	006° 20' 54.85"

the summary of the result presented in table 4.11 below;

Table 4.11: Summary of Soil Analysis

PARAMETER	TOP SOIL	SUB SOIIL
	RANGE	RANGE
pH	5.73 to 7.52,	5.14 to 8.92
Moisture content (%)	2.89% to 6.51%	2.88% and 7.33%
TOC (%)	1.98% and 10.34%	2.56% to 9.21%,
Color	Light Reddish Brown (2.5YR 7/4) to Dark Reddish Gray (10R 3/4)	Dull Brown (7.5R 6/3) to Yellowish Red (5YR 4/6)
Porosity,%	1.38% to 24.81%	2.12% and 21.90%
Bulk Density, g/cm_3	10.8 g/cm^3 to 19.2 g/cm^3	10.4 g/cm^3 to 19.6 g/cm^3
TPH, mg/kg	10.319 - 22.865	8.074 - 18.315
THC, mg/kg	53.781- 112.563	44.876 - 112.472
TOG, mg/kg	60.219 - 163.641	53.087 - 121.583
Nitrite (NO_2^-), mg/kg	0.011 to 0.250	0.014 to 0.178
Sulphate (SO_4^{2-}), mg/kg	0.104 to 0.921	0.095 to 0.942
Phosphate (PO_4^{3-}), mg/kg	0.178 to 4.366	0.123 to 3.119
Chloride (Cl^-), mg/kg	0.99 to 9.99	1.99 to 9.99
Bicarbonate (HCO_3^-), mg/kg	<0.01	<0.01
Ammonium (NH_4^+), mg/kg	1.133 to 4.293	1.313 to 6.582
Total Nitrogen, mg/kg	0.143 and 0.648	0.182 to 0.843
Sodium (Na^+), mg/kg	125.460 to 438.380	115.319 to 599.495
Potassium (K^+), mg/kg	104.302 to 570.362	94.926 to 1136.408
Calcium (Ca^{2+}), mg/kg	266.733 to 967.836	217.685 to 1471.262
Magnesium (Mg^{2+}), mg/kg	107.456 to 190.013	87.172 to 195.235
Manganese (Mn), mg/kg	12.367 to 46.924	2.492 to 49.263
Cobalt, mg/kg	<0.001	<0.001
Barium, mg/kg	<0.001	<0.001
Cadmium, mg/kg	<0.001	<0.001
Chromium, mg/kg	<0.001	<0.001
Copper, mg/kg	0.024- 2.446	0.016- 1.995
Iron, mg/kg	1017.374 to 1936.963	1067.853- 1997.649
Vanadium, mg/kg	<0.001	<0.001
Lead, mg/kg	<0.001 to 0.379	<0.001to 1.098
Mercury, mg/kg	<0.001	<0.001
Nickel, mg/kg	<0.001 to 0.0145	<0.001 to 0.324
Zinc, mg/kg	0.016 to 0.312	0.013 to 0.307
THB, Cfu/g	5.1×10^5 to 8.9×10^6	7.0×10^4 to 7.8×10^5
HUB, Cfu/g	2.4×10^3 to 7.0×10^3	2.5×10^3 to 5.2×10^3
THF, Cfu/g	1.0×10^4 to 6.1×10^4	2.2×10^4 to 4.4×10^4
HUF, Cfu/g	2.5×10^3 to 2.5×10^4	2.5×10^3 to 7.0×10^3
Total Coliform, (MPN/100g)	7 to 39	7 to 64
Faecal Coliform, (MPN/100g)	0 to 28	0 to 15

The results of the soil samples are discussed below:

Physical analysis: The soil samples, comprising both topsoil (0–15 cm) and bottom soil (15–30 cm), exhibit a diverse range of physical properties essential for assessing their suitability for agricultural and ecological purposes. The predominant colors observed range from dark reddish gray to light reddish brown and dull brown, reflecting variations in mineral composition and organic matter content.

pH levels range from 5.14 to 8.92, indicating conditions from slightly acidic to alkaline, which are conducive to supporting various plant species and microbial activity. Moisture content varies between 2.88% and 7.33%, with moderate water retention across both soil layers. Total Organic Carbon (TOC) is present in varying amounts, ranging from 1.98% to 10.34%, suggesting adequate organic matter to support soil fertility and microbial processes.

The porosity of the soil ranges from 1.38% to 24.81%, while permeability is predominantly moderate, ensuring adequate water movement, except in localized areas with low permeability, which may limit drainage and aeration. Bulk density ranges from 10.4 to 19.6 g/cm^3, indicating variations in compaction that can influence root growth and water infiltration.

The soil texture ranges from sandy loam to clay loam, with sand content varying from 18.96% to 91.36%, silt from 6.53% to 70.82%, and clay from 1.96% to 38.02%. These textures highlight the soil's capacity for water retention, nutrient availability, and root penetration.

Hydrocarbon: Soil hydrocarbons are organic contaminants that can result from natural sources or human activities such as oil spills and industrial discharges. Their presence in soil is significant because they can harm soil health, reduce agricultural productivity, and pose risks to human and environmental health through contamination of groundwater and the food chain. Monitoring and managing soil hydrocarbon levels is crucial to ensure ecosystem integrity and public safety.

A comparative analysis of hydrocarbon contamination in topsoil (0–15 cm) and subsoil (15–30 cm) reveals variations in the distribution and concentration of hydrocarbons across the study area. Total Petroleum Hydrocarbons (TPH) in the topsoil ranged from 10.319 mg/kg to 22.865 mg/kg, indicating moderate hydrocarbon contamination near the surface. In contrast, TPH concentrations in the subsoil were slightly lower, ranging from 8.074 mg/kg to 18.320 mg/kg, suggesting limited vertical migration of hydrocarbons into deeper soil layers. This trend highlights surface exposure as the primary source of contamination, with attenuation mechanisms potentially reducing deeper penetration.

Both Polycyclic Aromatic Hydrocarbons (PAHs) and BTEX (Benzene, Toluene, Ethylbenzene, and Xylene) compounds were consistently below detection limits (<0.01 mg/kg) in both soil layers. This indicates negligible contamination from these toxic and volatile hydrocarbons, which are often associated with severe environmental and health risks. The absence of detectable levels is a positive indicator for the area but does not negate the presence of other hydrocarbon types.

The Total Hydrocarbon Content (THC) values further support the observed trends. THC in the topsoil ranged from 53.781 mg/kg to 112.563 mg/kg, with some areas exhibiting significantly elevated concentrations, likely due to direct exposure to hydrocarbon sources such as spills or leaks. Subsoil THC concentrations, ranging from 44.876 mg/kg to 112.473 mg/kg, were slightly lower, demonstrating attenuation processes like microbial degradation or adsorption in the deeper soil layers. Despite these differences, some locations exhibit comparable THC levels in both soil layers, indicating potential hotspots of contamination.

Total Oil and Grease (TOG) concentrations in the topsoil ranged from 60.219 mg/kg to 163.641 mg/kg, reflecting moderate to high accumulation near the surface. Subsoil TOG levels, ranging from 53.087 mg/kg to 140.423 mg/kg, followed a similar downward trend but remained relatively high in specific locations. This suggests that while hydrocarbon migration to deeper soil layers is limited, certain sites may still pose a risk to the subsurface environment.

Chemical Analysis: The chemical analysis of soil samples revealed distinct patterns in the distribution of exchangeable anions and cations between the topsoil and subsoil. Among the anions, nitrite concentrations in the topsoil ranged from 0.011 to 0.250 mg/kg, while subsoil levels were slightly lower, ranging from 0.014 to 0.178 mg/kg. This difference suggests localized nitrate accumulation in the topsoil, likely from anthropogenic sources such as fertilizers or organic matter. Sulphate concentrations were comparable between the layers, with topsoil levels ranging from 0.104 to 0.921 mg/kg and subsoil levels from 0.095 to 0.942 mg/kg, reflecting mobility across the soil profile. Phosphate levels were notably higher in the topsoil, ranging from 0.178 to 4.366 mg/kg, compared to 0.123 to 3.119 mg/kg in the subsoil, indicating recent fertilizer application or organic matter decomposition in the topsoil. Chloride concentrations were evenly distributed across both layers, with values ranging from 0.99 to 9.99 mg/kg in the topsoil and 1.99 to 9.99 mg/kg in the subsoil, highlighting its soluble nature and susceptibility to leaching. Bicarbonate levels were consistently below detectable limits in both soil layers, suggesting low carbonate buffering capacity.

The analysis of exchangeable cations revealed a slightly different pattern. Ammonium concentrations in the topsoil ranged from 1.133 to 4.293 mg/kg, with subsoil values slightly higher in some locations, ranging from 1.313 to 6.582 mg/kg. This pattern could indicate ammonium leaching or accumulation in the subsoil. Total nitrogen levels were generally higher in the topsoil, ranging from 0.143 to 0.648 mg/kg, compared to subsoil levels of 0.182 to 0.843 mg/kg, reflecting greater biological activity and organic matter presence in the surface layer. Sodium concentrations were higher in subsoil samples in certain areas, with topsoil levels ranging from 125.460 to 438.380 mg/kg and subsoil levels from 115.319 to 599.495 mg/kg, likely influenced by salt intrusion or irrigation practices.

Potassium showed significant variability, with topsoil concentrations ranging from 104.302 to 570.362 mg/kg and subsoil levels from 94.926 to 1136.408 mg/kg. Elevated potassium in some subsoil samples suggests interactions with clay minerals. Calcium concentrations were generally higher in the subsoil, ranging from 217.685 to 1471.262 mg/kg, compared to topsoil levels of 266.733 to 967.836 mg/kg. This may be attributed to the leaching of calcium carbonate or geological inputs. Magnesium levels showed consistent distribution between the two layers, with topsoil levels ranging from 107.456 to 190.013 mg/kg and subsoil levels from 87.172 to 195.235 mg/kg, suggesting stable availability. Manganese concentrations, ranging from 12.367 to 46.924 mg/kg in the topsoil and 12.492 to 49.263 mg/kg in the subsoil, displayed variability that may be linked to pH or redox conditions.

Heavy Metals: Heavy metals occur naturally in the environment at low concentrations (Table 4.12); however, elevated levels of these metals in the environment may be experienced due to anthropogenic activities. The presence of heavy metals in the soil at the level within the naturally occurring concentration is, therefore, not indicative of contamination. The concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed (McLean and Bledsoe, 1992).

Table 4.12: Naturally Occurring Heavy Metal Concentrations

Metals	Limits (mg/kg)
Cadmium	0.03-0.3
Nickel	5-500
Lead	2-20
Zinc	10-50
Copper	5-500
Iron	NS

Source: Alloway (1991); Allen *et al* (1974) NS = Not Specified

Based on the results of laboratory analysis conducted on soil samples from the Project site and its surrounding environment, no heavy metal pollution was recorded in the soil samples from the Project area.

Soil Microbiology: Microorganisms are one of the major components of soil. Microbial communities in the soil make important contributions to biogeochemical cycling and the carbon, nitrogen, sulfur, iron and manganese cycle.

The microbiological analysis of the soil samples from both the topsoil and bottom soil revealed various trends in microbial populations. In the topsoil, the total heterotrophic bacteria counts ranged from 5.1 x 10^5 to 8.9 x 10^6 Cfu/g, indicating a higher concentration of these bacteria in certain areas, which reflects the more active soil layer with greater organic matter. The hydrocarbon-utilizing bacteria in the topsoil were found in the range of 2.4 x 10^3 to 7.0 x 10^3 Cfu/g, suggesting a moderate level of bacteria involved in the degradation of hydrocarbons, with some variations across the samples.

For total heterotrophic fungi, the counts in the topsoil varied between 1.0 x 10^4 and 6.1 x 10^4 Cfu/g, showing a generally abundant fungal presence, likely due to organic matter decomposition. Hydrocarbon-utilizing fungi in the topsoil were found at counts ranging from 2.5 x 10^3 to 2.5 x 10^4 Cfu/g, indicating a smaller yet significant fungal population capable of degrading hydrocarbons. The total coliform levels in the topsoil ranged from 7 to 39 MPN/100g, reflecting a moderate presence of coliform bacteria, often associated with contamination from animal waste or organic matter. Similarly, the fecal coliform levels ranged from 0 to 28 MPN/100g, indicating varying degrees of contamination across the samples.

In the bottom soil, the total heterotrophic bacteria counts ranged from 7.0 x 10^4 to 7.8 x 10^5 Cfu/g, which were generally lower than those found in the topsoil, reflecting the reduced microbial activity in the deeper soil layers. The hydrocarbon-utilizing bacteria in the bottom soil were found in concentrations between 2.5 x 10^3 to 5.2 x 10^3 Cfu/g, showing a somewhat lower but consistent population involved in hydrocarbon degradation. The total heterotrophic fungi counts in the bottom soil ranged from 2.2 x 10^4 to 4.4 x 10^4 Cfu/g, which was similar to the topsoil but slightly lower, indicating a still significant presence of fungi involved in decomposition processes. The hydrocarbon-utilizing fungi counts in the bottom soil ranged from 2.5 x 10^3 to 7.0 x 10^3 Cfu/g, reflecting a steady presence of fungi capable of breaking down hydrocarbons.

For coliform bacteria, the total coliform counts in the bottom soil varied from 7 to 64 MPN/100g, which were notably higher compared to the topsoil, indicating possible contamination from external sources like runoff. The fecal coliform counts in the bottom soil ranged from 0 to 15 MPN/100g, indicating lower levels of fecal contamination compared to the topsoil, with the lowest levels found in some areas, which could suggest better sanitation or fewer direct sources of contamination.

4.3.5 Groundwater Quality

Naturally, groundwater contains mineral ions. These ions slowly dissolve from soil particles, sediments and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer (Harter 2003). They are referred to as dissolved solids or suspended solids as the case may be. Some dissolved solids may have originated in the precipitation water or river water that recharges the aquifer. Dissolved solids in groundwater can be divided into three groups namely: major constituents (such as Na^{+}, Ca^{2+}, SO_4^{2-}, Cl^{-}), minor constituents (e.g., K^{+}, NO^{3-}, CO_3^{2-}) and trace elements (e.g., heavy metals).

Except for natural organic matter originating from topsoil, all of these naturally occurring dissolved solids are inorganic constituents: minerals, nutrients, and trace elements, including trace metals. In most cases, trace elements occur in such low concentrations that they are not a threat to human health. However, high concentrations of trace metals can be found in ground water near contaminated sources, posing serious health threats.

The microbial matter is also a natural constituent of ground water. Just as microbes are ubiquitous in the environment around us, they are very common in the subsurface, including groundwater (Harter, 2003). Human activities can alter the natural composition of groundwater through the disposal of chemicals and microbial matter at the land surface and into soils, or injection of wastes directly into groundwater.

To assess the quality of existing groundwater in the study area, groundwater samples were collected within the study area and analysed. The results of the physicochemical and microbial characteristics of the analysed groundwater samples were compared with the FMEnv prescribed limits for drinking water as highlighted in the National Guidelines and Standards for Water Quality in Nigeria, 1999.

The results of physicochemical and microbial analyses conducted on groundwater samples collected from the study area are presented in Table 4.13.

Table 4.13: Physico-chemical and microbial characteristics of groundwater samples from the study area

	GW 1	GW 2	GW 3	GW C	NUPRC Target Value	FMEnv DRINKING WATER STANDARD
PHYSICAL CHARACTERISTICS						
Coordinates	N 05° 01' 58.77" E 06° 20' 56.98"	N 05° 01' 45.02" E 06° 20' 58.72"	N 05° 01' 41.08" E 06° 21' 12.05"	N 05° 03' 06.69" E 06° 20' 55.98"		
Colour, TCU	1	1	1	1	**-**	**15(Colourless)**
Total Suspended Solids, mg/l	11.093	10.431	17.223	15.314	**-**	10.00
Total Alkalinity, mg/l	50.0	10.0	66.0	15.0	**-**	**NA**
Acidity, mg/l	4.0	3.0	9.0	8.0	**-**	**NA**
Total Hardness, mg/l	10.0	4.0	18.0	6.0	**-**	**200.00**
Total Organic Carbon, %	<0.10	<0.10	<0.10	<0.10	**-**	**NA**
HYDROCARBONS						
TPH, µg/l	<0.001	<0.001	<0.001	<0.001	**50µg/l**	**NA**
PAH, µg/l	<0.01	<0.01	<0.01	<0.01	**0.057µg/l**	**NA**
BTEX, µg/l	<0.01	<0.01	<0.01	<0.01	**0.8µg/l**	**NA**
THC, mg/l	<0.001	<0.001	<0.001	<0.001	**-**	**NA**
TOG, mg/l	<0.001	<0.001	<0.001	<0.001	**-**	0.05
PHYSIOCHEMICALS (mg/l)						
Nitrate	0.035	0.012	0.040	0.016	**-**	**NA**
Sulphate	0.056	0.022	0.018	0.026	**-**	**NA**
Phosphate	<0.001	<0.001	<0.001	<0.001	**-**	**NA**
Chloride	1.90	0.90	0.90	0.90	**-**	**NA**
Carbonate	<0.1	<0.1	<0.1	<0.1	**-**	**NA**
EXCHANGEABLE CATIONS (mg/l)						
Sodium, Na	1.026	2.008	4.678	1.011	**-**	**NA**
Potassium, K	0.242	0.634	0.815	0.162	**-**	**NA**
Calcium, Ca	1.523	4.271	6.765	1.678	**-**	**NA**
Magnesium, Mg	0.825	0.656	1.418	0.835	**-**	**NA**
HEAVY METALS, mg/l						
Cadmium, Cd	<0.001	<0.001	<0.001	<0.001	**0.4**	**0.01**
Barium, Ba	<0.001	<0.001	<0.001	<0.001	**-**	**1.0**
Vanadium, V	<0.001	<0.001	<0.001	<0.001	**-**	**0.01**
Chromium, Cr	<0.001	<0.001	<0.001	<0.001	**1**	0.05
Cobalt,Cr	<0.001	<0.001	<0.001	<0.001	**-**	**NA**
Copper,Cu	<0.001	<0.001	<0.001	<0.001	**15**	**0.10**
Iron,Fe	0.081	0.067	0.035	0.062	**-**	1.00
Manganese, Mn	0.056	0.059	0.118	0.078	**-**	0.05
Lead,Pb	<0.001	<0.001	<0.001	<0.001	**15**	0.05
Mercury,Hg	<0.001	<0.001	<0.001	<0.001	**0.05**	0.001
Nickel, Ni	<0.001	<0.001	<0.001	<0.001	**15**	0.05
Zinc, Zn	<0.001	<0.001	<0.001	<0.001	**65**	5.00

BIOLOGICALS						
COD, mg/l	3.20	2.80	7.20	0.40		0.00
THB (cfu/ml)	5.7 x 10^5	3.1 x 10^5	3.9 x 10^5	3.6 x 10^5		0.00
TDB (cfu/ml)	3.9 x 10^3	2.6 x 10^3	5.3 x 10^3	7.1 x 10^3		0.00
THF (cfu/ml)	4.2 x 10^4	5.8 x 10^4	2.9 x 10^4	4.0 x 10^4		0.00
HDF (cfu/ml)	2.7 x 10^3	2.5 x 10^3	4.1 x 10^3	3.3 x 10^3		0.00
Total Coliform (MPN/100ml)	15	23	11	14		**NA**
Faecal Coliform (MPN/100ml)	0	0	0	0		**NA**

FMENV - Federal Ministry of Environment,
***Limit Source**:* The Federal Ministry of Environment National Guidelines and Standards for Water Quality in Nigeria, 2007 ;NUPRC Target Value

The results of the groundwater samples are discussed below:

Physical Characteristics**:** The colour of the groundwater samples across all locations was measured at 1 TCU, which is well below the FMEnv standard of 15 TCU. This indicates that the groundwater is clear and free from visible contaminants, making it suitable for consumption in terms of aesthetic quality. The Total Suspended Solids (TSS) values ranged from 10.431 mg/l (GW 2) to 17.223 mg/l (GW 3), exceeding the FMEnv limit of 10.00 mg/l. Elevated TSS levels suggest that the groundwater in these locations contains suspended particles, which could affect its clarity and may require additional filtration to meet drinking water standards. Total Alkalinity was found to vary from 10.0 mg/l (GW 2) to 66.0 mg/l (GW 3), which are within typical groundwater levels and do not raise immediate concerns for water potability. Similarly, acidity ranged from 3.0 mg/l (GW 2) to 9.0 mg/l (GW 3), indicating mildly acidic conditions, but not to a level that would be problematic without specific regulatory limits. Regarding Total Hardness, the groundwater samples showed values ranging from 4.0 mg/l (GW 2) to 18.0 mg/l (GW 3), all well below the FMEnv standard of 200.00 mg/l, indicating soft water, which is favorable for both human consumption and industrial use. Total Organic Carbon (TOC) concentrations were consistently below 0.10% across all samples, indicating minimal organic contamination, which is a positive indicator of groundwater quality.

Hydrocarbons: The Total Petroleum Hydrocarbons (TPH) values for all samples were <0.001 µg/l, which is far below the NUPRC target of 50 µg/l, suggesting that the groundwater in these locations is not significantly contaminated by petroleum products. Polycyclic Aromatic Hydrocarbons (PAH) concentrations were also very low at <0.01 µg/l for all locations, well under the NUPRC threshold of 0.057 µg/l, indicating no major contamination by these toxic compounds. Similarly, the Benzene, Toluene, Ethylbenzene, Xylene (BTEX) levels were <0.01 µg/l, significantly below the NUPRC target of 0.8 µg/l, further confirming the absence of harmful volatile organic compounds. The Total Hydrocarbon Content (THC) and Total Oil and Grease (TOG) were both measured at <0.001 mg/l, indicating negligible contamination from oil and grease, which is below the FMEnv threshold of 0.05 mg/l, suggesting the groundwater is clean in terms of hydrocarbon pollution.

Physiochemical Parameters: Nitrate levels in the groundwater samples ranged from 0.012 mg/l (GW 2) to 0.040 mg/l (GW 3), which are well within acceptable limits for drinking water and show no signs of agricultural contamination. Sulphate concentrations ranged from 0.018 mg/l (GW 3) to 0.056 mg/l (GW 1), indicating low levels of sulphates that do not pose any risks for water quality. Phosphate concentrations were consistently below 0.001 mg/l, suggesting that the groundwater is not polluted by agricultural runoff or wastewater. Chloride levels ranged from 0.90 mg/l (GW 2, GW 3, and GW C) to 1.90 mg/l (GW 1), well within the expected range and below any thresholds that would affect the taste or quality of the water. Carbonate concentrations were negligible (<0.1 mg/l) across all samples, further indicating that the water is unlikely to have significant mineral imbalances.

Exchangeable Cations: The cation concentrations in the groundwater showed typical levels for natural groundwater. Sodium levels ranged from 1.011 mg/l (GW C) to 4.678 mg/l (GW 3), suggesting that the groundwater is not excessively saline. Potassium concentrations varied from 0.162 mg/l (GW C) to 0.815 mg/l (GW 3), which are within expected limits and not high enough to cause concerns. Calcium and Magnesium concentrations were found to range from 1.523 mg/l (GW 1) to 6.765 mg/l (GW 3) for calcium, and from 0.656 mg/l (GW 2) to 1.418 mg/l (GW 3) for magnesium. These levels are typical for groundwater and do not raise concerns regarding hardness or water quality.

Heavy Metals: The concentrations of heavy metals in the groundwater were generally low. Cadmium, Barium, and Vanadium were all recorded as <0.001 mg/l, which is far below the NUPRC target for Cadmium (0.4 mg/l) and the FMEnv standards for Barium and Vanadium. Chromium, Copper, and Iron were also found at non-detectable levels (<0.001 mg/l), far below the FMEnv standard for copper (0.10 mg/l) and iron (1.00 mg/l), indicating that these metals are not present in harmful concentrations. Lead, Mercury, Nickel, and Zinc were similarly not detected (<0.001 mg/l), which is positive for water safety, as these metals have regulatory limits set by FMEnv (e.g., 0.05 mg/l for Lead and 5.00 mg/l for Zinc). Manganese concentrations, while detectable, were found at low levels (from 0.056 mg/l (GW 1) to 0.118 mg/l (GW 3)), which are within acceptable limits for groundwater.

Biological Parameters: The biological parameters in the groundwater samples indicated varying levels of microbial activity. The Chemical Oxygen Demand (COD) values ranged from 0.40 mg/l (GW C) to 7.20 mg/l (GW 3), with higher values suggesting some organic contamination in certain locations, but none exceeding dangerous levels. Total Heterotrophic Bacteria (THB) concentrations varied from 3.1 x 10^5 cfu/ml (GW 2) to 5.7 x 10^5 cfu/ml (GW 1), indicating moderate bacterial presence, though it is important to note that these levels are still within the tolerable range for groundwater. Similarly, Total Dissolved Bacteria (TDB) counts ranged from 2.6 x 10^3 cfu/ml (GW 2) to 7.1 x 10^3 cfu/ml (GW C), indicating bacterial presence but not exceeding levels that would make the water unsafe without treatment. Other microbial indicators, such as Total Heterotrophic Fungi (THF) and Heterotrophic Fungi (HDF), also indicated microbial activity, but all values were within manageable levels for potable water with appropriate treatment. The Total Coliform count ranged from 11 to 23 MPN/100ml across the locations, indicating that while the water may be microbiologically contaminated, it does not exceed the threshold for serious health risks. Importantly, there were no fecal coliforms detected, which is a positive indicator of the absence of fecal contamination.

4.3.6 Surface Water

Surface water samples were collected from three (3) different locations in the study area. The water quality analysis from the Upstream, Midstream, and Downstream locations reveals generally acceptable conditions for aquatic life and recreational purposes, based on the FMEnv Surface Water Standards.

Physical parameters such as pH, Colour (TCU), Turbidity, and Temperature were within the acceptable ranges for both aquatic life and recreational use. The pH values ranged from 7.56 to 8.59, and the turbidity levels were below the FMEnv threshold, suggesting clear water. The temperature (27.9°C - 29.3°C) was also within the suitable range for aquatic organisms and recreational activities. Additionally, salinity and Total Suspended Solids (TSS) were low, further indicating good water quality. Electrical Conductivity (EC) and Total Dissolved Solids (TDS) values were moderate, suggesting typical freshwater characteristics.

The hydrocarbon parameters, including Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), and BTEX, showed negligible levels (<0.001 µg/l), indicating no significant contamination from petroleum-based compounds. Similarly, Total Organic Carbon (TOC) was also low, contributing to the overall positive water quality.

Physiochemical parameters such as Nitrate, Sulphate, and Chloride were within reasonable limits, suggesting minimal contamination. The concentration of Nitrate ranged from 0.021 mg/l to 0.526 mg/l, indicating low agricultural or wastewater pollution. Sulphate levels ranged from 47.096 mg/l to 61.079 mg/l, which are typical for freshwater systems. Phosphate concentrations were consistently low (<0.001 mg/l), which is favorable for preventing eutrophication.

The concentration of Calcium, Sodium, Magnesium, and Potassium were found to be high, particularly in the Downstream location, but these are typical for groundwater-influenced surface waters and support healthy aquatic ecosystems.

Heavy metals were generally found in trace amounts, with most parameters like Cadmium, Barium, Chromium, and Nickel showing no detectable concentrations. Copper, however, showed elevated levels in the Midstream and Downstream locations, exceeding FMENV guidelines, indicating potential contamination that may require further monitoring. Manganese concentrations were higher than typical natural levels, warranting attention, while Iron was within the acceptable range.

biological parameters such as Chemical Oxygen Demand (COD) and microbial counts (Total Heterotrophic Bacteria and Hydrocarbon-Degrading Bacteria) were within normal limits, suggesting low organic pollution and a healthy microbial ecosystem in the water.Table 4.14 shows the summary of the physcio chemical and microbial results

Table 4.14: Physico-chemical and microbial results of surface water samples from the study area

FIELD ID	SW (Upstream)	SW (Midstream)	SW (Dowstream)	FMEnv SURFACE WATER STANDARD	
				Aquatic Life	Recreational Purpose
Coordinates	N 05° 01' 15.93" E 06° 20' 50.48"	N 05° 01' 53.47" E 06° 20' 56.48"	N 05° 02' 13.33" E 06° 20' 56.93"		
Colour,TCU	1	1	1	NA	<100.00
pH	7.96	8.59	7.56	6.00-9.00	5.00-9.00
Salinity	29.0	15.0	29.0	NA	<80.00
Turbidity	10	15	10	NA	55.00
Total Suspended Solids, mg/l	6.045	9.244	15.218	NA	NA
Temperature	29.3	28.5	27.9	20.00-33.00	20.00-33.00
Electrical Conductivity	84.0	65.0	90.0	NA	NA
Total Dissolved Solids	46.0	30.0	43.0	NA	NA
Dissolved Oxygen	5.8	6.5	5.8	6.80	>5.00
Total Alkalinity, mg/l	12.0	16.0	12.0	NA	NA
Acidity, mg/l	8.0	10.0	8.0	NA	NA
Total Hardness, mg/l	80.0	120.0	162.0	NA	NA
HYDROCARBONS					
TPH, µg/l	<0.001	<0.001	<0.001	NA	NA
PAH, µg/l	<0.01	<0.01	<0.01	NA	NA
BTEX, µg/l	<0.01	<0.01	<0.01	NA	NA
THC, mg/l	<0.001	<0.001	<0.001	NA	NA
TOG, mg/l	<0.001	<0.001	<0.001	NA	NA
Total Organic Carbon, %	<0.1	<0.1	<0.1	NA	NA
PHYSIOCHEMICALS (mg/l)					
Nitrate	0.033	0.526	0.021	NA	NA
Sulphate	47.096	53.102	61.079	NA	NA
Phosphate	<0.001	<0.001	<0.001	NA	NA
Chloride	29.90	49.90	99.90	NA	NA
Carbonate	<0.10	<0.10	<0.10	NA	NA
EXCHANGEABLE CATIONS (mg/l)					
Calcium, Ca	472.697	480.164	514.005	NA	NA
Sodium, Na	304.432	331.147	467.598	NA	NA
Magnesium, Mg	219.389	248.512	391.884	NA	NA
Potassium, K	72.697	80.164	101.005	NA	NA
HEAVY METALS, mg/l					
Cadmium, Cd	<0.001	<0.001	<0.001	0.002-0.0018	NA
Barium, Ba	<0.001	<0.001	<0.001	NA	NA
Vanadium, V	<0.001	<0.001	<0.001	0.10	NA
Chromium, Cr	<0.001	<0.001	<0.001	0.02-2.00	NA
Cobalt,Cr	<0.001	<0.001	<0.001	NA	NA
Copper,Cu	0.243	0.527	0.151	0.002 - 0.004	NA
Manganese, Mn	10.524	26.715	57.286	NA	

Iron,Fe	1.241	2.256	1.956	1.00	NA
Lead,Pb	<0.001	<0.001	<0.001	0.0017	NA
Mercury,Hg	<0.001	<0.001	<0.001	0.001	NA
Nickel,Ni	<0.001	<0.001	<0.001	0.025 - 0.15	NA
Zinc,Zn	<0.001	<0.001	<0.001	50.00	NA
BIOLOGICALS					
Chemical Oxygen Demands, mg/l	0.40	0.80	0.40	NA	NA
Total Heterotrophic Bacteria (cfu/ml)	5.1 x 10^5	3.9 x 10^5	2.9 x 10^5	NA	NA
Hydrocarbon Degrading Bacteria (cfu/ml)	2.9 x 10^3	4.3 x 10^3	5.1 x 10^3	NA	NA
Total Heterotrophic Fungi (cfu/ml)	6.0 x 10^4	4.5 x 10^4	3.0 x 10^4	NA	NA
Hydrocarbon Degrading Fungi (cfu/ml)	2.6 x 10^3	3.2 x 10^3	4.5 x 10^3	NA	NA
Total Coliform (MPN/100ml)	39	21	28	NA	100.00
Faecal Coliform (MPN/100ml)	7	3	4	NA	NA

CFU - Colony forming unit, ***TN -*** Threshold Number, ***TCU*** - True Colour Unit, Detection Limit (<0.01, <0.001),
FMENV - Federal Ministry of Environment,

Limit Source*:* The Federal Ministry of Environment National Guidelines and Standards for Water Quality in Nigeria, 2007

4.3.7 Sediment Quality

Sediment quality is an important aspect of aquatic ecosystems, as it can influence the quality of overlying waters and also support the benthic community. Sediment also acts as a sink for pollutants. Monitoring the chemical content and physical composition of sediment samples provides information on how the environment is changing and the natural or human factors that may be linked to environmental change. Sediment samples were collected at three (3) different stations (collocated with surface water samples) from Etelebo creek. Plate 4.4 shows the sediment sampling activities.

Plate 4:4: Photograph during surface water and sediment sampling

The physicochemical, microbiology and textural characteristics of the sediment samples are presented in Table 4.15.

Table 4.15: Physico-chemical and microbial results of sediment samples from the study area

FIELD ID	SED 1	SED 2	SED 3
Sample Coordinates	N 05° 01' 15.93" E 06° 20' 50.48"	N 05° 01' 53.47" E 06° 20' 56.48"	N 05° 02' 13.33" E 06° 20' 56.93"
pH	7.24	8.11	6.79
Moisture content (%)	2.98	8.36	4.22
TOC (%)	<0.1	<0.1	<0.1
Color	Dull Brown7.5R 6/3	Light Red 2.5YR 7/6	Dark Reddish Gray 10R 3/4
Porosity	6.42	12.33	3.51
Permeability	2.91	6.25	1.26
Bulk Density	4.18	2.13	8.39
Sand (%)	15.96	16.22	2.94
Silt (%)	23.18	13.91	11.82
Clay (%)	60.86	69.87	85.24
Texture	Loamy Silt	Loamy Silt	Loamy Silt
TPH, mg/kg	16.568	12.660	10.973
PAH, mg/kg	<0.01	<0.01	<0.01
BTEX,mg/kg	<0.01	<0.01	<0.01
THC, mg/kg	19.036	14.876	11.765
TOG, mg/kg	25.172	18.213	12.367
Nitrite, mg/kg	0.018	0.008	0.012
Sulphate, mg/kg	22.016	19.972	30.218
Phosphate, mg/kg	2.934	1.365	0.193
Chloride, mg/kg	14.90	20.90	22.90
Bicarbonate, mg/kg	<0.1	<0.1	<0.1
Ammonium, mg/kg	0.093	0.042	0.018
Total Nitrogen, mg/kg	4.943	1.536	0.257
Sodium, mg/kg	212.373	166.293	218.372
Potassium, mg/kg	351.011	450.538	560.125
Calcium, mg/kg	616.267	999.983	412.378
Magnesium, mg/kg	338.134	344.924	306.256
Manganese, mg/kg	1.903	0.822	0.319
Cobalt, mg/kg	<0.001	<0.001	<0.001
Barium, mg/kg	<0.001	<0.001	<0.001
Cadmium,mg/kg	<0.001	<0.001	<0.001
Chromium,mg/kg	<0.001	<0.001	<0.001
Copper, mg/kg	0.011	0.008	0.004
Iron, mg/kg	1530.267	1318.562	1224.617
Vanadium, mg/kg	<0.001	<0.001	<0.001
Lead, mg/kg	<0.001	<0.001	<0.001
Mercury, mg/kg	<0.001	<0.001	<0.001
Nickel, mg/kg	0.023	0.051	0.063
Zinc, mg/kg	0.726	0.418	0.908
Total Heterotrophic Bacteria, Cfu/g	3.0×10^5	3.0×10^5	3.0×10^5
Hydrocarbon Utilizing Bacteria, Cfu/g	5.1×10^3	2.8×10^3	2.9×10^3
Total Heterotrophic Fungi, Cfu/g	2.8×10^4	3.0×10^4	2.6×10^4

Hydrocarbon Utilizing Fungi, Cfu/g	3.4×10^3	2.7×10^3	2.6×10^3
Total Coliform, (MPN/100g)	64	23	39
Faecal Coliform, (MPN/100g)	15	7	9

The sediment results are briefly discussed in the paragraphs below.

Physical Characteristics: The pH values for the sediment samples ranged from 6.79 to 8.11, indicating slightly acidic to neutral conditions, which are typical for most soils. The moisture content varied significantly, with SED 2 showing the highest at 8.36%, suggesting higher water retention compared to the other samples (SED 1: 2.98%, SED 3: 4.22%). The Total Organic Carbon (TOC) content was consistently low (<0.1%), indicating low organic matter in the sediments. The sediments were classified as loamy silt for all three locations, with a high clay content (60.86%–85.24%), which influences the sediment's porosity, permeability, and bulk density. SED 2 had the highest porosity (12.33%) and permeability (6.25), indicating better water flow and air circulation compared to the other sites. SED 3 exhibited the highest bulk density (8.39), suggesting more compacted sediments.

Chemical Parameters: The analysis of Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), and BTEX showed negligible concentrations (<0.01 mg/kg), indicating minimal contamination from petroleum-based compounds. However, Total Hydrocarbon (THC) and Total Organic Geochemical (TOG) were present at low levels, with SED 1 showing the highest THC (19.036 mg/kg) and TOG (25.172 mg/kg) content, which might suggest slight pollution from hydrocarbons. Nitrite, sulfate, phosphate, chloride, ammonium, and total nitrogen concentrations varied across the sites, with SED 1 having higher nitrite (0.018 mg/kg) and total nitrogen (4.943 mg/kg) levels, indicating possible nutrient enrichment. SED 3 showed the highest concentration of phosphate (2.934 mg/kg), which may be linked to agricultural runoff or other nutrient sources.

Heavy Metals: The heavy metals analysis revealed very low concentrations of harmful metals such as cadmium, chromium, barium, and mercury, which were below detection limits (<0.001 mg/kg). Copper and zinc concentrations were low but detectable, with SED 1 showing the highest copper content (0.011 mg/kg) and SED 3 having the highest zinc concentration (0.908 mg/kg). Iron levels were relatively high across all sites, with SED 1 exhibiting the highest concentration (1530.267 mg/kg), which is typical for sediments with high clay content. The manganese concentrations were moderate across all sites, with SED 1 showing the highest (1.903 mg/kg). Nickel levels were low but detectable, with SED 3 showing the highest concentration (0.063 mg/kg).

Biological Parameters: The biological analysis revealed similar microbial activity across all sediment samples, with Total Heterotrophic Bacteria consistently at 3.0 x 10^5 cfu/g across all sites, indicating a healthy microbial population. Hydrocarbon-utilizing bacteria and fungi were also detected at moderate levels, suggesting the presence of biodegradation activity in the sediments. The Total Coliform and Faecal Coliform counts were within a range typical for environmental samples, with SED 1 showing the highest coliform counts (64 MPN/100g for total coliform and 15 MPN/100g for faecal coliform).

4.3.8 Biodiversity Assessment

The assessment of biodiversity was conducted to provide information on some aspects such as floristic and faunal composition, the status of habitat as well as an inventory of economic plants including any crop of medicinal value in the project area .

Habitat status

The project area is located within the lowland rainforest ecological zone of Nigeria. Field surveys revealed that the vegetation cover comprises a forest structure characterized by an open canopy with a few emergent trees, shrubs, and an undergrowth of herbs, grasses, and climbers. However, due to significant anthropogenic activities within and around the project area, the vegetation structure has undergone substantial transformations from its original ecotone. These changes have resulted in the current landscape, which is predominantly a degraded secondary forest with sparse trees and a dominance of shrubs and grasses.

The landscape is composed of various habitats, including fallow bush, plantations, subsistence agricultural farms, and degraded secondary forests. Plantation agriculture, such as oil palm plantations and patches of cassava farms, represents the primary agricultural activities in the area.

Plate 4.5: Typical Vegetation of the proposed project area

Flora Sampling Methodology

Vegetation sampling was carried out using the line transects method. Transects were laid randomly across the Project site as well as Gas pipeline RoW and distributed across the different habitats. The investigation of the flora composition of the project area was conducted in four (4) different habitats as identified during assessment which include; Secondary forest, plantation, farmland and fallow bush area. Quadrats of 10m x 10m each were systematically laid along each transect for vegetation sampling. Further subdivision of 1m x 1m within each quadrat was carried out for enumeration of lower species such as grasses, herbs and climbers. Point Centered Quarter (PCQ) method was applied for the inventory of the species within each quadrant during the study. In each quadrat, vegetation components (plants) were identified, enumerated and recorded on field to species level using their floristic and structural attributes with the aid of flora field guides and taxonomic keys.

Species Composition and Taxonomic Diversity

Taxonomic diversity within the study area and is represented by 119 species belonging to 52 plant families. Diversity at the rank of family is dominated by 6 families which account for a total of 56 species. These families in decreasing order of their number of representative species are: Fabaceae (15), Euphorbiaceae (12), Annonaceae (9), Poaceae (7), Rubiaceae (7) and Moraceae (6). The checklist of species and their classification are provided in Table 4.16

Table 4.16: Checklist of Plant Species of the Study Area

SPECIES NAMES	FAMILY	COMMON NAME	HABIT	ETHNOBOTANY
Acacia sp.	FABACEAE (Mimosoideae)		Shrub	
Aframomum sceptrum	ZINGIBERACEAE	Alligator Pepper; Fisani	Herb	Condiment, Weaving
Afzelia bipindensis	MORACEAE	Igbengi	Tree	Food
Albizia ferruginea	FABACEAE (Mimosoideae)		Tree	Fuel wood/Timber
Albizia zygia	FABACEAE (Mimosoideae)	*Yanyan*	Tree	Canoe Carving
Alchornea cordifolia	EUPHORBIACEAE	Christmas bush	Herb	
Allophylus africanus	SAPINDACEAE		Shrub	
Alstonia boonei	APOCYNACEAE	Stool Wood	Tree	Timber / Soft Wood
Anthocleista nobilis	GENTIANACEAE	Boundary Plant	Tree	
Anthostema aubryanum	EUPHORBIACEAE		Tree	
Antiaris africana	MORACEAE	False Iroko	Tree	Timber / Hard Wood
Antidesma vogelianum	EUPHORBIACEAE	*Ingolo golo*	Tree	Medicine
Aspilia africana	ASTERACEAE	Hemorrhage plant	Herb	Medicine

Asplenium africanum	ASPLENIACEAE		Tree Fern	
Bambusa vulgaris	POACEAE	Bamboo	Tree	
Baphia nitida	FABACEAE (Faboideae)	Camwood	Shrub / Tree	
Berlinia grandiflora	FABACEAE (Faboideae)	*Berlina*	Tree	Timber
Blighia sapida	SAPINDACEAE	Akee Apple	Tree	Fuel wood
Bosqueia angolensis	MORACEAE		Tree	Timber
Bridelia grandis	EUPHORBIACEAE	*Igbara gbara*	Tree	Medicine
Calamus deeratus	ARECACEAE / PALMAE	Rattan Palm; *Apie*	Liana	Fish Trap; Handicraft
Canarium schweinfurthii	BURSERACEAE		Tree	Oleoresin / Food
Carapa procera	MELIACEAE		Tree	Canoe Carving
Carpolobia lutea	POLYGALACEAE		Shrub	Medicine
Ceiba pentandra	BOMBACACEAE	Silk Cotton	Tree	Timber / Medicinal
Christella dentata	THELYPTERIDACEAE		Fern	
Chromolaena odorata	ASTERACEAE	Awolowo; Siam weed	Herb	Medicine
Cissus aralioides	VITACEAE	Ibiabia	Liana	Medicine
Cissus arguta	VITACEAE	Iguasi	Climber	
Clappertonia ficifolia	MALVACEAE(Grewioideae)		Shrub	
Cleistopholis patens	ANNONACEAE	Canoe Carving	Tree	Timber / Soft Wood
Clerodendrum umbellatum	LAMIACEAE	Medicinal	Climber	Medicine
Combretum paniculatum	COMBRETACEAE		Shrub	
Combretum racemosum	COMBRETACEAE		Liana	
Commelina spp	COMMELINACEAE		Herb	
Costus afer	COSTACEAE	Ogbodo	Herb	Fibre; Medicine
Craterispermum cerinanthum	RUBIACEAE		Tree	Food
Ctenolophon englerianus	CTENOLOPHONACEAE		Tree	
Cyclosorus dentatus	PTERIDOPHYTA		Fern	
Cyrtosperma senegalensis	AGAVACEAE	Bou Ake	Herb	Medicine
Dracaena arborea	ASPARAGACEAE		Tree	
Eichhornia crassipes	PONTEDERIACEAE	Water Hycinth	Herb	Invasive plant
Elaeis guineensis	ARECACEAE / PALMAE	Palm Tree	Tree	Food, Handicraft
Erythrophleum ivorense	FABACEAE(Caesalpinioideae)	Sass wood	Tree	Timber

Ficus exasperata	MORACEAE	Sand paper tree; Ikoronsi	Shrub / Tree	Medicine
Ficus ovata	MORACEAE		Liana	
Fleroya ledermannii	RUBIACEAE	Abura	Tree	Timber / Soft Wood
Fleurya aestuans	URTICACEAE		Herb	
Funtumia africana	APOCYNACEAE	Lagos Rubber	Tree	Rubber
Garcinia kola	CLUSIACEAE	Bitter Cola tree	Tree	Medicine
Gongronema latiflolium	APOCYNACEAE		Climber	Food / Medicine
Greenwayodendron suaveolens	ANNONACEAE		Tree	Timber
Hannoa klaineana	SIMAROUBACEAE		Tree	Medicine
Harungana madagascariensis	HYPERICACEAE		Shrub	Medicine
Hekistocarpa minutiflora	RUBIACEAE		Shrub	
Hevea brasiliensis	EUPHORBIACEAE	Rubber	Tree	Rubber
Homalium africanum	FLACOURTIACEA E		Shrub / Tree	
Irvingia gabonensis	IRVINGIACEAE	Ogbono; Bush Mango	Tree	Timber / Hard Wood
Klainedoxa gabonensis	IRVINGIACEAE		Tree	Canoe; Furniture
Laccosperma secondiflorum	ARECACEAE / PALMAE	Rattan Palm	Liana	Fish Trap; Handicraft
Lannea sp	ANACARDIACEAE		Tree	Medicine
Leucaena leucocephala	FABACEAE(Mimosoideae)		Tree	Domestic Fuel wood
Lonchocarpus griffonianus	FABACEAE(Faboideae)		Tree	
Lophira alata	OCHNACEAE	Efenfen Afanfan; Ekki	Tree	Timber / Hard Wood
Macaranga barteri	EUPHORBIACEAE		Tree	
Macaranga heudelotii	EUPHORBIACEAE		Shrub/Tree/ Liane	
Maesobotrya barteri	EUPHORBIACEAE		Tree	Timber
Mallotus oppositifolius	EUPHORBIACEAE		Herb	
Mammea africana	GUTTIFERAE		Tree	Timber/Hard/Medicine
Mangifera indica	ANACARDIACEAE	Mango	Tree	
Manihot esculenta	EUPHORBIACEAE	Cassava	Shrub	
Marantochloa purpurea	MARANTACEAE		Herb	
Microdesmis puberula	PANDACEAE		Herb	
Mimosa invisa	FABACEAE		Straggling	
	(Mimosoideae)		Herb	
Mimosa pudica	FABACEAE(Mimosoideae)		Straggling Herb	
Monodora myristica	ANNONACEAE	Calabash Nutmeg	Tree	Condiment

Musanga cecropioides	EUPHORBIACEAE	Umbrella tree	Tree	Timber / Soft Wood
Nauclea diderrichii	RUBIACEAE	Opepe	Tree	Timber / Hard Wood
Nephrolepis biserrata	NEPHROLEPIDACEAE	Giant Sword Fern	Fern	
Neptunia oleracea	FABACEAE(Mimosoideae)		Straggling Herb	
Newboulda laevis	BIGNONIACEAE	Boundary tree	Construction	
Olax spp.	OLACACEAE			
Oleandra distenta	OLEANDRACEAE		Tree Fern	
Ouratea calantha	OCHNACEAE			
Palisota hirsuta	COMMELINACEAE		Herb	
Panicum maximum	POACEAE		Grass	
Paspalum vaginatum	POACEAE		Grass	
Pennisetum purpureum	POACEAE			
Pentaclethra macrophylla	FABACEAE (Faboideae)	Oil bean tree	Tree	
Pentadesma butyracea	CLUSIACEAE		Tree	Timber / Hard Wood
Pentodon pentandrus	RUBIACEAE		Herb	
Phymatodes scolopendria	POLYPODIACEAE		Tree Fern	
Piptadeniastrum africanum	FABACEAE (Mimosoideae)			
Platycerium stemaria	POLYPODIACEAE		Tree Fern	
Psydrax palma	RUBIACEAE		Tree	Hard wood
Pterocarpus santalinoides	FABACEAE (Faboideae)			
Raphia hookerii	ARECACEAE / PALMAE	Wine Palm	Tree	Sap Wine; Handicraft
Rauvolfia vomitoria	APOCYNACEAE		Shrub	Medicine
Rhigiocarya racemifera	MENISPERMACEAE			
Rothmannia hispida	RUBIACEAE			Medicine
Sacciolepis africana	POACEAE		Grass	
Selaginella myosurus	SELAGINELLACEAE		Fern	
Setaria megaphylla	POACEAE		Grass	
Smilax kraussiana	SMILACACEAE		Straggling Herb	
Spondianthus preussii	EUPHORBIACEAE	Okolota	Tree	Hard/hand dug canoe
Spondias mombin	ANACARDIACEAE	Iginein	Tree	Food/Medicine
Symphonia globulifera	CLUSIACEAE		Tree	Chewing stick
Syzygium guineense	MYRTACEAE		Tree	
Terminalia ivorensis	COMBRETACEAE	Idigbo; Black Afara	Tree	Timber / Hard Wood

Terminalia superba	COMBRETACEAE	White Afara	Tree	Timber / Hard Wood
Tetrapleura tetraptera	FABACEAE (Faboideae)		Tree	Condiment/Medicine
Treculia africana	MORACEAE	African Bread Fruit	Tree	Food
Triumfetta cordifolia	MALVACEAE		Herb	
Uapaca guineensis	PHYLLANTACEAE		Tree	Food / Timber
Urena labata	MALVACEAE		Herb	
Vitex grandifolia	LAMIACEAE		Tree	Timber
Vossia cuspidata	POACEAE		Grass	
Xylopia aethiopica	ANNONACEAE		Tree	Boat making, Condiment
Xylopia staudtii	ANNONACEAE		Tree	Timber/Soft/Food/Condiments

Bluestem grass

Tripsacum grass

Palm Tree

Banana Tree

Plate 4.6: Flora Specie within the project area

Fauna Survey

Understanding the habitat requirements (habitat utilization) of a species at the project site is important for the prediction of environmental impact and any mitigation measure that can be predicted for the conservation of such endemic species. The faunal occurrence and distribution in the project area are revealed to be uniform. This is attributable to the fact that the area is nearly homogenous in terms of habitat conditions. The methods adopted for the fauna survey includes direct and indirect methods. The direct method involves recording species based on actual sightings or calls into data sheets along the predetermined transects, while an indirect method is the recording of the significant signs along the same transect lines. Point transect survey was carried out opportunistically, to quickly appraise the fauna species diversity in the project area. Considering time as a limiting factor, fauna species were counted at random point stations along a transect. A transect walk was carried out and ten (10) minutes stop at every 100m interval to observe, listen to calls along the transect and recording of all the species along the transect. Field guides and binoculars were used to aid in the proper identification of the various species of fauna. Indirect methods involved taking note of signs of animal presence in the site such as burrows, faecal droppings, footprints and interviews with the locals. Field-based interviews were conducted to collect wildlife biodiversity data by discussing with local hunters and members of the community. Furthermore, questions relating to poaching activities and the type of games killed further provided a yardstick for confirming the presence or otherwise of some of the wildlife. The Conservation Status of every species and sub-species recorded in the project area were evaluated according to the International Union for Conservation of Nature (IUCN) Red List Categories and Criteria Version 13 (IUCN, 2017).

Species Inventory

A total of 84 wildlife species was identified in the study area. The major Classes of wildlife in order of the number of species reported are: Aves (29 species belonging to 15 families), Mammals (27 species from 12 families) and Reptiles (22 species spread across 11 families). Amphibians had the least number of 6 belonging to 4 families.

Table 4.17 Some of the sensitive wildlife species within the study area and their local and IUCN status

	Common Name	**Species**	**IUCN / LOCAL STATUS**
Mammals	White-throated Guenon	*Cercopithecus erythrogaster*	Endangered
	Sclater's Guenon	*Cercopithecus Sclateri*	Vulnerable
	Spot-necked otter	*Lutra maculicollis*	Vulnerable
	Maxwell's duiker	*Cephalophus maxwelli*	Locally threatened
	Brush-tailed porcupine	*Atherurus africanus*	Locally threatened
	Calabar angwantibo	*Arctocebus calabarensis*	Locally Vulnerable
	Sitatunga	*Tragelaphus spekei*	Vulnerable
Reptiles	Dwarf Crocodile	*Osteolaemus tetraspis*	Vulnerable
	Serrate hingeback tortoise	*Kinixys erosa*	Threatened
	Nile Monitor lizard	*Varanus niloticus*	Threatened
	Nile Crocodile	*Crocodylus niloticus*	Threatened
	Rock Python	*Python sebae*	Locally Vulnerable
	Long tailed/Black-bellied pangolin	*Phataginus tetradactyla*	Vulnerable
	Tree/White Bellied Pangolin	*Phataginus tricuspis*	Vulnerable
Birds	Black Kite	*Milvus migrans*	Locally Common
	African Harrier Eagle	*Polyboroides typus*	Locally Common

4.3.9 Hydrobiology

Phytoplankton

Samples were collected in sub-surface area of the water of about 20-50cm deep. Fifty (50) litres of surface water sample were collected along Etelebo Creek (downstream, midstream and upstream point) and subjected to filtration process using a plankton net of 30–50µm mesh size. The filtrate was collected in 50ml and preserved with 4% formalin. In the laboratory, the collected samples were further concentrated by sedimentation over a period of 48 hours. The concentration was viewed under a binocular microscope (x200).

Zooplankton

Plankton net of mesh size of 30–50µm was towed for a minimum of 5 minutes at a speed of approximately 5km/h. The zooplankton on the sides of the net was washed down into the collection bottle. Samples were then put in a 10 ml labelled container and preserved with 4% formalin prior to microscopic analysis (Yigit, 2006; Kolo*et al*., 2010). APHA 1998 was used as a guide to aid species identification.

Benthic macrofauna

Samples were collected using an Eckman's grab. The composite sample was washed using a sieve with 0.5mm mesh. The retained residue was moved into a well labelled container and preserved with 4% formaldehyde. A total of three samples were collected (downstream, midstream, and upstream) along the stream. In the laboratory, the samples were washed using 0.125 mm mesh sieves, then sorted and identified under a stereomicroscope. The identification of the benthic macro-invertebrates collected in the study were based mainly on the keys provided by Brown (1980), Madsen (1985), Schneider (1990), Bouchard (2004) and Verma (2006).

Hydrobiology

Hydrobiology studies are concerned with species composition, community structure and diversity of the biota (phytoplankton, zooplankton, benthic invertebrates, and fisheries) of the aquatic environment, their interactions amongst themselves and their relationships with the physico-chemical components of the environment. The results of field and laboratory investigations of the ecological studies of the area are presented below. Three (3) sampling stations (downstream, midstream, and upstream) were studied.

4.3.9.1 Plankton Flora and Fauna

Phytoplankton

Phytoplankton are the autotrophic microscopic plant organisms (prokaryotic or eukaryotic algae) that live near the surface of water bodies, which adsorbs light to supports photosynthesis. They are of great ecological significance as they constitute the major portion of primary producers in the aquatic ecosystems and are at the base of the aquatic food pyramid. Majority of phytoplankton species are used for biological monitoring of the environment since most cannot survive in adverse environmental conditions like high turbidity, anoxic state, extreme salinity and low nutrient level (Fonge *et. al*. 2012; Peerapornpisal, *et al*. 2004). Major important members of this group include the divisions Chlorophyta (green algae), Cyanophyta or Cyanobacteria (blue-green algae) and Bacillariophyta (diatoms). A total of 48 phytoplankton taxa were identified and recorded during this study as shown in Table 4.18. These belong to seven divisions: Bacillariophyta (10), Chlorophyta (14), Cyanophyta (12), Dinophyta (05), Euglenophyta (04), Xanthophyta (02) and Chrysophyta (01).

Table 4.18: Phytoplankton species identified in the Study Area

S/N	DIVISION	Species
1	**Bacillariophyta**	*Cymbellagracillis*
2		*Cymbellalata*
3		*Diatoria*sp.
4		*Gomphonemenaaccuminatum*
5		*Naviculavividula*
6		*Navicullabacillium*
7		*Nitzschia sigma*
8		*Penulariaundalata,*
9		*Penulariaundalata,*
10		*Ulnotiapectinali*
11	**Chlorophyta**	*Cariteriamultifilis*
12		*Carteriaglobasa*
13		*Chlamydomonas* sp.
14		*Cladophoria*spp.
15		*Coelastrum reticulate*
16		*Cosmariumobsolatum*
17		*Crucigeniatetrapedia*
18		*Microsteria*spp.
19		*Microstriarotata*

20		*Pedioperarugurosum*
21		*Pleuroteniumtrumata*
22		*Spirogyra sp*
23		*Volvox aureus*
24		*Xantidium*spp.
25	**Cyanophyta**	*Anabenaflos – aqua*
26		*Lyngbyaconctreta*
27		*Merismapediaelagans*
28		*Mycrocystis incerta*
29		*Oscillatoria nigra*
30		*Oscillatoria brevita*
31		*Oscillatoria simplisima*
32		*Oscillatoria amphibia*
33		*Oscillatoria limosa*
34		*Raphidiopsiscurvata*
35		*Raphidiopsismediteranea*
36		*Spirulina princeps*
37	**Dinophyta**	*Ceratiumfurca*
38		*Ceratiumfusus*
39		*Dinophysiscaudata*
40		*Gymnodiumsp*
41		*Peridiniumsp*
42	**Euglenophyta**	*Euglena acus*
43		*Euglena caudate*
44		*Phacusaustreatus*
45		*Phacuslongicauda*
46	**Xanthophyta**	*Tribonemaviride*
47		*Tribonema vulgare*
48	**Chrysophyta**	*Dinobryonsertularia*

Chlorophyta were the dominant phytoplankton community followed by the Cyanophyta and Bacillariophyta. The Xanthophyta and Chrysophyta were the least in terms of occurrence and abundance. Chlorophyta contributed 29%of the total phytoplankton population. Cyanophyta and Bacillariophyta contributed 25% and 21% respectively, while Dinophyta an Euglenophyta contributed only 11% and 8% of the total phytoplankton biomass of the water.

Contributions by Xanthophyta and Chrysophyta were the least with 4% and 2% respectively.

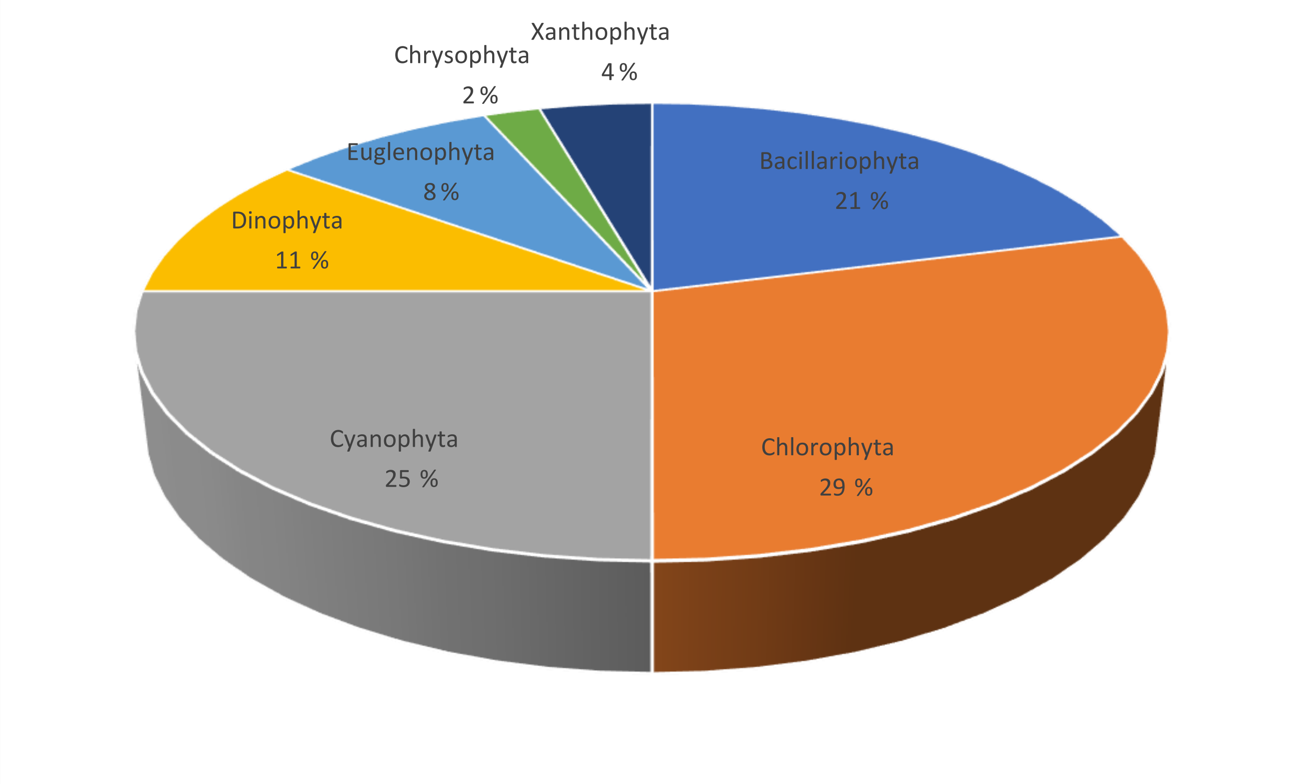

Figure 4.5: Percentage composition of phytoplankton division in the Study Area

Zooplankton

Zooplanktons are microscopic animals found mainly in the pelagic zone of water bodies where they depend on water currents and waves for locomotion. They consist of the Rotifers, Cladocera, Calanoid, Copepoda and Planktonic Ostracoda, Shrimps, Decapod crustaceans, and larval forms of bivalve molluscs and various fishes which made part of the important components of inland and coastal waters. Zooplankton community may be holoplanktonic (those organisms that spend their entire life cycle as zooplankton e.g. rotifers, cladocerans and copepods) or meroplanktonic (organisms that spend only part of their life cycle as plankton e.g. larvae of fish, crabs, molluscs and polychaete worms). The meroplanktonic forms are more sensitive to pollution than the holoplanktonic community because the former is composed largely of larval forms, that are, by their nature more sensitive to environmental perturbation (RPI, 1985). Besides the interruption of delicate food webs, the decimation of larval stocks can have serious impacts on the recruitment levels of economically important fish species. The zooplankton occupy a central position in the food webs of aquatic ecosystems and many of them feed largely on phytoplankton, algae and bacterial, and in turn, fall prey to numerous invertebrate and fish predators. They are good biological indicators of water quality as their

sensitivity to environmental factors (natural and man-made), makes them of considerable significance in pollution and environmental impact assessment studies (Asibor, 2015).
Occurrence and distribution of zooplankton in the Study area are presented in Table 4.19. Thirty-four (34) species of zooplankton were identified and recorded during the sampling period. This is made up of holoplankton (76%) and meroplanktonic (24%) zooplankton forms respectively (Figure 4.13).
Among the holoplankton, the major occurring zooplankton group in the study area as shown in Figure 12 are Cladocera, Copepods, Rotifers and Protozoa with a proportional representation of 26%, 23%, 15% and 12%; while within the meroplankton shrimp zoea and larva were the dominant groups.

Table 4.19: Zooplankton distribution and abundance in the study area

S/N	DIVISION	Species
HOLOPLANKTONIC		
	CLADOCERA	
1	**Bosminidae**	*Bosminalongirostris*
2		*Bosminopsisdeitersi*
3	**Chydoridae**	*Alonaaffinis*
4		*Alonadiaphana*
5		*Alonellaexcisa*
6	**Moinidae**	*Moinamicrura*
7		*Moniadubia*
8	**Sididae**	*Diaphanosomaexcisum*
9		*Peniliasp*
	COPEPODA	
10		*Acanthocyclopsviridis*
11		*Centropagestypicus*
12		*Copepod nauplius*
13		*Macrocyclopsalbidus*
14		*Macrocyclopsdistinctus*
15		*Mesochrasulfunensis*
16		*Nitocvalacustris*
17		*Paracalanusparvus*
	ROTIFERA	
18	**Brachionidae**	*Brachionus angularis*
19		*Brachionuscaudatus*
20		*Brachionusfalcatus*

21	**Trichocercidae**	*Trichocercacylindrica*
22		*Trichocercalongiseta*
	PROTOZOA	
23		*Arecellamitrata*
24		*Frontonia leucas*
25		*Holophryavesiculosa*
26		*Tintinnopsis*sp.
MEROPLANKTONIC		
27		Shrimp zoea
28		Shrimp larva
29		Gastropod veligar larva
30		Doloidid larva
31		Zoae (Crab)
32		Polycheate larva
33		Fish eggs
34		Fish larva

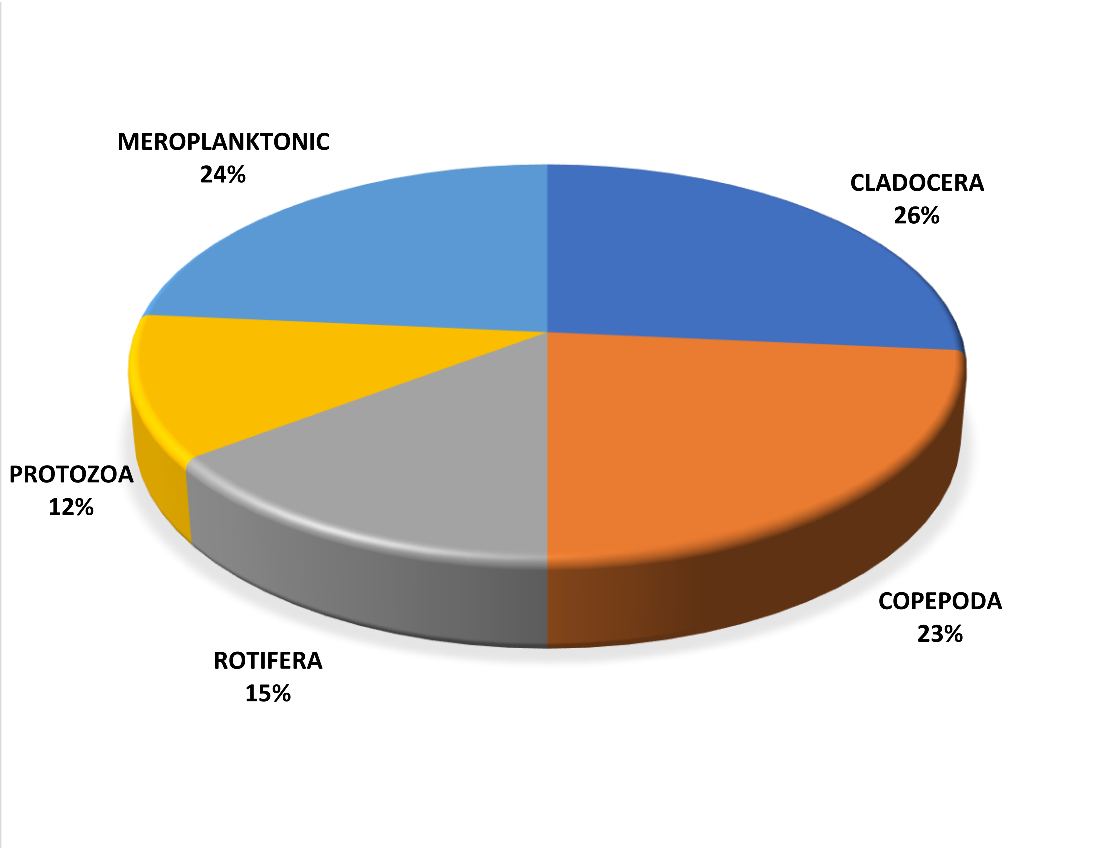

Figure 4.6: Percentage composition of Zooplankton division in the Study Area

Benthic Invertebrate Fauna

The benthic invertebrate fauna are organisms which are over 1.0mm in size, living on or in the substrate of a water body. They may be wholly or partially buried in soft or hard substrates. They constitute the consumer trophic level and contain the top-level predators in the aquatic ecosystem. These organisms are economically and ecologically important. They have been used as bio-indicators in pollution/impacpt assessment studies (Arimoro*et. al*. 2007; Ayoade and Olusegun 2012; Okoroafor 2014; Asibor 2015; Asibor and Adeniyi 2017).

The composition, abundance and diversity of microbenthic invertebrate fauna in the study area are presented in Table 4.20 **.**A total of twenty-five (25) benthic invertebrates were recorded during the study. The benthic invertebrates belong to the following Crustacea, Gastropod, Bivalves, Annelids and Insecta group (Table4.53). Annelida (31%) has the highest number of taxa and spread of species in the area followed by Crustacea and Insecta (23% each), as shown in figure 4.14, while benthic Bivalves (8%) was the lowest with respect to taxonomic spread in the study area. However, gastropada taxonomic spread was 15%. *Eiseniella tetrahedral*, *Tubifex sp* and *Lumbricussp* were the dominant Annelida species, while *Callinectes amnicola* was the dominant *Crustacean species*, while*Tympanotonusfuscatus* and *Crassostrea gasar* were the dominant *Gastropods* and *Bivalvesspecies* respectively.

Table 4.20: Macro-invertebrate distribution and abundance in the study area

S/N	GROUP	Scientific Name	Common Name
1	**Crustacea**	*Alpheus pontederiae*	Snapping shrimp
2		*Callinectes amnicola*	Swimming crab
3		*Cardisomaarmatum*	Rainbow crab
4		*Mysis sp*	
5		*Palaemon maculates*	
6		*Ucatangeri*	Fiddler crab
7	**Gastropoda**	*Littorina sp*	
8		*Pachymelaniaaurita*	
9		*Thais sp*	
10		*Tympanotonusfuscatus*	Mud-flat periwinkle
11	**Bivalve**	*Crassostrea gasar*	Oysters
12		*Mutela Larva,*	
13	**Annelida**	*Capitella sp*	
14		*Nereis pelagica*	

15		*Notomastusaberans*	
16		*Eiseniella tetrahedral*	
17		*Tubifex sp*	
18		*Dero sp,*	
19		*Naidid sp.*	
20		*Lumbricus sp.*	
21	**Insecta**	*Baetissp*	Mayfly larva
22		*Coenagrionsp*	Dragonfly larva
23		*Chironomus sp*	
24		*Libellula sp.*	
25		*Chlorosypha sp.*	
26		*Odonnata larva*	
27		*Enochrussp.*	

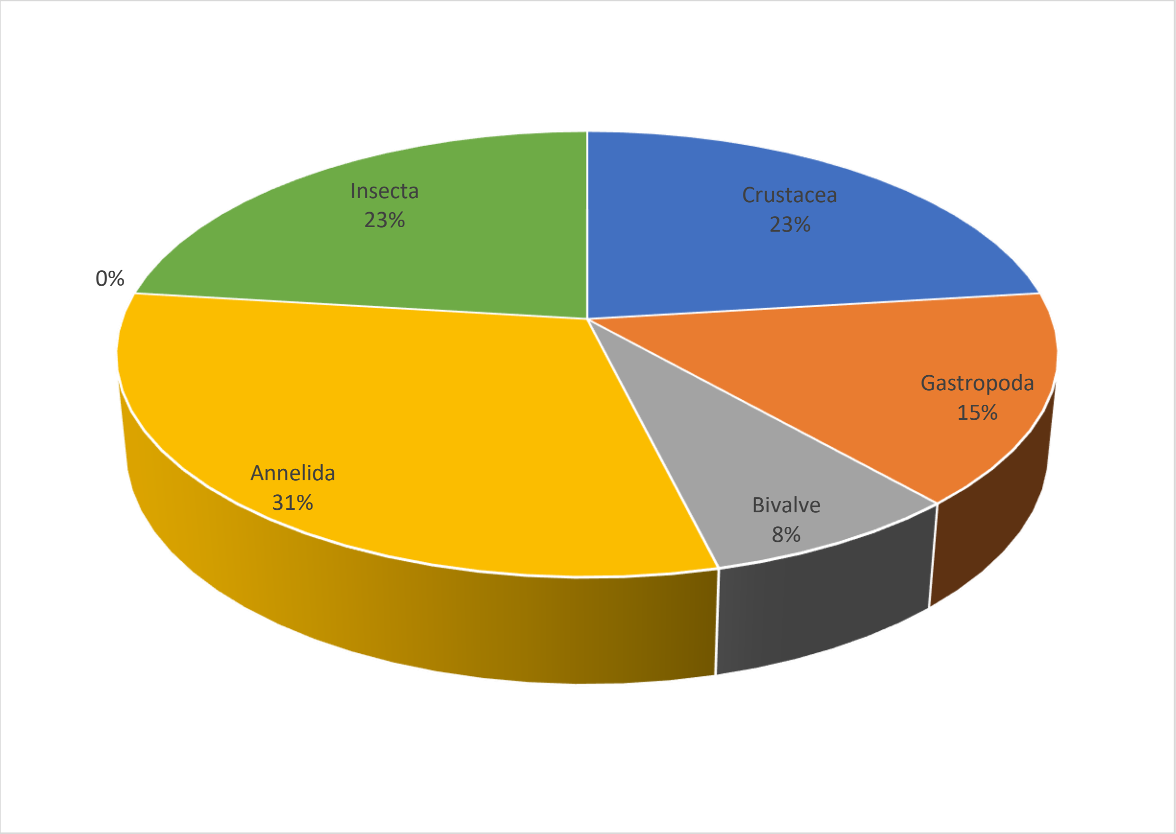

Figure 4.7 Percentage composition of Benthic Invertebrates fauna in the Study Area

4.4 Socio Economics and Health Studies

4.4.1 Study Approach/Data Collection and Analysis

Acquisition of baseline socioeconomic characteristics of a project area is an important phase of any integrated Impact Assessment (ESIA/EIA) process. Baseline data provides vital information on the existing human environmental quality in which a development is planned. It is also useful for delineating sensitive socioeconomic areas for avoidance and/or preparing of mitigation measures for potential adverse impacts.

The socio-economic study was planned to include the use of both the qualitative and quantitative techniques; fieldwork for data collection using structured questionnaires (Appendix 4.1), interviews (in-depth, key-informants and focus group discussions (FGDs)) within the project affected communities and settlements as well as using extensive literature materials.

4.4.2 Socioeconomic Survey Methodologies

The socio-economic survey of the proposed project was designed with the fundamental aim of extracting relevant socioeconomic information on the communities within the project area. Both qualitative and quantitative study techniques were employed for data collection. Data were collected from both primary and secondary sources;

The study design adopted for the socioeconomic study includes;

- Conducting literature searches and reviews;
- Conducting field visits to the project area;
- Design and deployment of questionnaire/ appraisal tools for the study;
- Determining target population and sample size for household survey and interviews;
- Conducting consultations and socio-economic surveys such as; Focus Group Discussions (FGDs), Key Informant Interviews (KII) and In-Depth Interviews (IDI) with various stakeholder groups and interviews with key informants in the host communities;
- Interviews with key stakeholders involved with the project;
- Direct observations;
- Collating and analyzing data obtained from all the sources; and
- Report preparation.

As part of the primary data collection, a structured questionnaire was developed and deployed using a Computer Assisted Personal Interviewing (CAPI) tool. This involved the designing of the questionnaire, deployment to the server, and data collection in the field using Android mobile phones. The questionnaires were administered randomly to household members within the selected host communities, to generate information on socio-economic and demographic characteristics of communities such as; age, sex, marital status, family size, major and other sources of income (occupations), and size of households, among others.

The sampling approach involved multistage random sampling within the project-impacted communities in the project area of influence (AoI). This involved drawing up a list of the project-impacted communities within the project area of influence (AoI).

- **Sample Size**

A spatial boundary of 5km was used for Socio-economic, Socio-cultural, Educational, Security and Health Impact Analysis. Visitations were also made to existing basic facilities e.g. educational facilities, health facilities, and traditional/Cultural resources.

- **Focus Group Discussions in the Host Communities**

The objectives of the meetings were to disclose, interact, and enlighten them about the proposed project and its impact on the host communities and the livelihood of the people. Vital information about the entire project area was elicited from community members during the FGD meeting. All the people present participated actively and a sufficient time frame was allocated for each participant to express their views on the issue. Plate 4.7 displays stakeholders' engagement and consultations with various groups within the host communities.

- **Target Population**

The target population for this study was essentially indigenes of the communities aged above 15 years. The age was carefully chosen to capture the groups that would be most directly impacted and also most active, physically, socially, economically, and health-wise. Generally, the target groups are:

- Community/Village Heads
- Youth Associations
- Other community-based organizations
- Individuals/household

4.4.3 Consultations

Consultation is an important element of socioeconomic assessment and an integral component of an entire EIA process. This is because appropriate and adequate consultations will ensure smooth project implementation and guarantee the economic and commercial sustainability of the proposed project. The consultation incorporates all stakeholders that may be directly or indirectly affected by the proposed project. 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 allowed the affected populations to raise issues that should be considered before, during, and after the project operation. The overall result would be the optimization of the potential of the proposed project and the maximization of its benefits. The key objectives of consultation for the EIA of the proposed project are to:

- Ensure that the communities and all stakeholders are given early and adequate information on the EIA of the proposed project;
- Provide a framework for improving the understanding of the potential impacts of the proposed project on the ecological, social, and health environment;
- Include stakeholders' views and concerns as part of the EIA execution especially as it concerns the potential impacts;
- Identify alternative sites or designs, and mitigation measures, to improve environmental and social soundness;
- Clarify values and trade-offs associated with these different alternatives;
- Identify contentious issues in the proposed project execution;
- Establish transparent procedures for carrying out the proposed project; and
- Create accountability and a sense of local ownership during project implementation thus minimizing community conflicts and project delays that may result thereof.

Extracts from the Stakeholder's Engagement Meeting

Plate 4.7: Consultation with stakeholders

***Source**: EnvironHeroes fieldwork, 2024*

Levels of Consultation

There are two broad levels of consultation in this study:

Institutional Consultation: This level of consultation is intended to engage relevant regulatory authorities, government, and non-governmental institutions based on their concerns about the proposed project. The stakeholders consulted for this project include; The Federal Ministry of Environment; Federal Ministry of Power; National Environmental Standards and Regulatory Enforcement Agency; Nigerian Police Force, Bayelsa State Command; Bayelsa State Ministry of Environment; Ministry of Trade and Investment, Bayelsa State; Ministry of Physical Planning, Yenagoa Local Government Area.

Primary Stakeholders consultation: The procedure employed in the primary stakeholders' consultation includes a participatory approach, where public meetings were held with the traditional rulers of the host community and members of the traditional institution cabinet as well as other groups in the community. The primary impacted stakeholders are members of the host community which will be directly affected by the proposed project, within the Local Government Area.

4.4.4 Stakeholders Engagement Programme

Several meetings were held prior to the actual fieldwork. One of such meetings was a stakeholder scoping and engagement workshop which was held at Ogbodofei Integrated services conference room in Yenagoa, on October 22, 2024. Project affected communities (PACs)/stakeholders, including those from Ogboloma Community, Consultants and other interest Groups gathered at the venue for the exercise. In attendance also were officers representing the Federal Ministry of Environment Abuja (including the Zonal Office in Yenagoa), and the Bayelsa State Ministry of Environment, Yenagoa.

Project presentations were made by OISL's Lead Environmental Management Consultant, and OISL project Manager Dr. Francis Ikuponisi the Lead Consultant and Engr. Funmi Ajayi the Project Manager. Engr. Funmi Ajayi enlightened the Stakeholders present of the relevance of power plant in the Nigeria economy and how beneficial the project will be for everybody.

The scope of the EIA studies (issues and spatial) were identified and grey issues involving data collection from the environmental and social and health domains were discussed and clarified.

The Engagement/Interactive Session

The stakeholders' engagement session was a face-to-face interactive forum where participants expressed their thoughts and expectations regarding the proposed project. Community leaders, family representatives, and other stakeholders contributed actively to the discussion.

Mr. Gigi Cleansman, the CDC Chairman, appreciated the project's location on his family’s land and raised concerns about waste management plans during construction and operational phases. He also advocated for preferential treatment and fair compensation for his family as primary landowners.

Mr. Tobia Idoubo Seaman, representing the Efereda family, requested that the project provide electricity to the community, aligning with its energy production focus.

Similarly, Mr. Tobia Benjamin, another Efereda family member, thanked the proponents and commended the involvement of the Ijaw people in leading the initiative. He emphasized the need for honesty and transparency throughout the project.

Mr. Gigi W. Obert, the PRO of the Efereda family, stressed the importance of involving all stakeholders at every stage of the project. He also urged the proponents to prioritize local employment, ensuring community members benefit from available opportunities.

Mr. Warrifunmu Yumuh, a host community member, inquired about the role of youth in the project and the possibility of providing them with training for skilled positions beyond general labor. He expressed hope that the project would empower the youth in meaningful ways.

Additional contributions came from other participants requesting for proper feasibility studies on the proposed project to include all relevant stakeholders’ communities.

The Representatives of Ministries of Environment both from Federal and State, also made their views known as Regulators that the proponent should not make the mistake to consider only the federal laws governing environmental matters but also State Laws since the state government has domesticated the federal laws to suit the local conditions. They therefore advised the proponent to adhere strictly to the demands of the state laws and by extension the Local demands if any so as to have an enabling environment to operate.

Plate 4.8: Stakeholders in active participation during the Engagement

Responses to Stakeholders Concerns and Suggestions:

The project proponent representative Chief. Preye Ebimzor responded by reaffirming their commitment to the continuous development of the host community and emphasized that ongoing consultations would be prioritized throughout the project's lifecycle. He also stated that the company is an indigenous entity established to bring tangible benefits to the people and expressed their dedication to working in the best interest of the community.

Regarding waste management, Engr Funmi Ajayi (Company's Representative) assured the stakeholders that comprehensive waste management plans are in place for both the construction and operational phases, aligning with industry best practices and environmental standards.

In response to the request for electricity, the proponent noted that the project's energy production capacity could be harnessed to provide power to the community. They committed to further evaluating the feasibility of this during project planning.

On local employment, the proponent pledged to prioritize hiring from the host community, including providing training opportunities to equip local youth for skilled roles within the project. This approach aims to maximize community participation and foster economic empowerment.

To address concerns about transparency, the proponent assured stakeholders that project updates, progress, and decisions would be communicated openly, and all engagements would be guided by honesty and inclusivity.

Finally, the proponent explained that Bayelsa State was chosen for its strategic location, resource availability, and the potential for mutual benefits between the company and the local community. They also reaffirmed their intention to build a sustainable partnership with the host community, ensuring that the project delivers lasting positive impacts.

The meeting which started with a prayer also ended with a closing prayer of thanksgiving to God for successful deliberations.

4.4.5 Administrative and Governance Structure

Historical Background of the Project Host State (Bayelsa)

Bayelsa State was created on October 1, 1996 out of the old Rivers State. The name, Bayelsa, is an acronym of three former Local Government areas 'Brass, Yenagoa and Sagbama' in the then Rivers State, which had earlier on comprised the entire area now constituting Bayelsa State. The then Brass LGA is what makes up the present Nembe, Brass and Ogbia Local Government Areas; the then Yenagoa LGA consist of the present Yenagoa, Kolokuma/Opokuma and Southern Ijaw Local Government Areas and the then Sagbama LGA is what makes up the present Sagbama and Ekeremor Local Government Areas. The tradition in the old Rivers State, which is still the norm in Bayelsa State now, is the use of acronyms for local government areas. People referred to Brass Local Government Area as BALGA while Yenagoa was YELGA and Sagbama was SALGA. Since personalities from Balga, Yelga, and Salga made up the state creation movement prior to the 1996 exercise, the proposed name agreed upon was Bayelsa.

Bayelsa State has one of the largest crude oil and natural gas deposits in Nigeria. Bayelsa State is geographically located within Latitude 04°15' North, 05°23' South and longitude 05°22' West and 06°45' East. It shares boundaries with Delta State on the North, Rivers State on the East and the Atlantic Ocean on the West and South. The State is a picturesque tropical rain forest, with an area of about 21,110 square kilometers. More than three quarters of this area is covered by water, with moderately low land stretching from Ekeremor to Nembe. The area lies almost entirely below sea level with a maze of meandering creeks and mangrove swamps. The network of several creeks and rivers in the South, all flow into the Atlantic Ocean via the major rivers such as San Bartholomew, Brass, Nun, Ramos, Santa Barbara, St. Nicholas, Sangana, Fishtown, Ikebiri Creek, Middleton, Digatoro Creek, Pennington and Dobo. The vegetation here is characterized by the mangrove forest. In the North, it has a thick forest with arable lands for cultivation of various food and cash crops.

There are four main languages in Bayelsa State, which are Izon, Nembe, Ogbia and Epie-Atissa as presented in Table 4.21. The predominant religions in the State are Christianity and Traditional worshipers. Bayelsa State has 24 first class traditional rulers (and many second and third class traditional rulers) recognized by the State Government.

Table 4. 21: Languages of Bayelsa State listed by LGA

LGA	Languages
Brass	Abureni; Southeast Ijo; Ogbia; Kugbo
Ekeremor	Izon
Kolokuma Opokuma	Izon
Nembe	Abureni; Southeast Ijo
Ogbia	Abureni; Southeast Ijo; Odual; Ogbia; Oruma
Sagbama	Biseni; Isoko; Izon; Ogbah; Okodia; Urhobo
Southern Ijaw	Southeast Ijo; Izon

Inspite of the petroleum production in the state, most of its indigenes live in poverty. The people are mainly rural dwellers who also lack adequate transportation, healthcare, education or other infrastructure as a result of decades of neglect by the State and Federal governments, as well as petroleum prospecting companies in the state. This has been a large problem in the state since its creation and successive state governments have not been able to properly address this issue. Successive State governments have, however, embarked on various industrial projects (even venturing into the oil and gas sector), and "povertyalleviation" programs to reverse this situation. Unfortunately, these have not fully resolved all the issues.

Yenagoa Local Government Area

Yenagoa is a Local Government Area in Bayelsa State. Yenagoa as the State capital is in the south of the State, at 4°55′29″N and 6°15′51″E. The LGA has an area of 706 km^2 and a population of 352,285 as at the 2006 census. The projected population of Yenagoa LGA as at 2020 is 500,033. The postal code of the area is 561. Yenagoa is the traditional home of the Ijaw people. English is the official language, but Epie/Atissa language, one of the Ijaw languages, is the major local language spoken in Yenagoa. Since attaining the status of state capital in 1996, construction and other activities have accelerated appreciably.

Gbaran Clan

Gbaran clan comprise of the following communties: Tunama, Polaku, Obunagha, Okolobiri, Koroama, Okotiama, Ogboloma, Nedugo, Agbia and Ibiaye (Ebiyai). Okotiama is the most senior community in the clan. The close proximity of Gbaran villages along Taylor Creek has helped them maintain their shared cultural traditions. The clan traditional god is known as *Gbaran Ziba* (Alagoa, 2005). The Gbaran people are part of the Izon (Ijaw) ethnic nationality. Gbaran was founded by a man called Gbaranowei, son of Oporoza the son of Izon. Gbaranowei's brothers are Kumbowei and Kabowei in Sagbama Local Government Area of Bayelsa State in Nigeria. Gbaran people speak Izon dialect. Their occupations, like other of Izon groups, include fishing, farming, canoe-carving and palm oil production (Tuaweri, 2008).

Religions Affiliations, customs, beliefs systems and cultural heritage

One of the most critical characteristics of Nigeria as a country is cultural diversity. From language, religion, cultural insignia to the economic setting, diversity is the word. Take for example, the linguistic diversity; Nigeria has more languages than any other African country. While this diversity provides more localized identity for millions of Nigerians, this diversity can and has also posed challenges.

Bayelsa State, with its diverse ethnic and linguistic groups, is also very rich in culture and the arts. Several cultural bonds exist, particularly in music, dances, plays and masquerades. The State therefore, has a very distinctive culture. Overall, the socio-cultural aspects of the population in the different ethnic groups are highly dependent on their ethnic background and religion.

Christianity is the dominant religion across Gbaran clan to include the project host community Ogboloma. The Christians here constitute about 89% of the population. There was no testament from respondents to the presence/activities of Islam in the community except by assumption, since the area is prone to visitors' influx. Thus, 1% was allotted to Muslims. However, no physical presence of a Mosque was observed from the socio economic exercise. This further confirms the absence of Islam in the area

There are traditional worshipers who from this socio-economic assessment constitute about 10%. Traditional worship adherents are devoted to the veneration of ancestral deities dedicated to their individual family, whose shrine is mostly constructed close to the family house. But, the overwhelming presence of Christianity has to a very large extent overshowed the practice of traditional worship.

Culture

Ijaw (also known by the subgroups "**Ijo**" or "**Izon**") are a collection of people indigenous mostly to the forest regions of the Bayelsa, Delta, and Rivers States within the Niger Delta in Nigeria. Some are resident in Akwa-Ibom, Edo, and Ondo states also in Nigeria. Many are found as migrant fishermen in camps as far west as Sierra Leone and as far east as Gabon along the Western Africa coastline. The Ijo population is estimated to be over 10 million people. They have long lived in locations near many sea trade routes, and they were well connected to other areas by trade as early as the 15th century (Ijo Information 3 November 1998).

The Ijaw people live by fishing supplemented by farming paddy rice, plantains, yams, cocoyams, bananas and other vegetables as well as tropical fruits such as guava, mangoes and pineapples; and trading. Smoke-dried fish, timber, palm oil and palm kernels are processed for export. While some clans (those to the east- Akassa, Nembe, Kalabari, Okrika and Bonny) with powerful chiefs and a stratified society had centralized confederacies until the arrival of the British. However, owing to influence of the neighbouring Kingdom of Benin individual communities even in the western Niger Delta also had chiefs and governments at the village level.

Marriages are completed by the payment of a bridal dowry, which increases in size if the bride is from a different village from the groom (so as to make up for the bride's village's loss of a daughter). Funeral ceremonies, particularly for those who have accumulated wealth and respect, are often hugely celebrated with bountiful feasts. Traditional religious practices in the

Niger Delta area centre on "Water spirits" and tribute to ancestors. These Ijaw cultural practices are all subscribed to in Obunagha community.

Family Patterns

The family system observed in the area was patriarchal in nature with most family responsibilities reposed on the father, who is taken to be the head of the family with a single wife for most of the families observed in the area. The possession of few children was a popular practice by most families. This may not be unconnected with the harsh economic reality of the land. The value for the female child was more compared to that of the male, as the tradition reveres the girl child. Polygamy is a rare practice among the people of this area owing largely to their religious practice (Christianity).

4.4.6 Socio economic data analysis and presentation

Simple descriptive methods and uni-variate summary statistics (e.g. means, range, mode, and percentages) in tabular and graphical modes, considered the most appropriate analytical techniques for the study objectives were used. Six (6) major units of analysis (or levels of aggregations) were employed to describe both empirical and/or secondary data: National; Regional (Niger Delta), State; LGA; Settlement; and Household.

Although a national census was completed far back as 2006, details with regards to the constituent settlements/communities and localities are yet to be released even as a new census is planned. Results are only available for the 36 States and the Federal Capital Territory, Abuja, and the 774 Local Government Areas (LGAs). As a consequence, the populations of the study communities were projected using the 1991 National Population Census, which had been projected to 1996 and thus served as base year. Two mathematical population projection methods (the linear extrapolation and exponential growth models) are often used in estimating the population of areas of interest. The Linear Extrapolation Model assumes that population growth occurs in constant increments over time. However, in practice, it has been shown that the rate of growth is never constant but rather changes with time, growing faster as the population size increases. In other words, population often tends to grow exponentially rather than linearly. Thus, the Exponential Growth Model was used in estimating the population of the projected affected communities (PACs). The formula is:

A. Linear Extrapolation Model

$$P_n = P_o * (1+r)$$

Where:

P_o = the base population

r = growth rate of the population (as obtained from NPC)

n = time lapse, in years

B. Exponential Growth Model

$P_n = P_o * (1+r)^n$; Where, P_o, r and n are as above.

Population size, growth and distribution

The population of a geographical area is the cornerstone of the development process, as it affects the economic growth through provision of labour and entrepreneurial skills, and forms the demand for the production output. Thus, the analysis of its dynamics, including size and growth pattern, is imperative for understanding the future population growth trends.

The constitution of Nigeria mandates the National Population Commission (NPC) to carry out population census in the country and provide accurate and reliable census results. The primary objective of the census results is to assist the country in capturing accurate and reliable information on the population size, its composition and distribution. The population figures and characteristics arising out of the census exercise helps the country to meet its developmental, administrative and political needs and ensuring planning for improving the quality of life of the country's citizens.

Accordingly, the population and housing census of 2006 was conducted, augmented with the Post Enumeration Survey (PES) in June, 2006. Population census gives information on age structure, demographic subjects, social household, Economic and housing data, marriage, migration etc. Good as the intention, results of the census for the individual localities and settlements/communities are yet to be published for use, 8 years after the completion of the exercise. Figures for the 774 LGAs and the FCT are the only available statistics. We are thus compelled to fall back on the 1991 Census, which had figures for the settlements and communities and were projected to 1996, which is taken as base year for further projections. At the State and LGA levels however, the 2006 census figures are readily utilized for discussions.

The National population census of 2006 (which is the latest official population census in Nigeria) puts the population of Bayelsa Local Government Area at 352,285. However, the Nigerian Population Commission forecasted that the population is expected to increase to 470,800 by the end of 2016. There are no official population figures on gender distribution in Yenagoa LGA and also there are no official population figures on individual communities' basis for the LGA. However, from respondents' accounts, including key informant interview (KII) and focus group discussion (FGD), the estimated population of each of the project affected communities are presented under their respective subheads below. Table 4.22 presents the population characteristic of Bayelsa State according to the 2006 National Population Census by the National Population Commission (NPC) with Yenagoa Local Government Area the project host area highlighted in yellow.

Table 4. 22: Local Government Areas in Bayelsa and population figures

Name	Status	Population Census 1991-11-26	Population Census 2006-03-21	Population Projection 2016-03-21
Bayelsa	State	1,121,693	1,704,515	2,278,000
Brass	LGA	...	184,127	246,100
Ekeremor	LGA	124,279	269,588	360,300
Kolokuma/Opokuma	LGA	...	79,266	105,900
Nembe	LGA	...	130,966	175,000
Ogbia	LGA	...	179,606	240,000
Sagbama	LGA	119,759	186,869	249,700
Southern Ijaw	LGA	267,371	321,808	430,100
Yenagoa	LGA	...	352,285	470,800
Nigeria	Federal Republic	88,992,220	140,431,790	193,392,500

Source: National Population Commission of Nigeria (web), National Bureau of Statistics (web)

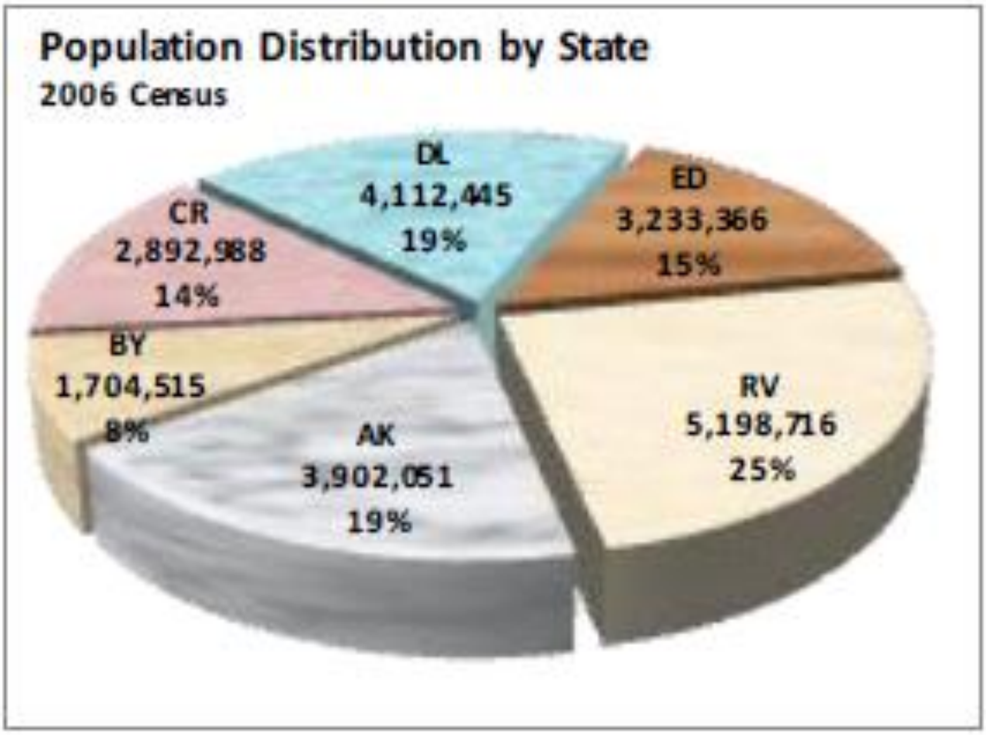

Figure 4.8: Population distribution and proportion by states in South-south Geopolitical Zone

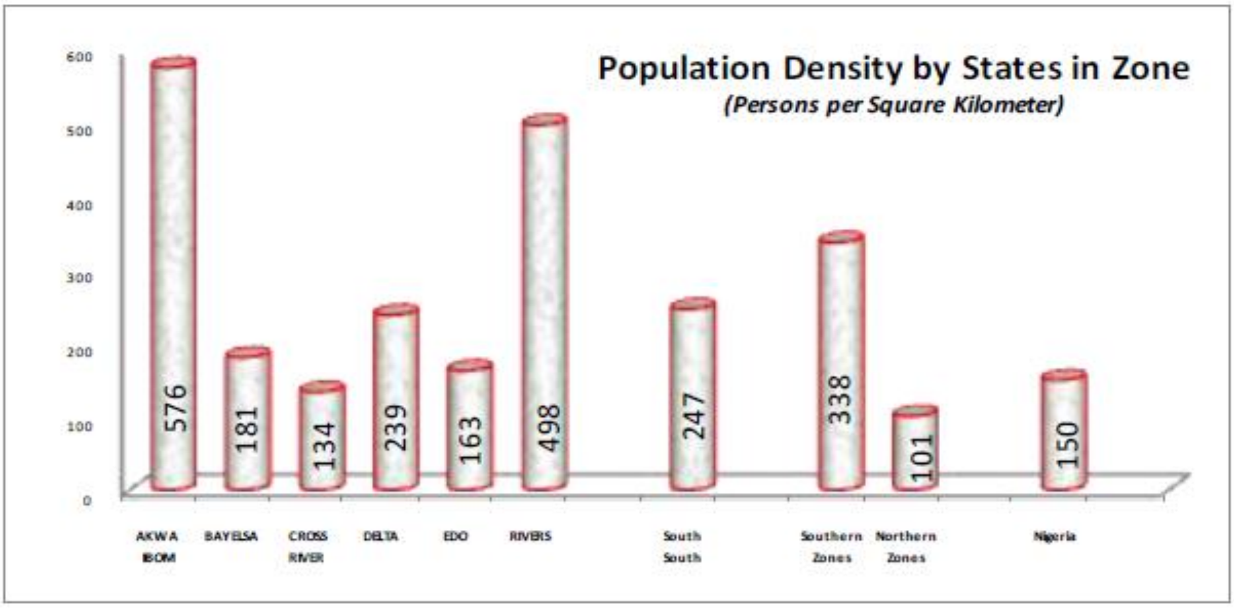

Figure 4.9: Population density of Bayelsa State relative to others in South-south Geopolitical zone and Nigeria

Household Composition, Marital Status and Household size

<u>Household structure, marital status, age and sex of respondents:</u>

Information on household composition is critical for understanding family size, household headship, and for implementing meaningful population-based policies and programmes. Household composition is also a determinant of health status and well-being (NPC and ICF Macro, 2014). These characteristics are important because they are associated with household welfare. Female-headed households are, for example, typically poorer than male-headed households. Economic resources are often more limited in larger households. Moreover, where the size of the household is large, crowding also can lead to health problems (NPC and ICF Macro, 2009).

The majority (82 percent) of households in Nigeria are headed by men, with only 18 percent headed by women. The proportion of female-headed households has remained almost the same in the last five years (i.e., between 2008 and 2013) (NPC and ICF Macro, 2014). The three different types of male-headed household structures are traditional (one husband and one spouse), polygamous, and single male (male with no spouse, including widowers and males that have never been married). Traditionally, the male is responsible for all the major household decisions.

Returned responses from administered questionnaires showed all respondents to be married persons (100%). This is a skewed representation of the population; there could be those of the single marital status, divorced and/or separated and widowed but may have been wittingly excluded by error of omission or commission. Although it is common to find men marrying more than 1 wife in riverine communities, it appears it is not a common practice in the Project affected study area. An overwhelming majority of the respondents (89%) are monogamists while just 11 percent practice polygamy, i.e., have two wives (Fig. 4.10). As in other climes and traditions; marriage is largely determined by the economic status of the adult male. This could account for why the well-placed individuals in the community (Chiefs and elders) were confirmed to be those with more than a wife. Similarly, although a higher percentage of the households were found headed by the males (61.8%), compared to the female gender, it is also not uncommon to have an admixture of some households headed by females (female-headed households).

The proportion of married persons tallied with the age of the respondents. 100 percent of the sampled population were aged 30 years and above. Two-thirds (67%) of the respondents were aged 40-59 years, while those in the 30-39 years age bracket amounted to 22.2 percent. The older age cohorts of 70- years and above also constituted 11.1 percent of the sampled population (Fig. 4.7.5). Both of the returned responses and community interactions indicated that opinions expressed even revealed those of matured persons in the study environment, it is noeworthy that the younger cohorts may have been excluded. This also applied to the gender representation among the sampled population. Even though some women turned out for the stakeholder workshop and engagement meeting, they were excluded from the focus group discussions had with the community leaders. They were further 'marginalised' in the survey instrument (questionnaire) administered and returned; just 11 percent (or 3 women only) participated in the survey

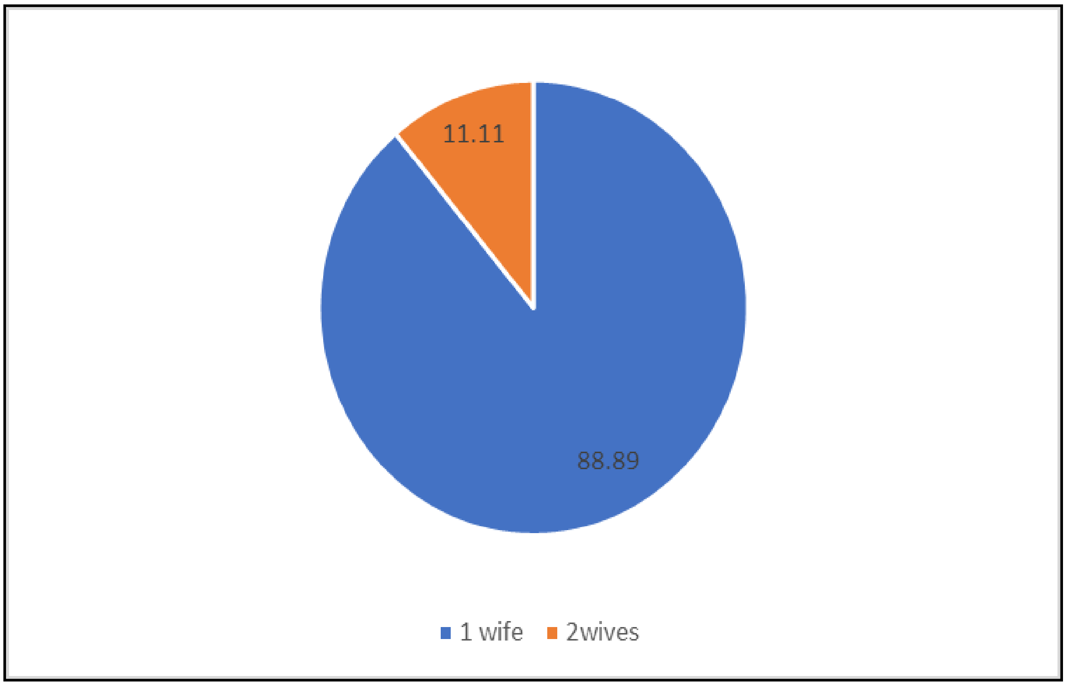

Figure 4.10: Number of wives by married males

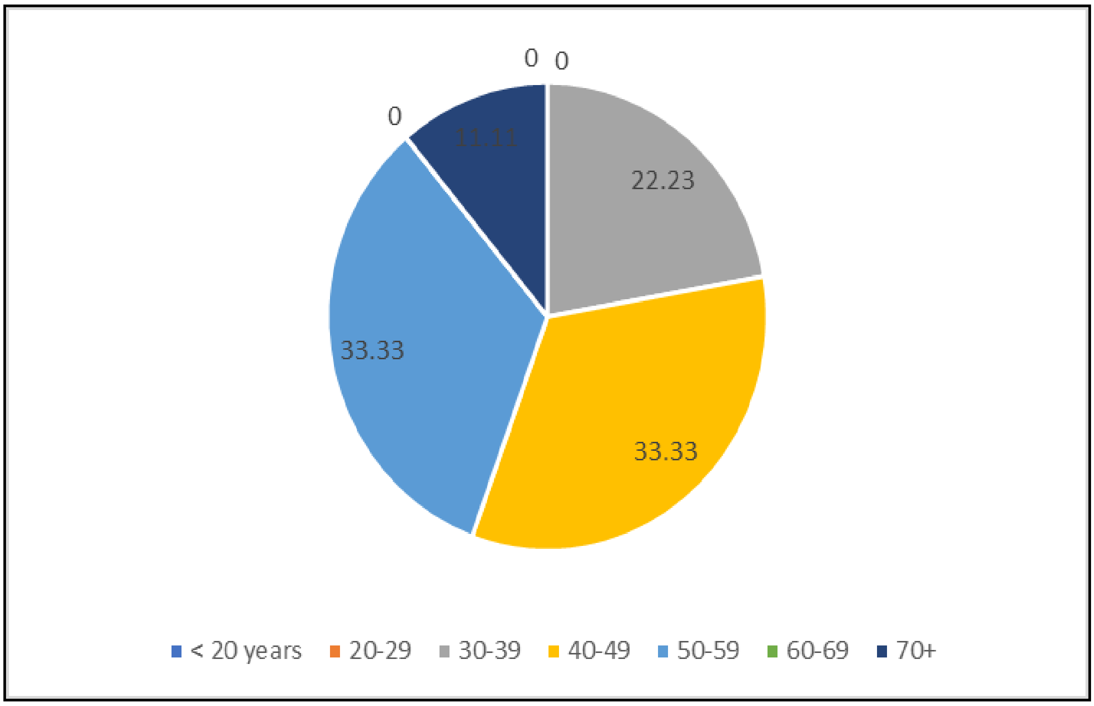

Figure 4.11: Age of respondents (Years)

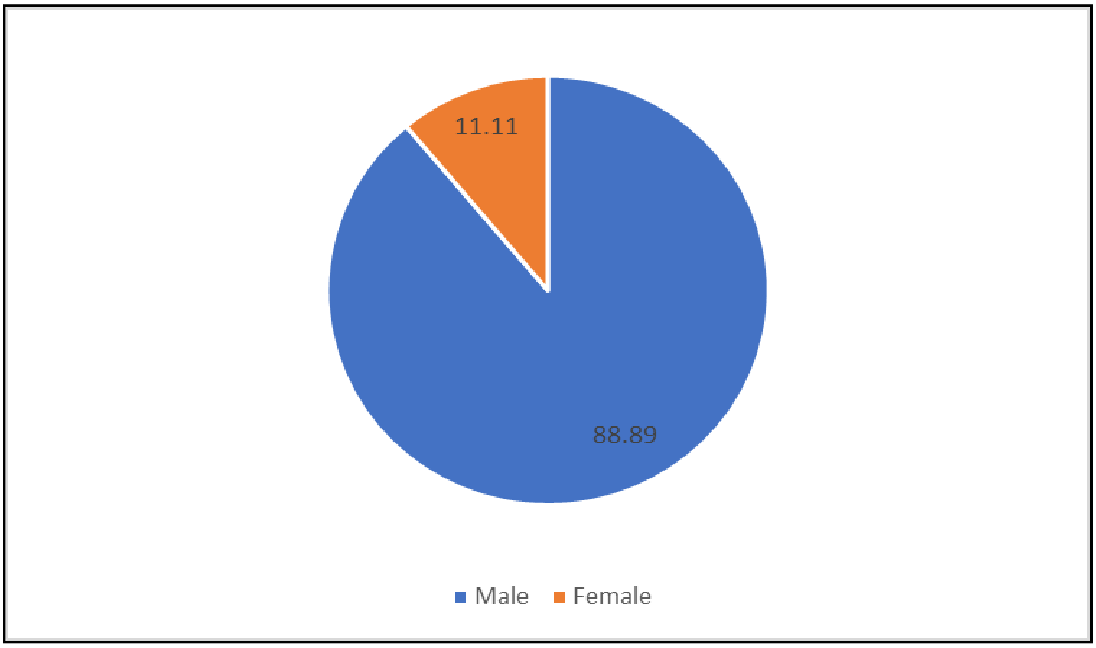

Figure 4.12: Sex of respondents

Household Size

The average household size is an indication of the average residential density of an area. But household sizes usually vary from region to region, and between male-headed and female-headed households. The size of families also differs from community to community, influenced in large measure by the cultural attitude of the people, economy of the settlement and educational status/awareness of the resident population amongst other factors.

Majority of the households in the surveyed area (42.8%) have 2 children younger than 18 years (i.e., 1-17 years), while equal proportions of the households (14.3% each) have 3 and 8 children in same age range. Over one quarter of the households (28.6%) are also without children less than 18 years (Figure 4.17). In addition to the households having higher number of younger children, respondents reported having a range of 1-10 dependents (maybe an exaggeration), with majority (44.5%) having 2 dependents (Figure 4.13).

Data from the field survey areveal that as a consequence of the large number of children aged less than 18 years living in the households, coupled with higher number of dependents, household sizes are found to be large. Households with 6-7 members are predominant, constituting one half of the sampled households. Over a third also have between 8 and 14 members, while over a tenth (12.5%) also having 3 members. The fact that a very high proportion of the households have large family size could be attributed to many reasons; early marriage, cultural beliefs and the practice of polygamy, common with rural households involved in fisheries and farming activities.

Average household size for the Yenagoa LGA was 4.7 as at the 1991 population count. However, a household size of 5-6 has been reported for most of the Niger Delta region (NDES, 2000). This however, could not be the case for the local study area because slums/squatter and migrant settlements are very much associated with high concentrations of people, with household sizes being abnormal.

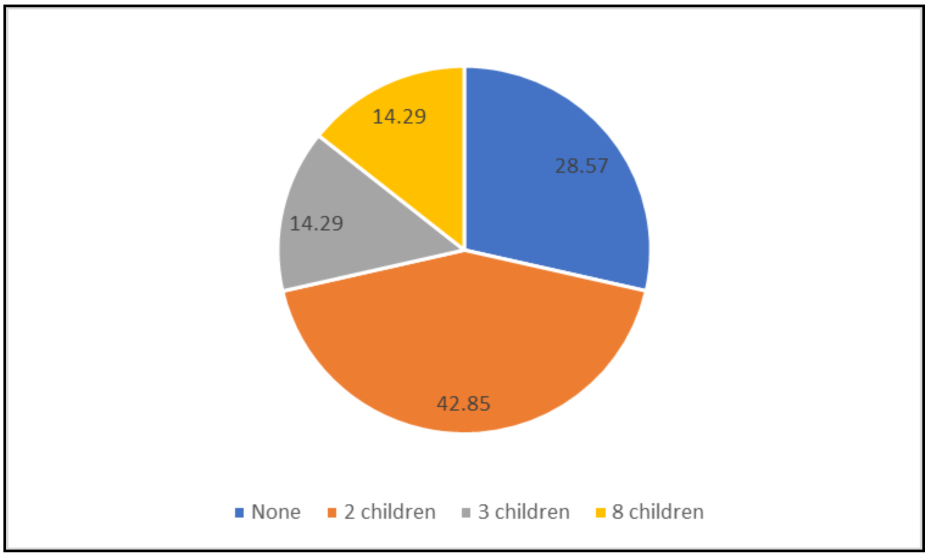

Figure 4.13: Number of children in respondents' households less than 18 years old

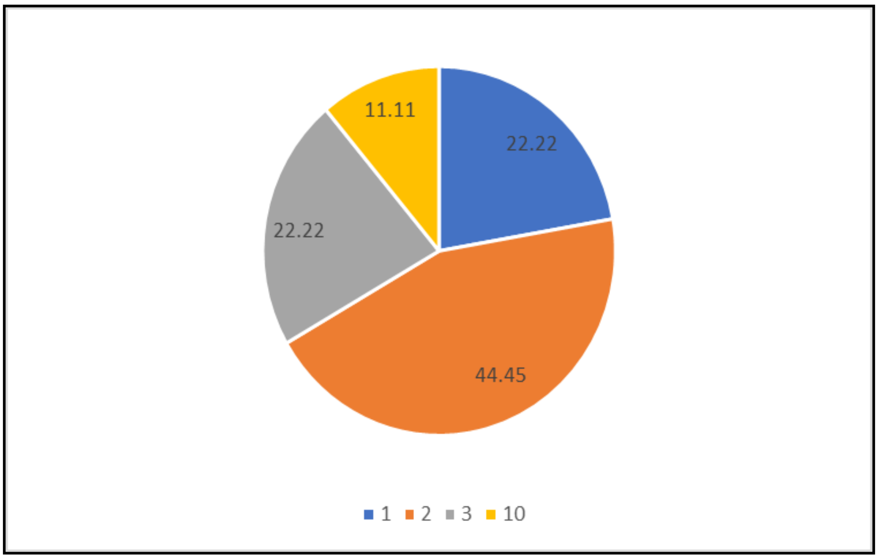

Figure 4.14: Dependents in households

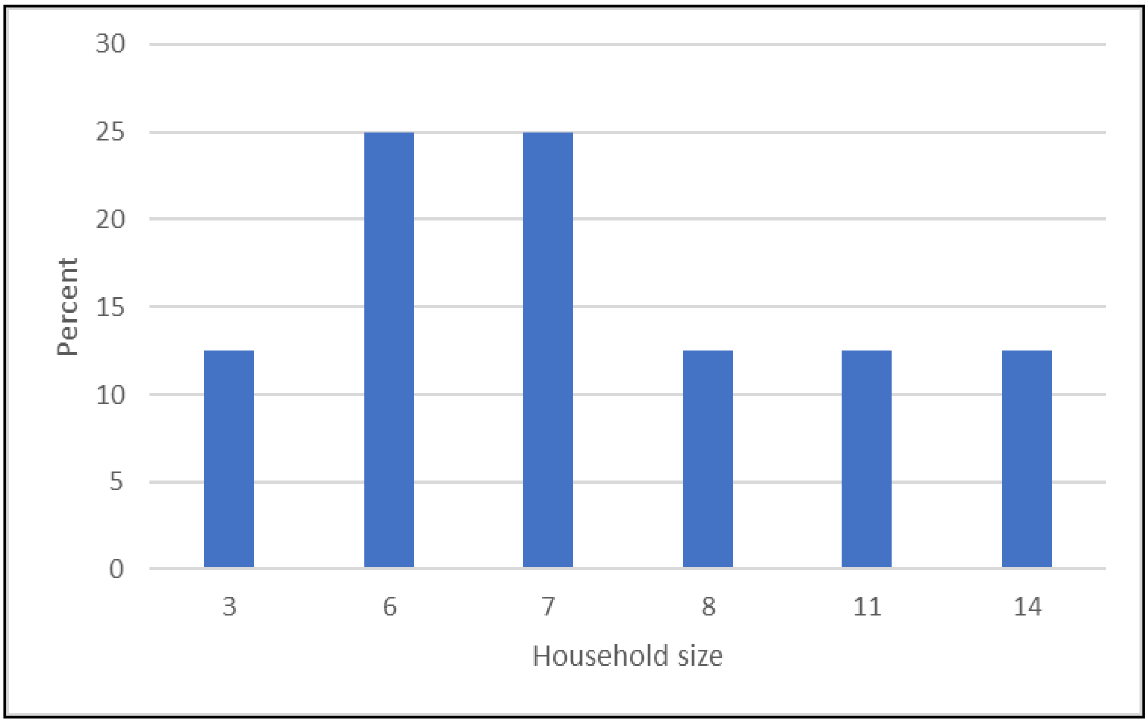

Figure 4.15: Household size in the project affected community

During the preparation of the Niger Delta Regional Master Plan (NDDC, 2006), 3,919,364 households were enumerated across the region, with an average household size of 7.46. More than 70% of these households had an average of 8 occupants, with large households being particularly prevalent in rural areas. In Bayelsa State, like other parts of the Niger Delta, rural communities generally have larger household sizes, with an average of 8 persons per household. Field studies across the region have reported household sizes ranging from 6 to 30 persons, though the regional average is approximately 6 persons, with variations among states, Local Government Areas, and senatorial districts.

While Rivers State had the highest proportion of households with 8 persons (16.6%) in 2006 and 12.6% of households exceeding 8 persons, Bayelsa State similarly reflects the broader regional trend of larger households. Rural households in Bayelsa often comprise extended family members, contributing to the higher average

The 2013 Nigeria Demographic and Health Survey (NDHS) reported an average household size of 4.6 persons nationwide, compared to 4.4 in 2008. Rural areas consistently recorded larger household sizes (4.9) compared to urban areas (4.2). Rural Bayelsa State aligns with this trend, reflecting higher household sizes due to traditional practices and extended family structures prevalent in the Niger Delta.

Population dynamics in Nigeria, including Bayelsa State, are shaped by high fertility rates. According to the Population Reference Bureau (PRB, 2013), Nigeria's total fertility rate (TFR) was as high as 6.0, signifying a tendency toward large households. This trend has persisted, with the 2015 TFR at 5.5 births per woman, rising to 5.8 in 2016 (NDHS, 2013). The high fertility rate underscores limited use of contraception among both men and women.

Bayelsa's rural areas likely mirror these national patterns of high fertility, though specific state-level data is scarce. In 2016, Jigawa State recorded the highest TFR (8.5), followed by Kano and Kebbi (7.7), while Rivers State had the lowest (3.3). These demographic characteristics, including high fertility and large household sizes, have significant implications for Bayelsa's socio-economic planning, resource distribution, and health services.

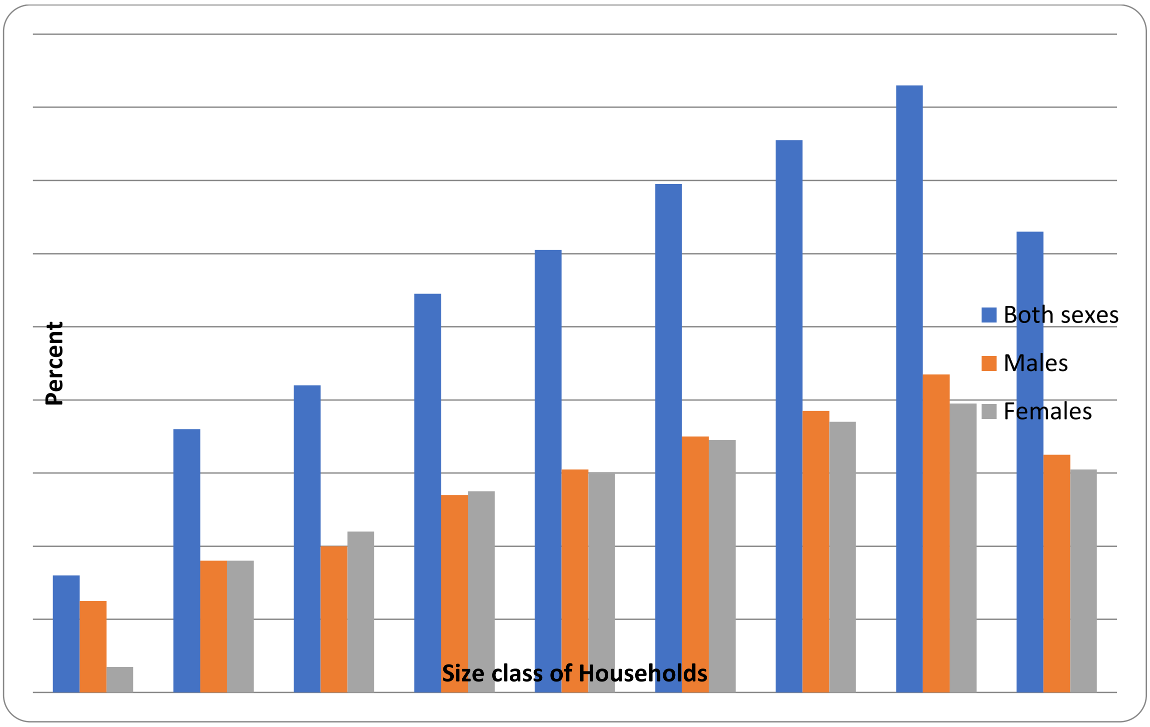

Figure. 4.16: Size class of households and sex in Bayelsa State

Source: NPC, 2009

Population Structure: Age and sex distribution

The population structure reflects the age and sex composition of a population. Information on age and sex composition is very important especially for the evaluation of the quality of the enumeration, and for the description and analysis of several types of socioeconomic and demographic data. The population structure is usually characterized with reference to (a) the age-sex distribution and (b) two other key demographic ratios: the sex ratio and the dependency ratio.

(i) Age and Sex Distribution of Population:

Age and sex are important demographic variables and are the primary basis of demographic classification. They are also important variables in the study of mortality, fertility, and nuptiality. The household age structure and distribution of the project area population conforms to the overall Niger Delta and indeed Nigeria's pyramidal structure. Population is rather overwhelmingly loaded from the lower age-cohorts. According to the analyzed questionnaires, a high proportion of the population is made up of persons effectively classified as children (NPC 2002) **(**Fig. 4.17). Over one half (57.4%) of the household members are aged less than 19 years. Just a third (33.3%) are in the productive years of 19-59 years (NPC usually assumes 15 years as working age). The aged (60 years and above) were fewest amongst the population but constituted some 9.3 percent of the household members. Altogether, two thirds of the population are dependent on the remaining one third! The adult working population must cater for at least 2 other members, which is a high dependency ratio.

The age profile of the population plus revealed the population in Ogboloma community is both young and growing and also having a proportion of some aging members. It therefore, requires that the State Government need to commit more resources in the provision of socioeconomic infrastructure, particularly in the area of educational facilities as well as employment opportunities and other social welfare scheme to take care of the dependent members of the population. This will prepare the dependent young population to become productive when they move into the productive age group.

The population profile of Bayelsa State according to the 2006 Census showed similar pyramidal structure. Population is loaded from the lower age-cohorts; some 46.5% of the households' population was constituted of persons aged less than 20 years. Persons in the productive age bracket of 19-59 years (15 years usually taken as beginning of productive year-

NPC, 2010) constituted almost one half (49.32%) while the aged (60 years and above) made up less than 5 % (4.2% actual) of the state's population.

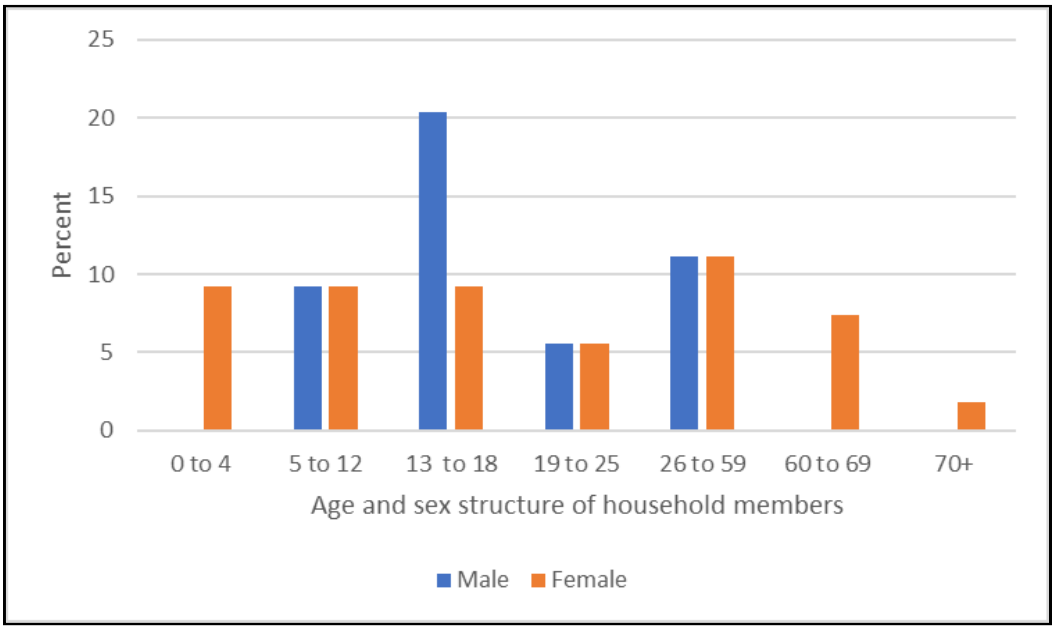

Figure 4.17 : Age and sex structure/distribution of households in Isaka community

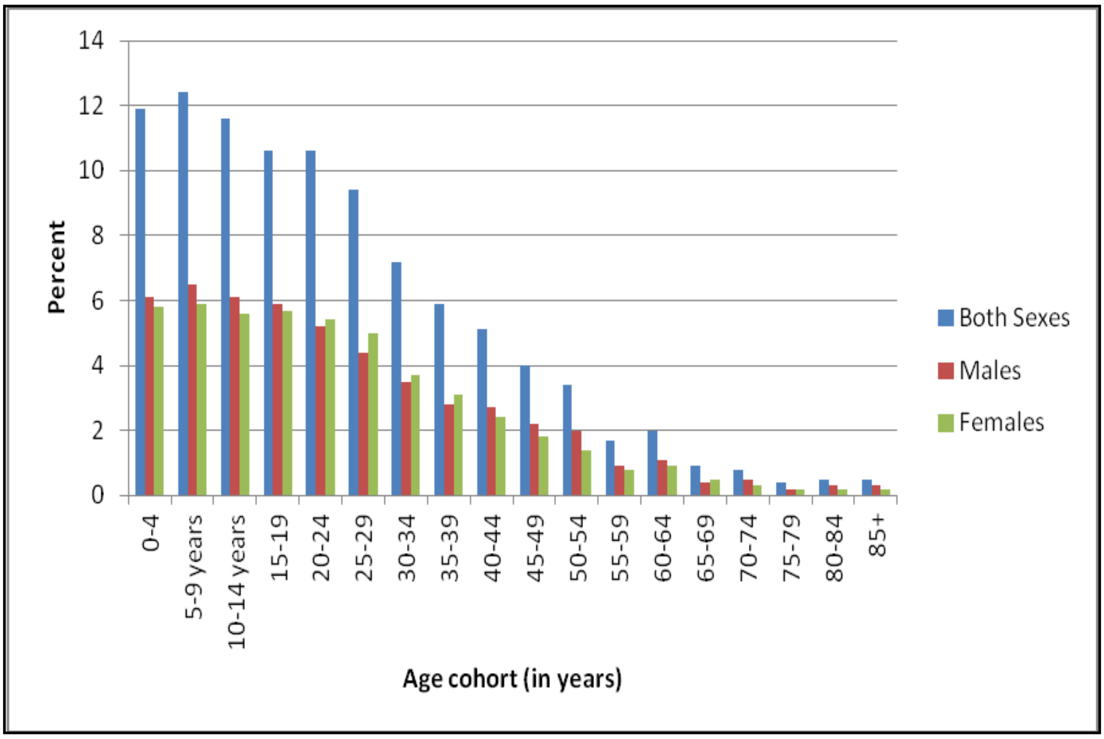

Figure 4.18: Age-sex distribution of Bayelsa State population (2006) Source: NPC, 2010

Gender distribution

The sex ratio, a useful demographic descriptor is the ratio of males to females in a given population, usually expressed as the number of males for every 100 females (Haupt and Kane, 2004). Sex distribution of the population in the Ogboloma stakeholder community indicates the preponderance of the female gender at the overall household level even though the male child was almost two times more at the younger age-cohort of children less than 18 years (62.5% males to 37.5% females; Figure 4.19). The overall household structure showed however, the preponderance of the female gender; 53.7 percent are females as against 46.3 percent males. The sex distribution of the population in the earlier population counts revealed the male gender was more than the females as at 1991 population and housing census (51.1% to 48.9%). Even at the LGA level, the sex ratio showed that some 52 percent of the population in Yenagoa was made up of males in 2006. This also tallied with the sex structure of Bayelsa State as a whole. The sex ratio of Bayelsa State according to the 2006 Population and Housing Census is 105:100 (NPC, 2010, 2009, NBS, 2012). For every 100 females, there are to be found 105 more males (105 males). Surveys carried out in the course of the Niger Delta Master Plan development process show that there are actually more males (54%) than females (46%) in the Region.

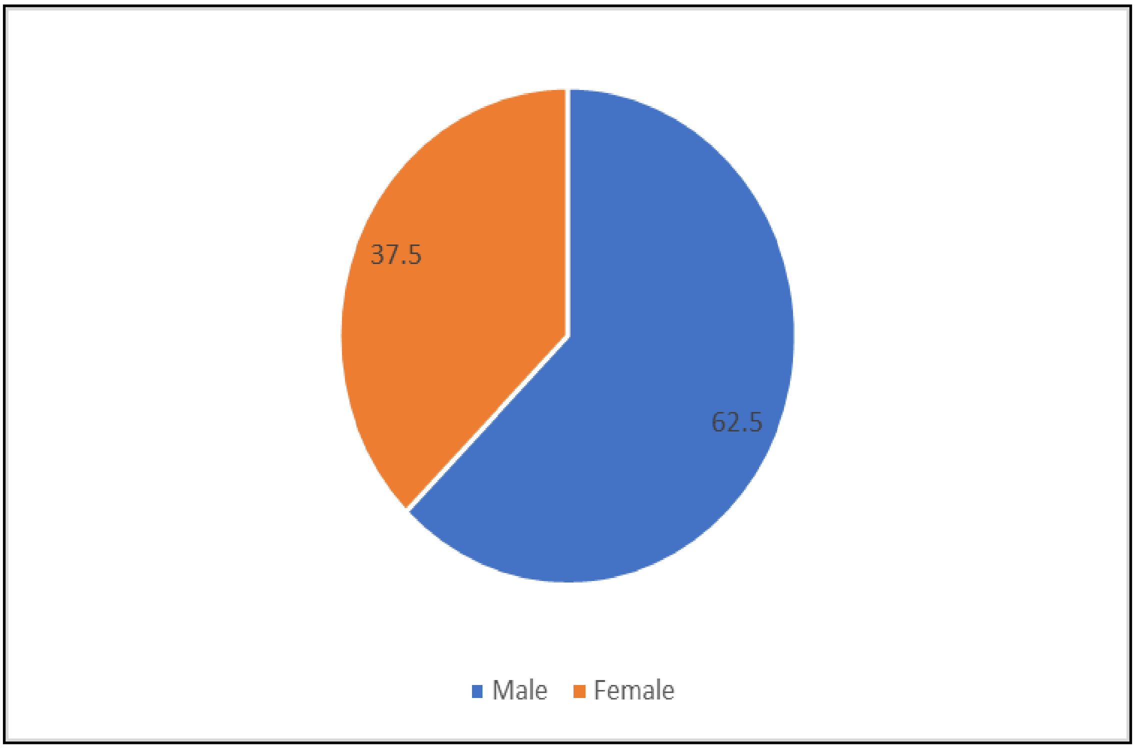

Figure 4.19: Gender of childern in sampled households

Educational characteristics

Education is a key determinant of the lifestyle and societal status an individual enjoys. Studies have consistently shown that educational attainment has a strong effect on health behaviours and attitudes. Education in Nigeria has evolved over a long period of time, with a series of policy changes. As a result, there have been increases in the enrolment of children and in the number of educational institutions both in the public and private sectors. The 1976 National Policy on UPE gives every child the right to free primary education. Later the 6-3-3-4 systems was introduced with 6 years for primary, 3 for junior secondary, another three years for senior and 4 years for the university/polytechnic education respectively. Subsequently, the national literacy programme for adults was launched, followed by the establishment of nomadic education to address the needs of children of migrant cattle herders and fishing people in the riverine areas. With the inception of the present democratic dispensation in 1999, the Universal Basic Education (UBE) was again launched, making it compulsory for every child to be educated free up to the junior secondary school level.

The literacy and educational attainment of the population in the study environment was found to be sufficiently high. Both qualitative indicators (key informant interviews and FGDs) and quantitative information (statistics from questionnaire analyses) revealed a large proportion of the population to have received some formal educational training. The society at large is thus adjudged to be literate. Expectedly, the younger cohorts of the population have either acquired or are in the process of acquiring different levels of educational training compared with the older/aged members of the communities, indicating that the literacy level declines as the age increases.

The modal educational attainment of the sampled population is the post secondary (tertiary). Over two-thirds of the primary respondents and their spouses possessed the teriary educational qualification. Two-fifth also have the post primary or secondary education, while for the spouses, a third has secondary education as highest educational attainment (Figures 4.20 and 21) The possession of vocational/technical training among the respondents amounted to some 11.1 percent which is considered low considering the industrial endowment in the area and the expectations that the people should be sufficiently equipped with vocaltional and skill sets needed for employment.

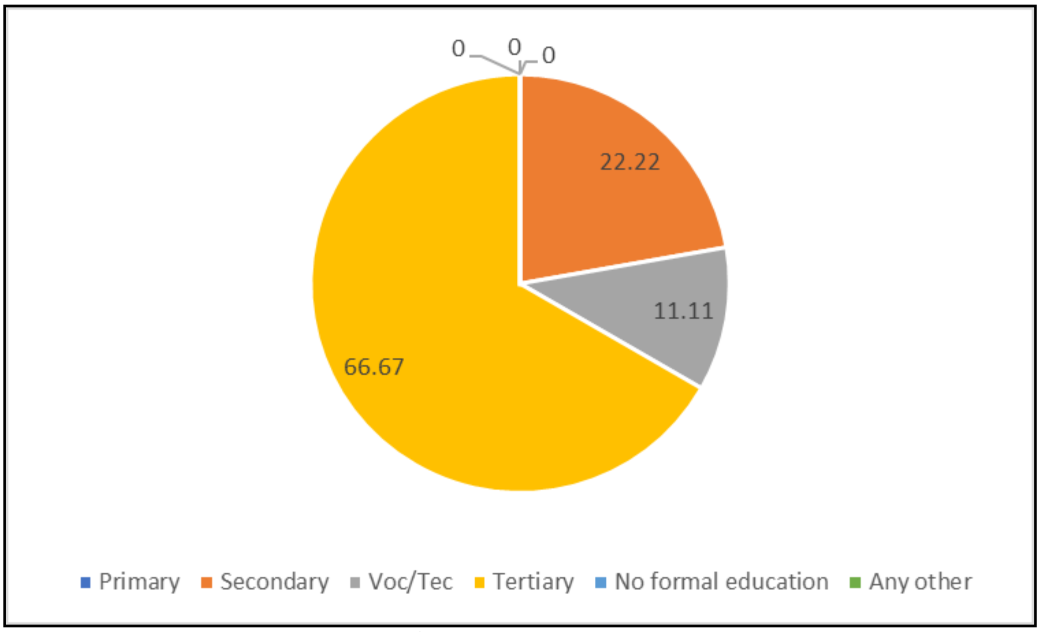

Figure 4.20: Respondents level of educational attainment

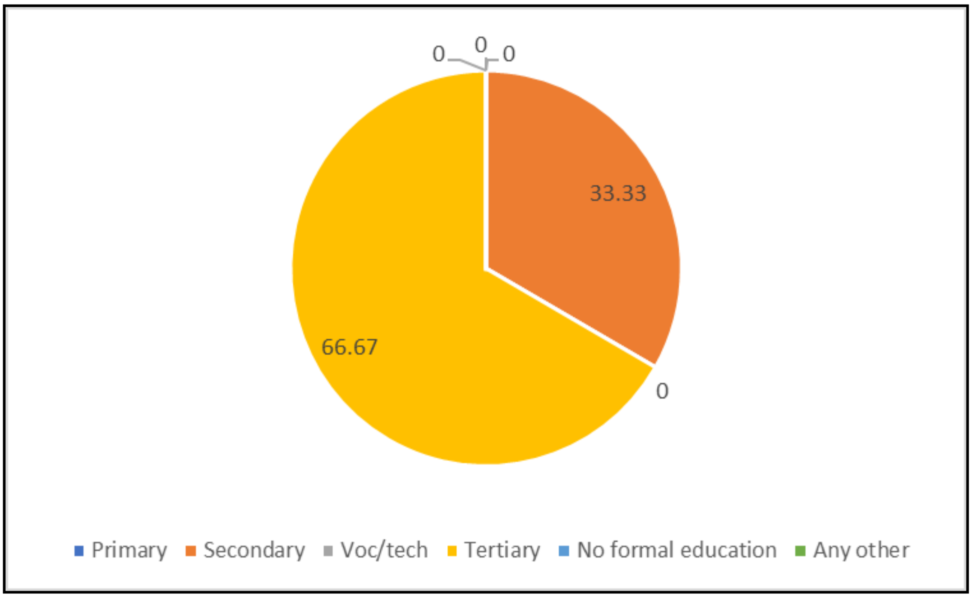

Figure 4.21: Level of education of respondents' spouses

A structural classification of the educational status of respondents' children revealed close to one half (48%) were enrolled in primary schools while close to a third (32%) were equally attending secondary schools. Sadly, there is a zero response on the proportion of children seeking vocational/technical skills' training while one fifth of the respondents' children were acquiring some tertiary education. The females (girl-child) are more enrolled in schools (52 percent). Compared to their male counterparts (48%).

During the field study, we were unable to access the available public primary school in the Ogboloma study community to compare and confirm the questionnaire responses on children's enrollment in schools. However, community leaders, during our interactive meeting, confirmed that both the available public primary and secondary schools in Ogboloma have satisfactory pupil and student enrollments. In addition to the public schools, several privately-operated nursery, primary, and secondary schools are established within the community and its surrounding areas to serve the growing population.

The 2006 Census results indicate that 51.8% of males and 48.2% of females in Bayelsa State are literate. Approximately 84.2% of men and 82.9% of women aged 6 years and above have attained some form of education, placing the state slightly above the national average. However, 14.6% of men and 17.3% of women over the age of six have no formal schooling. Similarly, 12.9% of men and 13.2% of women have completed nursery school. The percentages of males and females who completed primary school are nearly identical, standing at 13.4% and 13.6%, respectively, as recorded during the census period (National Population Commission, NPC, 2009, 2010).

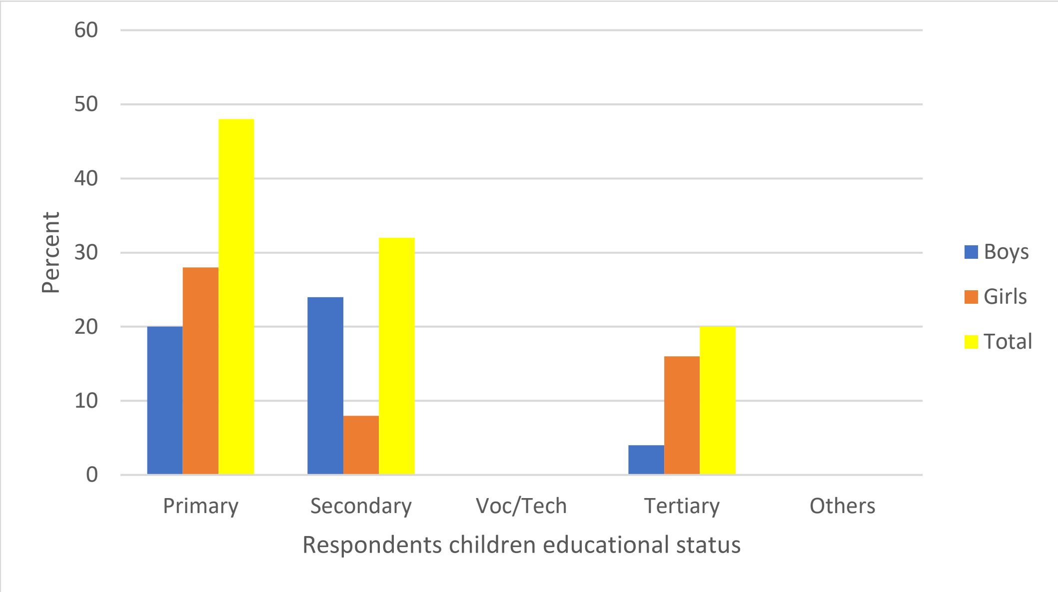

Figure 4.22: Educational attainment of children in OgbolomaProject affected community

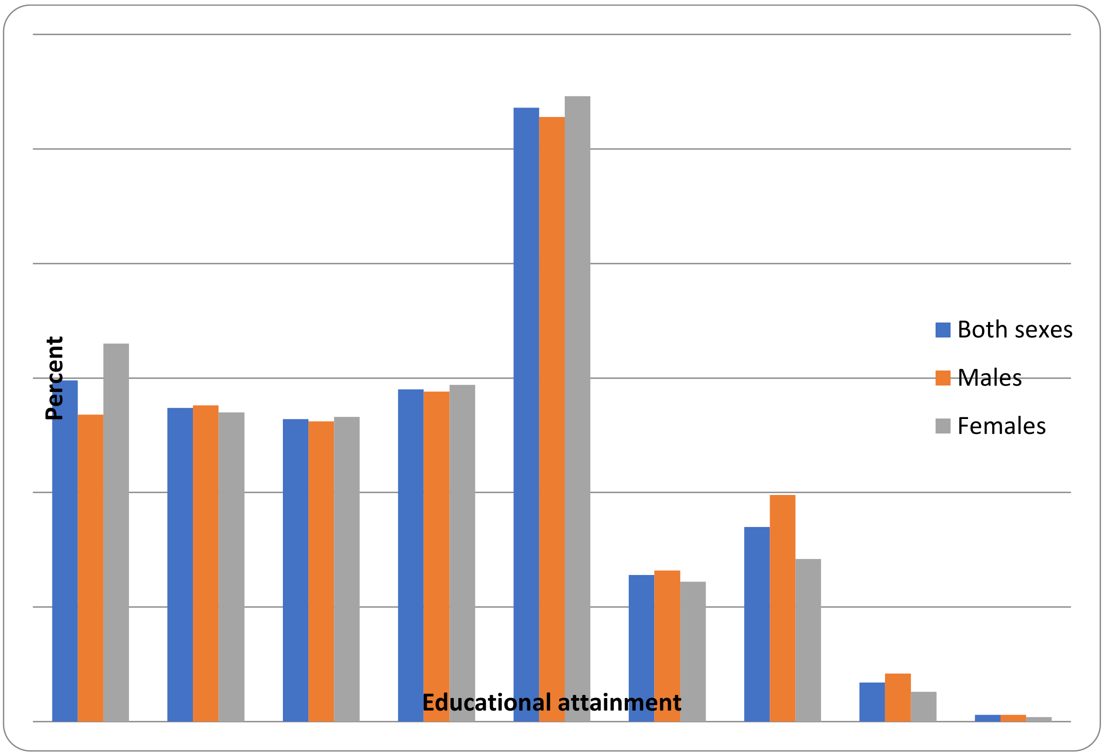

Figure 4.23: Educational attainment of the population in Bayelsa State (2006)

Source: NPC, 2010

The Local Economy of Project Study Environment and Communities

Economic conditions have a vital role to play in people's experience and perceptions of place. A person or a household's socioeconomic status influences the range of opportunities and constraints that people face. In fact, socioeconomic status affects almost all aspects of life. It affects nutrition levels and health, geographic mobility, educational attainment, and overall quality of life.

Fishing and agriculture have long been identified as the two major traditional occupations of the Niger Delta peoples (NDDC 2006, UNDP 2006). The urban sector, with its concentration of informal sector activities, plays a growing role in the economy of the Niger Delta region. Trading (17.4 per cent), services (9.8 per cent) and miscellaneous activities (11.1 per cent) are the most important areas of employment, after agriculture, fishing and forestry overall.

The Ogboloma community in particular has experienced serious occupational shifts and character over the years. From its riverine character and largely fisheries business (and some modicum of farming) outlook, it appears the traditional occupations of the people have taken the back seats. Community leaders, knowledgeable key informants' interviews, focus group discussants, and responses from administered questionnaires affirmed that agriculture; mainly fishing is the primary occupation that engages the adult population, male and female in the study community and its constituent village settlements. Questionnaire responses however, revealed that only a third of the population are left to conduct fishing as a primary occupation. Another one third are into business/contracting, while insignificant proportions (less that 10% each) are into farming, technical/artisanship, trading and civil service respectively. (Figure 4.24) Trading assumed more significance as a secondary employment in the study environment; 70 percent of the respondents claimed to be in this economic endeavour. One fifth and just 10 percent claimed to take to fishing and farming as secondary that bring in some additional income to the household (Figure 4.25).

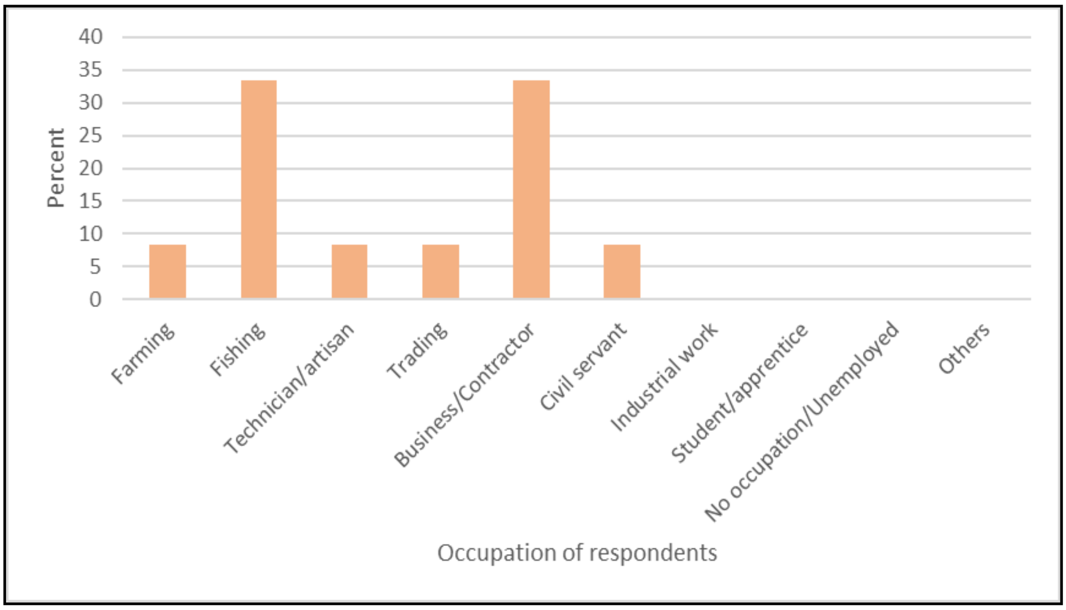

Figure. 4.24: Primary occupation of respondents

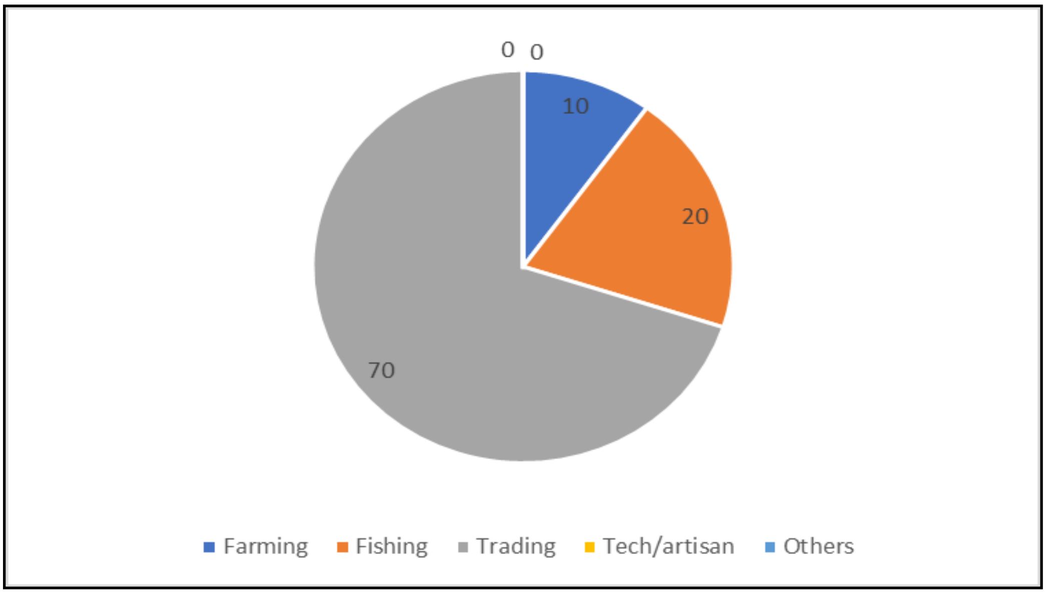

Figure 4.25: Other sources of income (secondary occupation) of respondents

Land use and management: ownership, tenure status

Land Ownership/Access and Tenure System

Generally, land is Nigeria’s most important long-term resource base and in areas where this finite resource is in short supply can be very contentious. Practically everywhere therefore, Nigerians share land as a common denominator wherein lie most of their hopes and most of their problem. Land means many things, and the manner in which it is acquired, owned, used, and transferred is referred to as ***land tenure*** (NEST 1991, Igbozurike 1978). Before rights can be exercised over land, it has to be acquired in one of six principal methods of land acquisition, namely*, inheritance, purchase, lease, pledge, exchange, and gift.*

Land is the base for all human activities, including agricultural and industrial development and ‘’land is a finite resource’, fixed in supply as it were. Even with a moderately growing rural population, land for all kinds of uses has become smaller with each passing year. The utilization of land can also be affected and influenced by hydrologic and physiographic characteristics; areas that lie within floodplains are susceptible to annual flooding incidences and therefore restrict land availability and overall use. In areas of the Niger Delta where lands on which oil wells and facilities are located confer additional advantages on the land-owning individual, family or community. Therefore, available land, no matter its size is held in very high value. Land in Nigeria falls under four broad ownership classes, regardless of who the law says holds the land in trust for whom. They are *individually-owned, family-owned, communally-owned, and government-owned* land.

In the Ogboloma study environment, varied forms of land ownership prevail. Principally however, families owned most of the land. The principal means of land acquisition and ownership was identified as both family inheritance and outright acquisition (33.3% each). Equal proportions of the respondents also mentioned land acquisition through rental/leased and share-cropping. It is difficult to comprehend where the land is within the area for acquisition both for framing and even housing development.

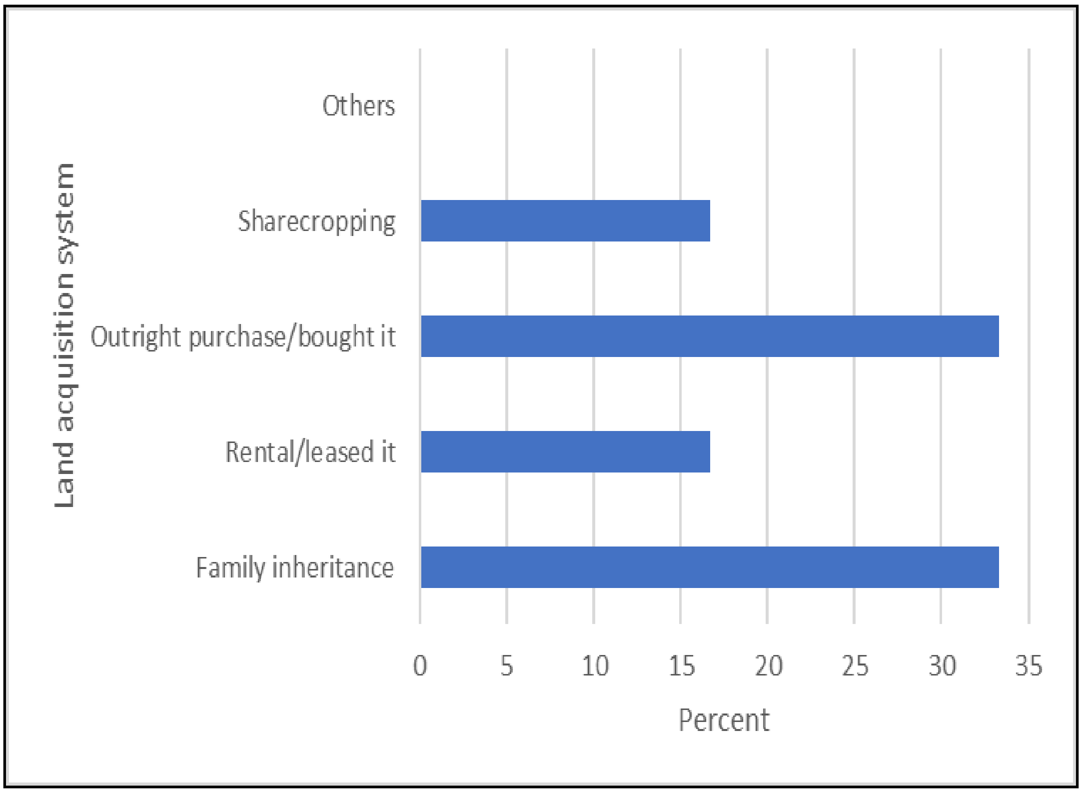

Figure 4.26: Method of land acquisition

Income Level of Population

Income is an important variable that influences socio-economic status of individuals and its distribution pattern has the potential of influencing other demographic variables. However, personal income levels of self-employed rural households have always proved very difficult to assess because many local people do not keep records and are therefore uncertain of the gross or net amount actually earned from self-endeavors. Many householders are also engaged in several income-generating activities and the respective contributions of the admixture of economic activities cannot be accounted for. Some who may have information about their earnings are also not willing to divulge such sensitive data, considering the effects of taxation. The consequence is that incomes of rural householders are very unreliable.

The only basis on which inferences could be drawn in terms of derived income from economic activities by respondents was information volunteered individually from administered structured questionnaires. Valid responses from the sureveyed population revealed incomes were generally low, spread across the income brackets but the income levels compared well with the current minimum wage in Nigeria. The current minimum wage in Nigeria is N70,000 increased from N30,000 per month, but yet to be implemented in all the States across the country. It refers to the recommended lower limit for the least paid worker in a Government establishment. The majority of the respondents (55.6%) earn above N50,000 monthly income. Another one fifth (22.2%), earn N45,000 –N50,000, 11.1 percent each earn N25,000-30,000 and N35,000-40,000 in a month. (Fig. 4.27) As would be expected, members of the communities, who are into Business/Contracting, industrial/company employment and the civil service earn higher incomes from their endeavours than those in traditional occupations who have to experience the vagaries of the time. From other sources (secondary), a greater majority still, earns above N50,000 monthly income, while another one quarter earns N40,000 – 45,000. (Fig. 4.29). Gross annual income levels of the community respondents showed over 80 earn abover N350,000 per annum. Specifically, majority of the respondents have their incomes in the N500,000 and above income bracket (44.4%). Another one fifth (22.2%), also earns ₦450,000 to N500,000 while a combined percentage of 22.2 percent have their incomes in the bracket of 350,000 to ₦450,000 as annual earnimgs respectively (Fig. 4.30). These income levels appear high comparatively. The "2019 Poverty and Inequality in Nigeria" report released by the National Bureau of Statistics (NBS) highlighted that 40 percent of the total population in Nigeria, or almost 83 million people, live below the country's poverty line of 137,430 naira per year.

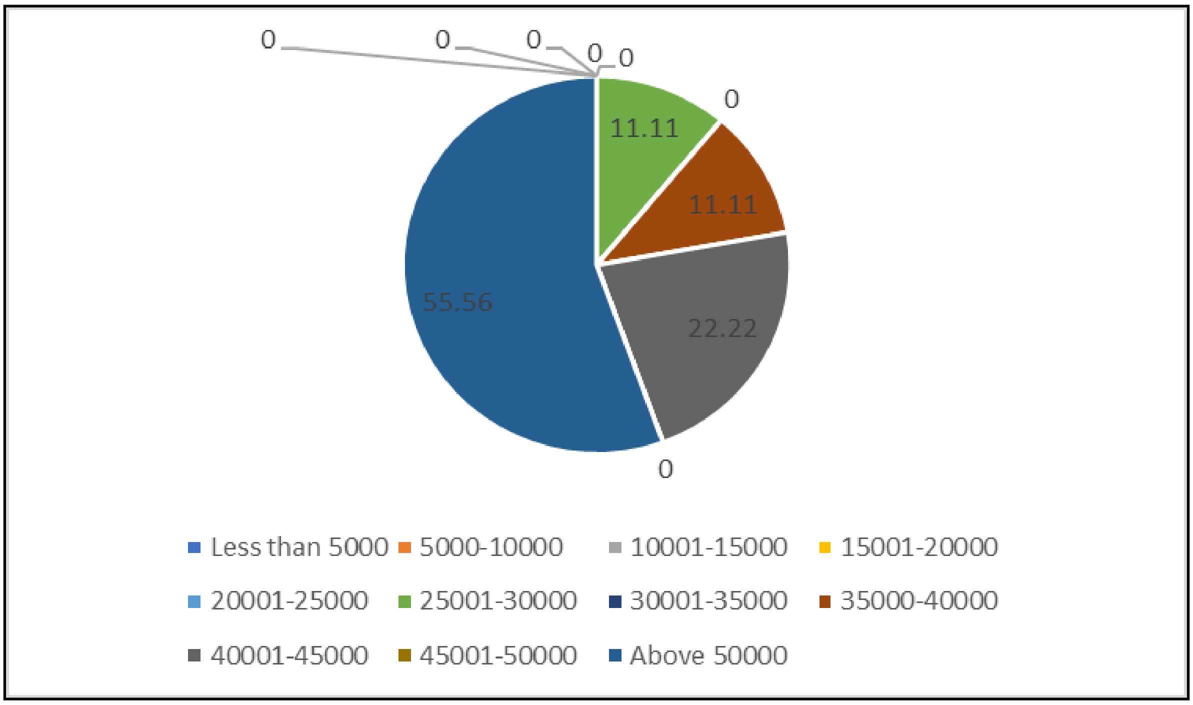

Figure 4.27: Monthly income levels of sampled respondents

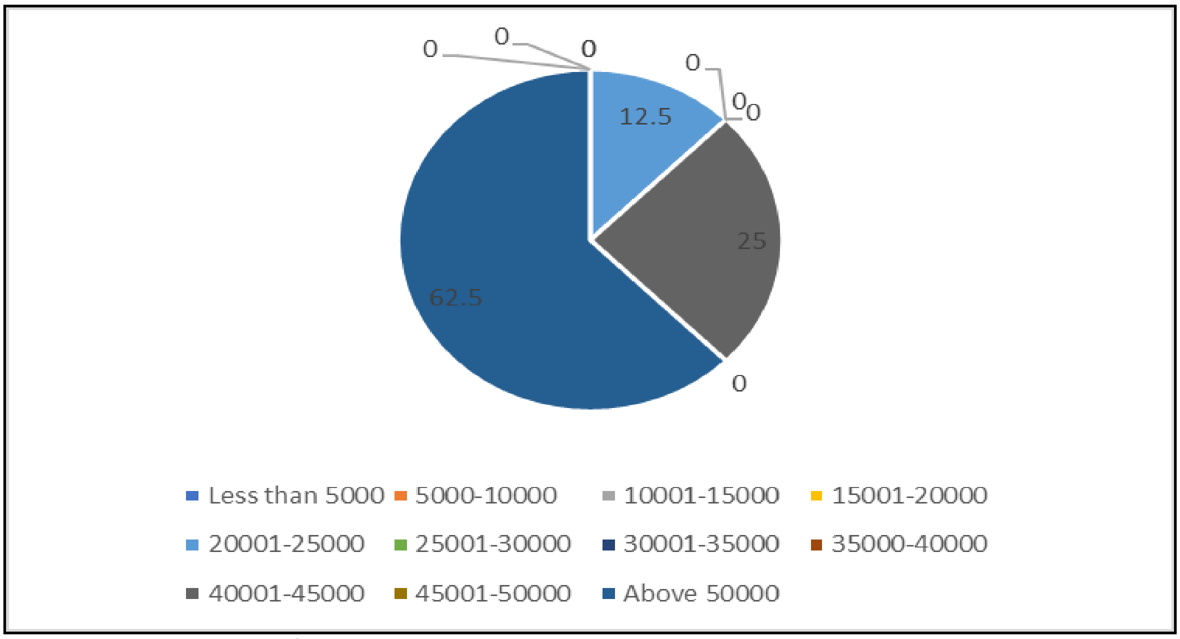

Figure 4.28: Income from other secondary sources

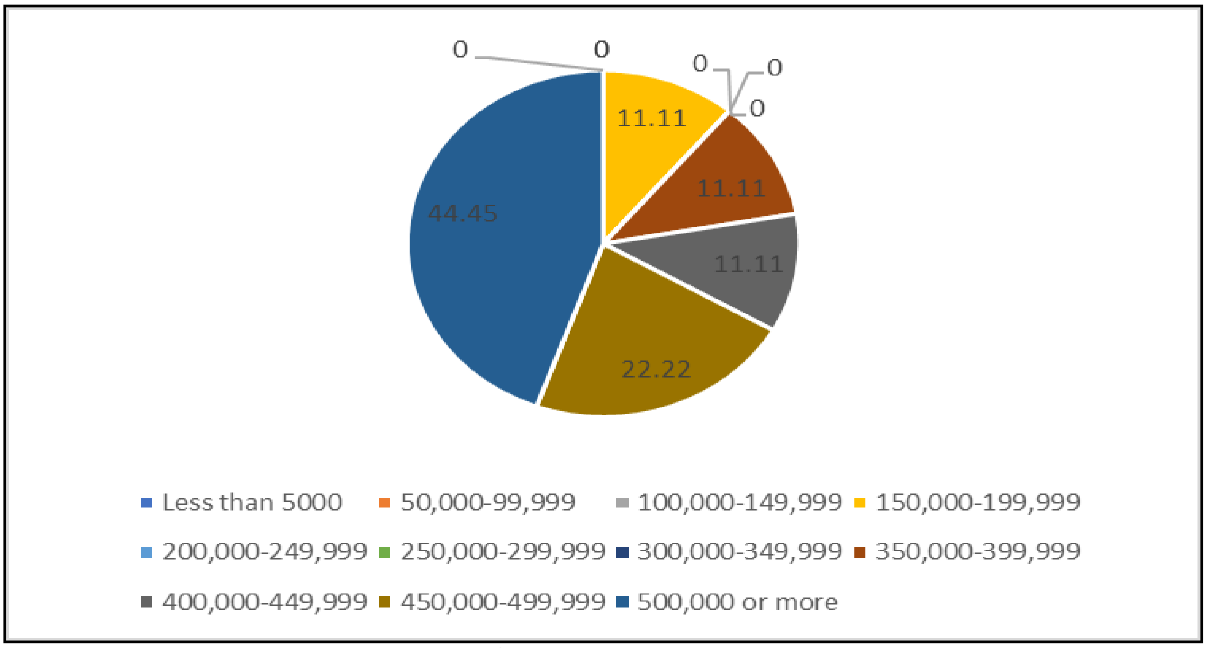

Figure 4.29: Gross annual income of respondents

Infrastructural Facilities/amenities, Functional status and quality of Life

The Ogboloma community and her population have access to a modicum of basic infrastructures and amenities, although more can still be done for the affected population to enjoy a quality life. There are both public primary and post primary schools within easy reach of children and wards in the community, but access to 'potable' water is lacking. The residents also have access to primary healthcare services. There is access to electricity/energy supply from the facility of the SPDC gas operated turbine as well as from the state grid supply through the (Port Harcourt Electricity Distribution Company - PHEDC). However, small businesses in the community have alternative power generators to complement their electricity needs. Accessibility into and out of the Ogboloma study community is through secondary distributor roads. The table 4.23 below shows the available infrastructures/social amenities, and status within the community.

Table 4.23: Summary of social infrastructures/ amenities available in Ogboloma Community

Infrastructure	Status
Education	✓ Ogboloma Community has public primary schools and secondary school located within its land which serve the educational needs of the children and wards. ✓ There are several privately-operated nursery/primary schools in close proximity to the community
Electricity/Energy supply	✓ The electricity distribution lines are very visible in the area with supplies from the facility of the SPDC gas operated turbine as well as from the state grid supply through the (Port Harcourt Electricity Distribution Company - PHEDC).
Water	✓ Population depends on private boreholes in their own houses and local hand-dug wells for household water supply.
Healthcare	✓ Ogboloma Community has a functional Modern Primary Healthcare Centre (PHC) under the management of the State Ministry of Health. ✓ Facility manned by nurses and other health workers.

	✓ PHC has a doctor's and nurses' quarters for accommodated of some staff.
Housing	✓ Private ownership of houses (owner-occupiers); walls and roofs of most dwellings are built of blocks and corrugated zinc sheets, with several also constructed of planks/wood walls with zinc roofing.

CHAPTER FIVE

POTENTIAL AND ASSOCIATED IMPACT OF THE PROJECT

5.1 Overview

In this chapter of the report, an overview of the methodology adopted for assessment of project impacts as well as a summary of the associated and potential impacts of the proposed project on the environmental and socio-economic conditions of the project area is presented. The assessment of impacts is as comprehensive as possible, within the limits of available information.

These impacts were identified by examining how the activities associated with the different phases interact with the environment and its different components. The two key aspects of the proposed project (construction/installation and operations) have several sub-components that can either directly or indirectly interact with different components of the environment leading to environmental issues. The assessment of the identified impacts was based largely on field observations, baseline data and existing literature. In practice, many elements of the environment are interrelated and cannot be considered in isolation. However, for convenience, some of these elements discussed here are under separate headings.

5.2 Impact Analysis and Objectives

Impact analysis is an aspect of the EIA study that identifies, predicts, evaluates and communicates information about the potential impacts of a project on the environment (EIA Act CAP E12, LFN 2004). The central objective of the impact identification and assessment is to identify and evaluate potential environmental and social impacts of the proposed Project, determine their significance, and design corresponding mitigation and other management measures aimed at reducing the severity of the impacts to acceptable levels. Therefore, the analysis of the impacts aims to:

- establish the type (whether positive or negative) impacts that may occur as a result of the project being undertaken;
- differentiate between the insignificant impact (those that can be sustained by the natural systems) and the significant impacts (those that cannot be sustained by natural systems);
- provide a framework for the development of amelioration/mitigation measures to address the significant negative impacts and, on the other hand, determine enhancement measures for the positive ones

5.3 Impact Assessment Methodology

The methodology adopted for impact assessment is the International Organization for Standardization (ISO) 14001 requirements for risk and impact assessment. Essentially, impact identification and assessment were based on primary information obtained during field data gathering in the proposed project area of influence, information obtained from members of affected communities and other stakeholders during consultations, existing literatures related to the implementation of the Proposed Project and professional experience and judgement of the multidisciplinary EIA team.

Project activities and environmental interfaces generally encompass a broad range of issues: air pollution, water pollution, effects on employment, community structure, etc. These issues were considered in arriving at the impacts of the proposed project.

The process of impact assessment includes:

- Establishing the basis
- Developing Interaction Matrix
- Identifying potential Impacts
- Integrating Impact Assessment including evaluation of significance of the impacts
- Developing the Environmental and Social Management Plan (ESMP)

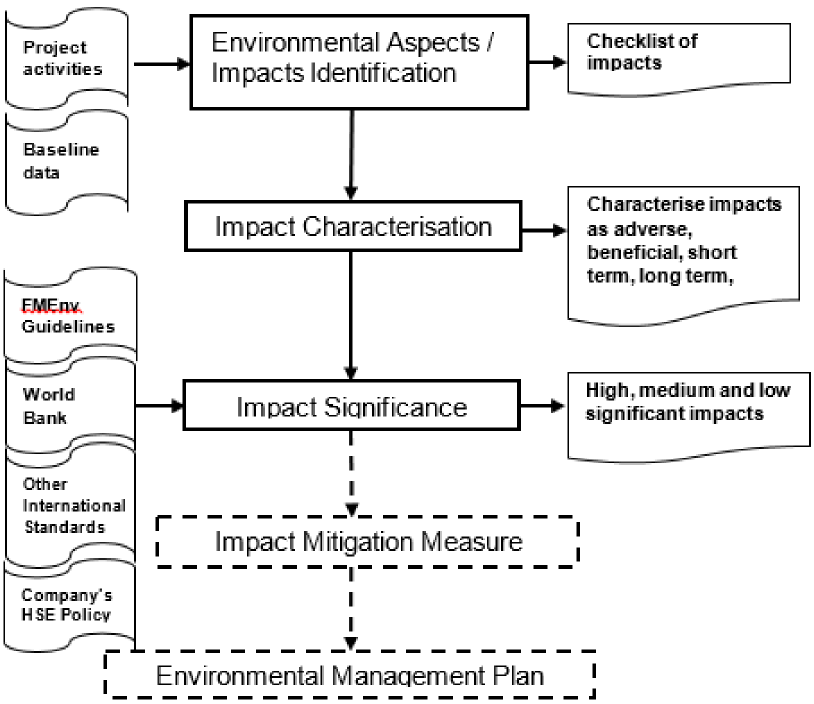

Figure 5.1: Impact Assessment Pathway

5.4 Project Activities

Several project activities would be carried out in phases. These planned activities are what would impact the environmental and social components positively or negatively. The Proposed Project activities are grouped into four phases as follows:

Pre-Construction Phase: Involves activities such as an award of contract, project front end engineering design and planning, consultation, recruitment, site preparation and mobilisation of equipment and materials to the site.

Construction/installation Phase: It involves activities such as mobilisation of workers and equipment to the site, piling, digging, trenching, grading, soil compaction; and erection of temporary camp and power plant structure and components, usually short term.

Operational Phase: This is usually long 'term', involving activities from post-construction to decommissioning. It commences once the proposed CNG and Power Plant Project has been commissioned and it is fully operational.

Decommissioning/Abandonment Phase: It begins once the proposed CNG and Power Plant Project stops operations or the project life span has come to an end.

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

Table 5.1: summary of project activities

Phases	Activities
Pre-construction	• Land Acquisition • Pre-mobilisation/Project design • Feasibility Studies • Site Preparation • Construction of workers' camp, internal roads and mobilization of equipment • Mobilisation of equipment and workforce to the site • Employment of skilled and unskilled labour • Transportation of materials
Construction/installation	• Civil work activities • On site fabrication of materials • Installation of equipment and machinery, • Installation of ancillary facilities • Waste generation and disposal
Operation	• Power Generation Activities • CNG Processing Activities

	• Operation and maintenance of infrastructure and other facilities • Waste generation and management.
Decommissioning	• Removal of equipment and dismantling of structures • Site remediation and rehabilitation • Waste generation and disposal • Abandonment

Source: Environheroes, 2024

5.5 Impact Identification

Impact identification aims to account for the entire potential and associated biophysical, social and health impacts making sure that both significant and insignificant impacts are accounted for. *ISO 14001* requires the identification, evaluation and registration of environmental aspects associated with the proposed project activities.

As with a project of this nature, the impactable components of the environment that will be affected by the proposed projects as well as impact indicators for the sensitivity of each component of the environment are shown in *Table 5.2* below.

Table 5.2: Environmental Components, Sensitivity and Associated Impact Indicators

Environmental Receptor	**Comment**	**Impact Indicators**
Climate		
Climate	Climate change	Humidity, Temperature, Rainfall, Wind
Air Quality	Ambient air quality within the Project site and its area of influence	Increased concentration of gaseous and particulate pollutants (such as Dust, NOx, SOx, CO, VOC, PM10, PM2.5, CO_2)
Noise and Vibration	Ambient noise and vibration level within the Project site and its area of influence	Increased ambient noise and vibration level, night and day-time disturbance, hearing loss, communication impairment etc.
Soil	Soil environment within the Project site and its area of influence	Changes in physical, chemical and biological properties, loss of soil

Environmental Receptor	**Comment**	**Impact Indicators**
		ecology and fertility, compaction, erosion etc.
Underground water/aquifers	Underground water resources within the Project site and its area of influence	Decrease in underground water/aquifer reservoir level, groundwater contamination, and availability of potable water.
Landscape/topography	The geomorphological landforms and terrain of the Project site and its area of influence	Alteration in drainage pattern, changes in landscape.
Biological		
Terrestrial Flora and habitats	Plant species within the Project site and its area of influence	Loss of terrestrial fauna, introduction of new species.
Terrestrial Fauna including avifauna	Terrestrial fauna and avifauna within the Project's area of influence	Loss of terrestrial fauna; involuntary migration.
Socio-economic Environment		
Visual prominence	The aesthetic quality of the project on the surrounding visual catchment.	The compatibility of the power plant project with the character of the locality.
Demography	Demography of communities in the Project's area of influence	Changes in total population, gender ratio, age distribution, socio-economic structure etc.
Infrastructure		
Utilities	The existing utilities (e.g. power supply, water,	Changes in existing utilities, and damage to public utilities e.g., pipes, cables, and road.

Environmental Receptor	**Comment**	**Impact Indicators**
	sewerage services) in the Project's area of influence	
Cultural values	Cultural sites within the Project's area of influence	Damage to cultural sites within the Project's area
Employment/income	The employment situation in the Project's area of influence	Opportunities for local and national employment; changes in income level
Other (Health and Safety)		
Construction workers	Workers' health and safety	Accidents, injury, fatality, exposure to nuisance (dust, noise), fire etc.
Workplace health and safety	The health and safety of employees involved with the plant operation.	Accidents, injury, exposure to nuisance (dust, noise), fire, explosion.
General public	Community health and safety	Exposure to road accidents, fire, explosions, etc.

Source: Environheroes, 2024

The first step in identifying impacts associated with the project is the development of an interaction matrix which shows the relationship/interaction between the project's environmental components and planned project activities. The full list of project activities used in the interaction matrix has been summarized in four (4) phases; pre-construction, construction, operation and decommissioning. Based on these interactions, the identified negative impacts were rated as High, Medium and Low. Positive impacts arising from the project were not further classified.

The development of the checklist was carried out using the FMEnv EIA Sectoral Guidelines for Power and Oil & Gas, IFC Performance Standards on Environmental and Social Sustainability (IFC, 2012), and the World Bank Environmental, Health and Safety (EHS) Guidelines.

Table 5.3: Identified Project Impacts

Project Phase	**-**	**Environmental/Socio-economics Aspect**	**Potential/Associated Impacts**
Pre-Construction	Land acquisition	Socio-Economics	• Community agitation over compensations, land disputes, wrong stakeholder identification, leadership tussles etc • Increased income generation. • Increased incidence of Intra and inter-inter-community conflicts. • Change in Geology/topography
	Employment of skilled and unskilled labour	Socio-economics	• Creation of employment for skilled and unskilled workforce. • Skill acquisition and enhancements to local indigenes and workforce. • Business opportunities for local contractors through sub-contracting activities • Conflicts/community agitations over employment issues(quota and methods)
	Construction of workers' camp, access roads and mobilization of equipment	Air Quality/Noise	• Increase of dust particles and vehicular emissions Nuisance (noise and vibrations) due to movement from heavy-duty equipment and vehicles affecting site workers
	Movement of personnel to the site.	Socio-Economic	• Increased pressure on housing and other amenities/ existing social infrastructure. • Increased cost of living due to inflation arising from an increase in demand. • Increased traffic during mobilization on the road with risk of accidents leading to injury/death and loss of assets. • Security issues; Risk of unknown gunmen attack and hostage-taking leading to injury/death of personnel. • Abandonment of traditional occupations, alterations of religion, gender and age balance. • Increase in incidence of intra-and inter-community conflicts.

Project Phase	**-**	**Environmental/Socio-economics Aspect**	**Potential/Associated Impacts**
		Health	• Increase in social vices (prostitution, unwanted pregnancies, abortions etc.) resulting from increased number of people. • Increased pressure on health facilities and cost of health care services. • Health & Safety risks for the construction workers and general public • Increase of communicable diseases due to influx of people. • Increase in sexually transmitted diseases e.g. HIV/AIDS, STI
		Waste/Environmental Aesthetics	• Reduction in environmental aesthetics value due to indiscriminate deposition of base camp-associated wastes.
	Clearing of vegetation and other debris	Vegetation	• Loss of vegetation in the project site area. • Loss of habitat for wildlife
		Soils	• Exposure of soil surface to the elements that can trigger erosion. • Soil degradation e.g. compaction of soil as a result of the movement of earth-moving equipment • Exposure of soil surface to wind and sheet erosion.
		Human Health	• Injuries from wildlife attacks (snake bites and insect stings). • Injuries from machete and other equipment during vegetation clearing.
Construction/Installation	Civil works activities such as construction of buildings, Equipment installations, Installation of ancillary facilities, Installation of electricity power infrastructure etc	Socio-Economics	• Employment of local labour and skills acquisition for workers taking advantage of new opportunities. • Increased pressure on existing infrastructures/utilities. • Increased business and economic activities as well as diversification of income sources due to supply contracting and sub-contracting • Increase in revenue opportunities for the local population due to the presence of non-resident workers and travelers.

Project Phase	**-**	**Environmental/Socio-economics Aspect**	**Potential/Associated Impacts**
			• Increased cost of living due to inflation arising from increased demands.
		Human Health	• H&S risks for the construction workers and general public • Workplace accidents from burns, cuts, bruises, trips and falls, and objects at height lead to injury or fatalities. • Risks of injury/death and loss of assets resulting from accidents associated with road transportation to and from construction site • Traffic congestion during transportation of demobilized equipment and personnel
		Flora and Fauna	• Reduction in wildlife population as a result of poaching due to easier access created by project site clearing. • Noise nuisance (including impulsive noise) from construction activities, resulting in the temporal migration of sensitive mammals and rodents
		Groundwater	• Groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, lubricants, hydraulic oil etc)
		Air quality/Noise	• Generation of dust and automobile/heavy-duty equipment emissions. • Decrease in air quality as a result of emissions from vehicles and equipment. • Increased ambient noise level from heavy equipment and machinery, vehicular movement, and civil work activities.
		Waste/Environmental Aesthetics	• Reduction in environmental aesthetics value due to indiscriminate disposal of wastes. • Visual intrusion as a result of alterations from accidental ignition of onsite diesel storage tanks
		Soil	• Soil degradation and possibly accelerated erosion

Project Phase	**-**	**Environmental/Socio-economics Aspect**	**Potential/Associated Impacts**
			• Reduction in structural stability and percolative ability of the soil. • loss of soil-dwelling organisms
Operation	Operation and maintenance of Power Plant	Human Health	• Noxious gas emissions
		Air quality/Noise	• GHG Emissions • Fugitive emissions • Noxious gas emission due to pipeline failure; • Increase in noise level during operation hours.
		Socio-Economics	• Increased business opportunities and quality of life (small, medium and large scale) • Enhanced aesthetic appeal due to the presence and eventual operation of many facilities on the project site • Increase in social vices
Decommissioning and Abandonment	Demolition of buildings, Site remediation and rehabilitation	Socio-Economic	• Loss of employment • Availability of land for alternative uses
		Air quality/noise	• Increased noise level • Generation of dust and automobile/heavy-duty equipment emissions.
		Human and Health	• Risk of accident and injury to workers during decommissioning of equipment and structure • Traffic obstruction from transportation of decommissioned structures and equipment

5.6 Impact Characterisation

Based on the interaction matrix developed, associated and potential impacts at various phases of the project are further characterised using a checklist. This involves categorising impacts (i.e. potential and associated) based on the following terms as presented in Table 5.4.

Table 5.4: Definition of Impact Characterization Terms

S/N	Impact Characterization	Definition
1	Direct Impacts	These are impacts resulting directly (direct cause-effect consequence) from power generation activity
2	Indirect Impacts	These are impacts that are at least one step removed from the power plant project activities. They do not follow directly the project activities
3	Adverse Impacts	Adverse impacts are those that would produce negative effects on the biophysical or socio-economic environment.
4	Beneficial Impacts	These are impacts that would produce positive effects on the biophysical or socio-economic environment.
5	Reversible Impacts	These are impacts where environmental components can recover over time.
6	Irreversible Impacts	These are such that the impacted component cannot be returned to its original state even after adequate mitigation measures are applied.
7	Cumulative Impacts	These are impacts resulting from an interaction between the project activities and other activities, taking place simultaneously.
8	Residual Impacts	Impacts whose effects remain after mitigation measures have been applied
9	Long term	Those predicted adverse impacts which remain after mitigating measures have been applied (about 5 years)
10	Short term	Impacts that are removed after mitigating measures have been applied (about 6 months)

Table 5.5: Impact Characterisation

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Beneficial /Adverse**	**Short Term**	**Long Term**	**Reversible Irreversible**
Pre-construction	Land Acquisition	• Community agitation over compensations, land disputes, wrong stakeholder identification and leadership tussles.	**-**	**ST**	-	**R**
		• Lobbying, agitations for jobs, employment and contractual agreement by local workers.	+	**ST**	-	**R**
		• Exclusion of vulnerable groups from consultations which may lead to strife.	**-**	**ST**	-	**R**
		• Increased income generation.	+	**-**	**LT**	**R**
	Employment of both Skilled and Unskilled workers	• Creation of employment for skilled and unskilled workforce.	+	**-**	**LT**	**R**
		• Skill acquisition and enhancements to local indigenes and workforce.	+	**ST**	-	**I**
		• Business opportunities for local contractors through sub-contracting activities.	+	**ST**	-	**R**
		• Conflicts/community agitations over employment issues (quota and methods).	**-**	**-**	**LT**	**R**
		• Increase in social vices (crime rate, prostitution, device, polygamous marriage etc),	**-**	**-**	**LT**	**I**
		• Increase of dust particles and vehicular emissions Nuisance (noise and vibrations) due	**-**	**ST**	-	**R**

Project Phase	Project Activities	Potential/Associated Impacts	Beneficial /Adverse	Short Term	Long Term	Reversible Irreversible
	Mobilization of equipment and personnel to site	to movement from heavy duty equipment and vehicles affecting site workers				
		• Increased Income and local economy.	+	-	**LT**	**R**
		• Increased pressure on existing social infrastructure	–	**ST**	-	**R**
		• Increased social vices.	-	**ST**	-	**R**
		• Increase of communicable diseases due to influx of people	-	**ST**	-	**R**
		• Increased traffic during mobilization on road with risk of accidents leading to injury/death and loss of asset	–	**ST**	-	**R**
	Clearing of vegetation and other debris	▪ Loss of vegetation in the project area.	-	-	**LT**	**I**
		• Exposure of soil surface to the elements and triggering of erosion.	-	**ST**	-	**I**
		• Soil degradation e.g. compaction of soil as a result of the movement of earth moving equipment	-	-	**LT**	**I**
		▪ Injuries from wildlife attacks (snakes bites and insects stings).	-	**ST**	-	**I**
		▪ Injury from equipment usage during vegetation clearing.	-	-	**LT**	**R**
		▪ Domestic and Sanitary Waste Generation	-	**ST**	-	**R**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Beneficial /Adverse**	**Short Term**	**Long Term**	**Reversible Irreversible**
Construction/Installation	Civil works activities such as construction of buildings, Installation of power plant equipment, CNG Processing Plant and other ancillary facility	• Employment of local labour and skills acquisition for workers taking advantage of new opportunities.	+	-	LT	**R**
		• Increased business and economic activities as well as diversification of income sources due to supply contracting and sub-contracting	+	-	LT	**R**
		• Increase in revenue opportunities for the local population due to the presence of non-resident workers.	+	-	LT	**I**
		• Increased cost of living due to inflation arising from increased demands.	-	-	LT	**I**
		• Increase in social vices	-	-	LT	**R**
		▪ Decrease in air quality as a result of emissions/dust from vehicles and equipment.	-	-	LT	**I**
		▪ Noise nuisance (including impulsive noise) from construction activities, resulting in the temporal migration of sensitive mammals and rodents	-	-	**LT**	**I**
		▪ Groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, lubricants, hydraulic oil etc)	-	**ST**	-	**I**
		▪ Workplace accidents from burns, cuts, bruises, trips and falls, and objects at height lead to injury or fatalities.	-	**ST**	-	**I**

Project Phase	Project Activities	Potential/Associated Impacts	Beneficial /Adverse	Short Term	Long Term	Reversible Irreversible
		▪ Risks of injury/death and loss of assets resulting from accidents associated with road transportation to and fro construction sites	**-**	**ST**	**-**	**I**
		▪ Reduction in environmental aesthetics value due to indiscriminate disposal of wastes.	**-**	**ST**	-	**I**
		▪ Inhalation by onsite workers of cement dust and toxic fumes during foundation works and welding of material components	**-**	**ST**		**R**
		▪ Soil degradation and possibly accelerated erosion	**-**	**ST**	-	**I**
		▪ Reduction in structural stability and percolation ability of the soil.	**-**	**ST**	-	**I**
		▪ Traffic congestion during transportation of demobilized equipment and personnel	**-**	**ST**	-	**R**
		▪ Potential collapse of civil structures on land as a result of unstable geotechnical conditions	**-**	**ST**	-	**I**
		▪ Restriction of access roads to prevent unauthorized uses	**-**	**ST**	-	**R**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Beneficial /Adverse**	**Short Term**	**Long Term**	**Reversible Irreversible**
		▪ Increased business and economic activities as well as diversification of income sources due to supply contracting and sub-contracting	+	**-**	**LT**	**R**
		▪ Increase in revenue opportunities for the local population due to the presence of non-resident workers and travelers	+	**-**	**LT**	**I**
		▪ Employment of local labor and skills acquisition for workers taking	+		**LT**	**I**
		▪ Injury and death due to workplace incidents.	**-**	**ST**	-	**I**
		▪ Community conflicts arising from disagreement over contracts and recruitment.	**-**	**ST**	-	**R**
		▪ Increase in social vices and kidnapping	**-**	**-**	**LT**	**R**
		• Visual intrusion as a result of alterations from accidental ignition of onsite diesel storage tanks.	**-**	**ST**	**-**	**R**
		• Offcuts and packaging materials (Solid), domestic/ sanitary waste etc.	**-**	**ST**	**-**	**R**
Operation	Operation of Power Plant and CNG Processing Facility	• Increased business opportunities and quality of life (small, medium and large scale)	+	**ST**	**-**	**R**
		• Waste Generation		**ST**		
		▪ Revenue generation for both state and federal governments.	+	**-**	**LT**	**I**
		▪ Employment for both skilled and unskilled labour.	+	**-**	**LT**	**R**

Project Phase	Project Activities	Potential/Associated Impacts	Beneficial /Adverse	Short Term	Long Term	Reversible Irreversible
		▪ Increased Power Generation			**LT**	**R**
		▪ Pressure on existing infrastructure.	**-**	**-**	**LT**	**R**
		▪ Noxious gas emissions			**LT**	
		▪ noise generation		**ST**		**R**
		▪ Fire hazard		**ST**		**R**
		▪ Increase of human interactions leading to diseases/ infections such as transmission of sexually transmitted diseases (STI's) and other communicable diseases			**LT**	**R**
		▪ Increased social vices.	**-**	**-**	**LT**	**I**
Decommissioning and closure	Demobilization of equipment and personnel from site after project lifespan.	▪ Loss of employment	**-**	**ST**	-	**R**
		▪ Availability of land for alternative uses.	+	**ST**	-	**R**
		▪ Risk of accident and injury to workers during demolition of structures	**-**	**ST**	-	**R**
		▪ Traffic obstruction from transportation of decommissioned structures and equipment.	**-**	**ST**	-	**R**
		▪ Waste generation and management.	**-**	**ST**	-	**I**
		▪ Emission of dust, exhaust fumes/noxious gases from vehicles, and increased ambient noise level.	**-**	**-**	LT	**I**
		• Loss of revenue earner for state and federal government.	**-**	**-**	**LT**	**I**
		• Reduced pressure on infrastructure.	+	**-**	**LT**	**I**

KEY: * - (Adverse), + (Beneficial); Short Term (< 3 months), Long Term (>3 Months); R = Reversible, I = Irreversible.

5.7 Impact Evaluation

The evaluation process is based on professional judgment and the use of clearly defined criteria; Legal/Regulatory requirements (L), Risk factor (R), frequency of occurrence of impact (F), the importance of impact (I) and Public perception/interest (P) to determine the significances or otherwise of the impacts. The framework of *ISO 14001* (EMS) was used in the impact evaluation. The criteria and weighing scale adopted for the evaluation of the significance of impact are described below.

Legal/ Regulatory Requirements (L)

The proposed project activities that resulted in impacts were weighed against existing legal/ regulatory provisions to determine the requirement or otherwise for permits before the execution of such activities. Such legal requirements (*Table 5.6*) were identified from national laws/ guidelines/standards (FMEnv), which have been reviewed in Chapter One of this report as well as those guidelines in the source references relating to the proposed project activity. The weighing scale used is as follows:

Table 5.6: Legal/ Regulatory Requirements

Ratings	**Conditions**
Low (0)	No legal/ regulatory requirement for carrying out project activity
Medium (3)	Legal/ regulatory requirements exist for carrying out an activity
High (5)	A permit is required before carrying out project activity which may result in an impact on the environment

Risk Posed by Impact (R)

The risks (a measure of the likelihood and magnitude of an adverse effect) associated with the project were evaluated in terms of; risk to human health, a risk to an asset (commercial and economic risk), risk to the biophysical environment and risk to Road Bit Limited. It involves the use of a matrix based on the interaction of the probability of occurrence of the impact against consequences. Five probability categories have interacted against four groups of consequences. Based on the various risks, impacts are ranked using the weighing scale. The resultant outcomes are given scores with colour-coding, where High-risk categories are red; intermediate risks, yellow and low risks, green.

Table 5.7: Probability of Occurrence

Probability Category	**Definition**
A	Possibility of Repeated Incidents
B	Possibility of Isolated Incidents
C	Possibility of Occurring Sometime
D	Not Likely to Occur
E	Practically Impossible

Table 5.8: Consequence Categories

Consequence Category	**Considerations**			
	Safety / Health	**Public Disruption**	**Environmental Aspects**	**Financial Implications**
I	Fatalities / Serious Impact on Public	Large Community	Major/Extended Duration/Full-Scale Response	High
II	Serious Injury to Personnel / Limited Impact on Public	Small Community	Serious / Significant Resource Commitment	Medium
III	Medical Treatment for Personnel / No Impact on Public	Minor	Moderate / Limited Response of Short Duration	Low
IV	Minor Impact on Personnel	Minimal to None	Minor / Little or No Response Needed	None

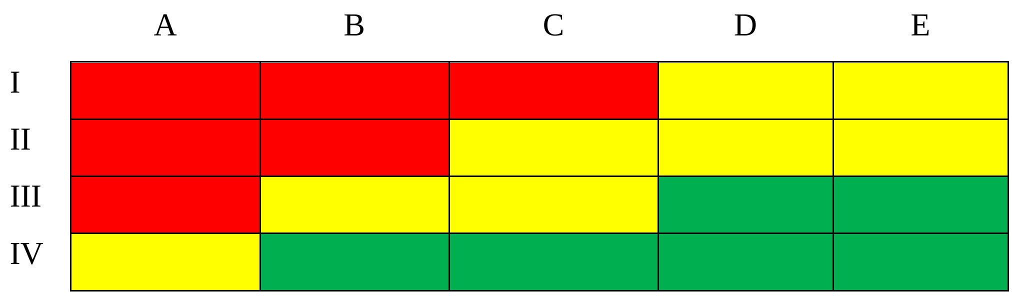

Figure 5.2: Risk Assessment Matrix

Table 5.9: Risk Criteria

Rating	Attribute – Environmental, Human Health, Safety and Reputation
Low risk (0)	• This means that no further mitigation may be required
Medium risk (3)	• This means that the impact can be mitigated with additional controls and modifications
High risk (5)	• This means that the impact requires avoidance or major control/mitigation

Frequency of Impacts Occurrence (F)

Frequency of impact refers to the number of occurrences of impact. Evaluation of the frequency of occurrence was rated as “high”, “medium” or “low” based on the historical records of accidents/ incidents, consultation with experts and professionals as well as local communities. The criteria for rating the frequency of impacts are summarised in *Table 5.10* below.

Table 5.10: Frequency Rating and Criteria

Frequency	Criteria
High (5)	Very likely to happen throughout the project's lifespan
Medium (3)	Likely to happen ≥ 5 years
Low (0)	Rare, not likely to happen within the project lifespan

Importance of Impact (I)

The importance of the affected environmental component in respect of identified potential impact was also determined and rated as “high”, “medium” or “low”. The ratings were based on a consensus of opinions among consulted experts including project engineers and other stakeholders in the proposed project. This was also further facilitated by information on experiences on the impacts of already existing facilities in the proposed project area. The rating of the important criteria of impact is summarised in Table 5.11 below:

Table 5.11: Importance Criteria

Importance	**Attribute – Environmental, Human Health and Safety**
High (5)	• Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) • Detrimental, extended flora and fauna behavioural change (breeding, spawning, molting) • Major reduction or disruption in value, function or service of impacted resource • Impact during an environmentally sensitive period • Continuous non-compliance with international best practices
Medium (3)	• Negative outcome • Measurable reduction or disruption in value, function or service of impacted resource • Potential for non-compliance with international best practices
Low (0)	• Imperceptible outcome • Insignificant alteration in value, function or service of impacted resource • Within compliance, no controls are required

Public Interest/ Perception (P)

Here, the interest/ perception of the public in the proposed project and the identified potential/associated impacts were determined through consultation with the proposed project stakeholders. The ratings of "high", "medium" or "low" were assigned based on a consensus of opinions among consulted known stakeholders. The public perception/interest criterion is summarised in *Table 5.12* below.

Table 5.12: Public Perception Criteria

Public Perception	**Attribute – Environmental and Human Health**
High (5)	• Elevated incremental risk to human health, acute and/ or chronic • Possibility of life endangerment for community inhabitants and site personnel • Major reduction in social, cultural, and economic value • Continuous non-compliance with international best practices • Any major public concern among the population in the project region
Medium (3)	• Limited incremental risk to human health, acute and/ or chronic

Public Perception	Attribute – Environmental and Human Health
	• Unlikely life endangerment for community inhabitants and site personnel • Some reduction in social, cultural, and economic value • Possibility of adverse perception among the population • Potential for non-compliance
Low (0)	• No risk to human health, acute and/or chronic • No possibility of life endangered for community inhabitants and site personnel • Minor reduction in social, cultural, and economic value • Unlikely adverse perception among the population

5.7.1 Result of Impact Assessment

The combination of the five impact rating weights forms the basis for judging the level of significance of each impact. A matrix displaying the combination based on the ISO 14001 tool is shown in *Table 5.13*. The significance of potential impacts of the proposed project (high, medium, and low) was obtained using this method and these are identified as those impacts to which the following conditions apply.

High Impact

(L+ R + F + I + P) ≥ (15): Sum of the weight of legal requirement, risk factor, frequency of occurrence, importance and public perception is greater than or equal to the benchmark (15).

Medium Impact

(L+ R + F + I + P) ≥ 8 < 15: Sum of the weight of legal requirement, risk factor, frequency of occurrence, importance and public perception is greater than or equal to (8) but less than the benchmark (15).

Low Impact

(L + R + F + I + P) = < 8: Sum of the weight of legal requirement, risk factor, frequency of occurrence, importance and public perception is less than or equal to (8).

Table 5.13: Impact Significance Value and Rating

Impact value	Cut off values	Impact Significance Rating
L+R+F+I+P	≥15	High
F + I	>6	
P	= 5	
L+R+F+I+P	≥8 but <15	Medium
L+R+F+I+P	<8	Low
Positive		Positive

Detailed impact evaluations using the criteria mentioned in the previous section are presented in *Table 5.14*. The impacts of the short-term pre-construction, construction and decommissioning phases and the long-term operational phase were considered where appropriate. The high and medium significant negative impacts were judged to require mitigation, while all positive impacts required enhancement.

Table 5.14: Potential and Associated Impact Assessment

Project Phase	Project Activities	Potential/Associated Impacts	L	R	F	I	P	L+R+F+I+P	Ranking (High/Medium/ Low)
Pre-construction	Land Acquisition	• Community agitation over compensations, land disputes, wrong stakeholder identification and leadership tussles.	**3**	**3**	**3**	**3**	**0**	**12**	**MEDIUM**
		• Lobbying, agitations for jobs, employment and contractual agreement by local workers.	**3**	**3**	**3**	**3**	**0**	**12**	**MEDIUM**
		• Exclusion of vulnerable groups from consultations which may lead to strife.	**3**	**3**	**3**	**3**	**0**	**12**	**MEDIUM**
		• Increased income generation.	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**
	Employment of both Skilled and Unskilled workers	• Creation of employment for skilled and unskilled workforce.	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**
		• Skill acquisition and enhancements to local indigenes and workforce.	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**
		• Business opportunities for local contractors through sub-contracting activities.	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**
		• Conflicts/community agitations over employment issues (quota and methods).	**3**	**3**	**3**	**3**	**0**	**12**	**MEDIUM**
		• Increase in social vices (crime rate, prostitution, device, polygamous marriage etc),	**3**	**5**	**5**	**5**	**5**	**23**	**HIGH**
	Mobilization of equipment and personnel to site	• Increase of dust particles and vehicular emissions Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting site workers	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**

Project Phase	Project Activities	Potential/Associated Impacts	L	R	F	I	P	L+R+F+I+P	Ranking (High/Medium/ Low)
		• Increased Income and local economy.	-	-	-	-	-	-	**Beneficial**
		• Increased pressure on existing social infrastructure	**0**	**3**	**3**	**0**	**3**	**9**	**LOW**
		• Increased social vices.	**3**	**5**	**5**	**5**	**5**	**23**	**HIGH**
		• Increase of communicable diseases due to influx of people	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		• Increased traffic during mobilization on road with risk of accidents leading to injury/death and loss of asset	**3**	**3**	**0**	**3**	**3**	**12**	**MEDIUM**
	Clearing of vegetation and other debris	▪ Loss of vegetation in the project area.	**3**	**3**	**0**	**3**	**3**	**12**	**MEDIUM**
		▪ Loss of wildlife, their habitat and migration of wildlife.	**3**	**3**	**0**	**3**	**3**	**12**	**MEDIUM**
		• Exposure of soil surface to the elements and triggering of erosion.	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
		• Soil degradation e.g. compaction of soil as a result of the movement of earth moving equipment	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Injuries from animal attacks (snakes bites and insects stings).	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Injury from equipment usage during vegetation clearing.	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Domestic and Sanitary Waste Generation	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**

Project Phase	Project Activities	Potential/Associated Impacts	L	R	F	I	P	L+R+F+I+P	Ranking (High/Medium/ Low)
Construction/Installation	Civil works activities such as construction of buildings, Installation of power plant & CNG Processing Facility and other ancillary facility	• Employment of local labour and skills acquisition for workers taking advantage of new opportunities.	-	-	-	-	-	-	**Beneficial**
		• Increased business and economic activities as well as diversification of income sources due to supply contracting and sub-contracting	-	-	-	-	-	-	**Beneficial**
		• Increase in revenue opportunities for the local population due to the presence of non-resident workers and travellers.	-	-	-	-	-	-	**Beneficial**
		• Increased cost of living due to inflation arising from increased demands.	**0**	**3**	**3**	**3**	**5**	**14**	**MEDIUM**
		• Increase in social vices	**3**	**5**	**3**	**3**	**5**	**19**	**HIGH**
		▪ Decrease in air quality as a result of emissions/dust from vehicles and equipment.	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Noise nuisance (including impulsive noise) from construction activities, resulting in the temporal migration of sensitive mammals and rodents	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, lubricants, hydraulic oil etc)	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Workplace accidents from burns, cuts, bruises, trips and falls, and objects at height lead to injury or fatalities.	**3**	**5**	**1**	**3**	**3**	**15**	**MEDIUM**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**L**	**R**	**F**	**I**	**P**	**L+R+F+I+P**	**Ranking (High/Medium/ Low)**
		▪ Risks of injury/death and loss of assets resulting from accidents associated with road transportation to and fro construction sites	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
		▪ Reduction in environmental aesthetics value due to indiscriminate disposal of wastes.	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Soil degradation and possibly accelerated erosion	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
		▪ Reduction in structural stability and percolation ability of the soil.	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
		▪ Traffic congestion during transportation of demobilized equipment and personnel	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
		▪ Potential collapse of civil structures on land as a result of unstable geotechnical conditions	**3**	**5**	**3**	**5**	**5**	**21**	**HIGH**
		▪ Restriction of access roads to prevent unauthorized uses	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
		Waste Generation	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
Operation	Operation of Power Plant & CNG Processing Facility	• Increased business opportunities and quality of life (small, medium and large scale)	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**
		• Waste Generation	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Revenue generation for both state and federal governments.	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**

Project Phase	Project Activities	Potential/Associated Impacts	L	R	F	I	P	L+R+F+I+P	Ranking (High/Medium/ Low)
		▪ Employment for both skilled and unskilled labour.	-	-	-	-	-	-	**Beneficial**
		▪ Increased Power Generation	-	-	-	-	-	-	**Beneficial**
		▪ Pressure on existing infrastructure.	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
		▪ Noxious gas emissions	**3**	**3**	**5**	**3**	**5**	**19**	**HIGH**
		▪ noise generation	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ OHS risk	**5**	**3**	**3**	**5**	**5**	**21**	**HIGH**
		▪ Increase of human interactions leading to diseases/ infections such as transmission of sexually transmitted diseases (STI's) and other communicable diseases	**3**	**3**	**3**	**3**	**3**	**15**	**MEDIUM**
		▪ Increased social vices.	**0**	**3**	**3**	**3**	**3**	**12**	**MEDIUM**
Decommissioning and closure	Demobilization of equipment and personnel from site after project lifespan.	▪ Loss of employment	**3**	**5**	**5**	**3**	**5**	**21**	**HIGH**
		▪ Availability of land for alternative uses.	-	-	-	-	-	-	**Beneficial**
		▪ Risk of accident and injury to workers during demolition of structures	**5**	**3**	**3**	**5**	**5**	**21**	**HIGH**
		▪ Traffic obstruction from transportation of decommissioned structures and equipment.	**3**	**3**	**3**	**5**	**5**	**19**	**HIGH**
		▪ Waste generation and management.	**3**	**5**	**3**	**3**	**5**	**19**	**HIGH**
		▪ Emission of dust, exhaust fumes/noxious gases from vehicles, and increased ambient noise level.	**3**	**3**	**3**	**5**	**3**	**17**	**HIGH**

Project Phase	Project Activities	Potential/Associated Impacts	L	R	F	I	P	L+R+F+I+P	Ranking (High/Medium/ Low)
		• Loss of revenue earner for state and federal government.	**0**	**3**	**3**	**5**	**5**	**16**	**HIGH**
		• Reduced pressure on infrastructure.	**-**	**-**	**-**	**-**	**-**	**-**	**Beneficial**

5. 8 Description of Impacts

5.8.1 Pre-construction

- **Impact on Transportation**

Transportation of workers and materials during the site clearing, preparation and onsite construction activities of the project will lead to increased traffic activity along the main road into Project areas. Increased vehicular traffic in the study area could lead to longer commuting times for existing road users. The increased traffic could also lead to additional road accidents. The overall impact significance is therefore moderate since it's a short term impact.

- **Impact on Soil and Ecology**

Site clearing activities will involve the removal of vegetation and top soil as well as the clearing of flora across various habitat types in the project Some flora and fauna within these habitats are economically, medicinally and ecologically important. Clearing will result in a loss of habitat for the fauna including wildlife. The clearing activity will also result in further degradation of soil fertility. Overall impact significance is therefore moderate

- **Impact on Micro and Macro Economy**

The physical presence of workers in the project areas during the site preparation of the access roads, excavation and construction together with employment-seeking migrants will result in increased commercial activities around the project office and nearby communities and those near active work areas. Some labour will be hired locally. There is a high likelihood of an increase in the price of food, medicine, transportation and general goods and services in the project areas as a result of the influx. Overall impact significance is moderate.

- **Vibration and Noise**

Site clearing activities will involve the use of earth moving equipment. Noise and vibration levels around work areas during site clearing will therefore increase, but only during the day as no work will be performed at night. Noise and vibrations would also cause birds, and other mobile fauna to move away from the source, while nearby communities could experience unusual noise and vibration impacts; noise effects on humans are covered under health impacts. Overall impact significance is therefore low.

- **Wastes generation**

Different wastes will be generated during the project's pre-construction activities. The wastes will comprise industrial and domestic waste from the project yard. Some wastes generated from site clearing that are not taken away for use by the local people will be burned on site. Contractor's project yard will be equipped with sanitary waste systems and garbage collection systems. The project contractor will also implement a waste management plan for all activities leading up to the commencement of the project operations. Overall impact significance is therefore low.

- **Air Emissions**

Ambient air quality monitoring indicates that only low levels of pollutants of concern currently exist in the project area. The pre-construction activities associated with the project will result in emissions of air pollutants during the operation of combustion engines, burning of organic material from site clearing, and dust during site clearing and grading. The emissions could cause an increase in concentrations of sulphur oxides, nitrogen oxides, carbon monoxide, Volatile Organic Compounds (VOC) and particulates within the immediate vicinity of emission sources. Dust created from general construction activities would also lead to an increase in air pollutants around the project area. Overall impact significance is therefore moderate.

5.8.2 Construction phase

- **Air Pollution**

  Construction works involving excavations, site preparation and construction traffic will generate substantial dust. Other possible sources of air pollution will arise from exhaust and engine emissions, construction machinery, aggregate crushers and asphalt plants. Air emissions including dust, are regarded as a nuisance when they reduce visibility, soils private property, is aesthetically displeasing or affect palatability of pastures and is also a health hazard. Overall impact significance is therefore moderate.

- **Noise Pollution**

  constructions generally require the use of heavy machinery, and although these activities may be intermittent and localized, they nevertheless contribute tremendous amounts of sustained noise during equipment operation. These can degrade the human welfare, health and disrupt activities within noise sensitive areas like schools and hospitals. The elevated noise and vibration levels within the site can variously affect the project workers and the residents, passers-by, wildlife and domestic animals, within the vicinity. All these disturb the natural surroundings; on the other hand, significant vibrations may also affect the nearby structures such as roads. Overall impact significance is therefore moderate.

- **soil erosion**

  Construction works usually expose soils to agents of erosion. Use of heavy machinery and equipment also compact soil hence inability to support plant growth leaving the soils bare and exposing them to erosion agents. Side drains, especially outfalls/mitre drains may increase soil erosion on cultivated fields. Land clearance needed will uproot trees and crops as well as displace topsoil. The clearing of natural vegetation cover could lead to increased soil erosion. This impact is rated significant.

- **Risks of Accidents and Injuries to Workers**

During construction activities including metal grinding and cutting, concrete work, steel erection and welding among others, construction workers will be exposed to risks of accidents and injuries. Such injuries can result to trip and falls, injuries from hand tools and equipment cuts from sharp edges of metal sheets among others. This impact is rated moderate.

- **Drainage**

Drainage structures to be designed shall include pipe culverts, box culverts and drains/ditches. Lack of drainages may increase the chances of soil erosion as with the current status of the project area. However, the proposed project shall provide drainages that will address drainage issues in the study area. This impact is beneficial to the project affected communities.

- **Groundwater contamination**

Construction equipment generates large amounts of waste oil and its proper handling is critical. Haphazard storage and leakage can result in the contamination of soils and ground waters. Oil products can also lead to contamination of surface and groundwater if there is a lack of fuelling, maintenance and servicing protocol for construction machinery at the project site. Pollution of water resources by oil-based pollutants from trucks and construction machinery during construction works could cause health problems for the population downstream. This impact is major.

- **Solid Waste**

Construction will result in the creation of various solid wastes, principally surplus earth (spoil) and rock (soil debris), metal scraps, plastics (wrappings and containers), cardboard, paper, wood, office wastes including e.g. used toner cartridges, kitchen (canteen) wastes, workshop wastes including e.g. used oil filters, and waste concrete. This can be a nuisance and the site should therefore be kept clean, neat and tidy at all times. No burying or dumping of any waste materials, vegetation, litter or refuse shall be permitted. The Contractor shall implement measures to minimize waste. Overall impact significance is therefore moderate.

- **Wastewater and contaminated water management**

During the construction phase, various liquid wastes including grey and black water (respectively washing water and sewage), concrete washings, runoff from project yard and workshop areas, and various liquid waste streams from washing construction equipment washing will be generated. These wastes pose real toxicity and quality threats to the soil and ground water, as well as existing wetlands within the area. Overall impact significance is therefore moderate.

- **Discrimination on Employment Opportunities**

Most of the skilled labourers will have to be brought in from outside the project area, and this may cause some resentment among the local people. Generation of employment opportunities by the project could result into conflict between local residents and new comers or outsiders, if not appropriately managed. A concern expressed during consultations was that unskilled labour may be available to men more than women leading to gender discrimination. Overall impact significance is therefore moderate.

- **Occupational Health and Safety**

Construction phase may involve employment of hundreds of workers in site, increasing chances of workplace accidents, injuries and illnesses. It will thus be paramount that the contractor adheres to best practices in occupational health and safety. Overall impact significance is therefore moderate.

- **Social Disruption**

Construction activities will cause some degree of disruption to social order within the project area, and specifically around the Contractors project yard. Managing the welfare of a significant number of workers is inevitably a major challenge, and the co-existence of multiple contractor crews of workers from diverse cultural and geographic backgrounds can be a challenge. During construction, the contractor will be required to implement measures to protect the welfare of the community. This should be achieved via application of a grievance mechanism, which must be developed prior to the construction programme. Overall impact significance is therefore moderate.

- **Impact on Infrastructure**

The influx of engaged workers and job seekers will lead to increased demand for goods and services and will cause some pressure on existing infrastructure such as housing, educational facilities, roads, hospitals and others in the study area. As has been observed on other similar projects in Nigeria, local residents may lease their houses to migrants and there will be an increase in road traffic, which will further put some pressure on the existing roads. Overall impact significance is therefore moderate.

- **Employment Opportunities**

Creation of employment opportunities has both economic and social benefits. During the construction period, new jobs will be created in the form of skilled and unskilled labour. A majority of unskilled labour will be sourced from the local residents. Indirect employment will be in the form of suppliers and other forms of sub-contracted works that will be required for construction. Support businesses such as food kiosks may also grow near the project office and along the road corridor. This is a major positive impact.

- **Skills Transfer and Training**

Through labour recruitment locally the workers will have an opportunity to learn an array of skills that relate to road construction and ancillary works. Improved transport will improve interaction with other communities that will also provide an opportunity for further learning and cultural exchange. This is a major positive impact.

- **Gains in the Local and National Economy**

There will be gains in the local and national economy as a result of the construction of this proposed Project, through the consumption of locally available materials including: timber, metals and cement. The consumption of these materials in addition to fuel oil for the machines to be used at the site and others will attract taxes including Value Added Tax (VAT) and Income Tax which will be payable to the government. The cost of the materials will be payable directly to the suppliers. This is a major positive impact.

- **Provision of Market for Supply of Construction Materials**

The proposed project shall require the supply of large quantities of materials most, of which will be sourced locally in and surrounding areas. This provides a market for material suppliers such as quarry companies, sand, wood, cement, paints and roofing material dealers as well as other dealers of building materials and local food sellers. The impact is rated significant and positive. This is a positive significant impact.

5.8.3 Potential Impacts of the CNG Plant and Power Plant Operations

The operation of the proposed CNG plant and power plant project will have various positive impacts on the region. One major benefit is the improved power supply, which will support industrial activities and stimulate economic growth in the area. This is a significant positive impact, as it contributes to regional development and energy security.

Furthermore, the project will create employment opportunities by hiring personnel for roles such as management, maintenance, security, and technical operations. These job opportunities will enhance local livelihoods, increase income levels, and support community welfare, marking another significant positive contribution.

The project will also lead to infrastructure development, including the improvement of social amenities and the stimulation of ancillary businesses. These enhancements will contribute to long-term economic development in the area.

However, the operation of the plant will introduce air emissions, including dust, nitrogen oxides, sulfur oxides, carbon monoxide, volatile organic compounds (VOCs), and particulates from fuel combustion. While the emissions are anticipated to be within permissible limits due to the use of cleaner fuels like natural gas, their impact is considered low.

Similarly, greenhouse gas (GHG) emissions, such as CO_2 and methane, will be inevitable due to fuel combustion, venting, and flaring. OISL's commitment to environmental stewardship includes adopting mitigation measures, such as improving energy efficiency and utilizing advanced technologies, to minimize these emissions.

Despite these benefits, there are potential negative impacts. Noise and vibration levels are expected to rise due to operational activities, vehicular movement, and equipment usage. These disturbances are anticipated to be moderate but may affect local residents if unmanaged. Additionally, the risk of accidents, including fuel spills, chemical leaks, fires, and vehicular incidents, poses a significant concern.

The influx of people during operations could exacerbate these risks. To address these challenges, stringent safety protocols, emergency response plans, and proper waste management systems will be implemented to mitigate hazards and ensure the safety of workers and the surrounding community.

5.8.4 Decommissioning

- **Air Pollution due to Dust Emission**

The demolition will inevitably generate dust in the atmosphere. Furthermore, the land levelling and grading while reinstating the area close to its natural condition will also generate dust in the atmosphere as well as transportation of debris and other unwanted materials from the site. Dust generated will impair local atmospheric conditions. The impact receptors are likely to include site workers and nearby communities as well as people/communities along the route where the spoil will be disposed of. The likelihood of public health concerns for onsite activities is minimal due to the distance to the nearby settlement.

- **Air Pollution due to Exhaust Emission**

The trucks and earth-moving equipment will be used for demolition works that will emit exhaust fumes which are unwanted atmospheric pollutants. Atmospheric pollutants from engines of vehicles/machinery include SO_2, NOx, CO_2 and particulate matter. The main impact is the impairment of local air quality, the extent of which will depend on quantities emitted, duration and prevailing atmospheric conditions. However, for demolition works to be involved the equipment to be involved will be fewer compared to during construction.

- **Noise Pollution from Demolishing Works**

The exercise will inevitably result in the generation of noise the aspect of which might create hazardous conditions for the receptors. However, the sensory receptors which are the nearby communities around the facilities may be impacted by the noise from the demolition work. Nevertheless, the workers within the power plant will be exposed to the excessive noise levels generated, the aspect of which is covered under occupational health and safety hazards below.

- **Waste Pollution from Hydrocarbons (oil, fuel, lubricants)**

If refuelling, servicing and maintenance of large vehicles and machines will take place at the demolition site, there will be fuel and lubricants involved. This will create the opportunity for accidental spills of hydrocarbons and contaminants could be washed into the environment and thus contaminate the site and eventually could be washed by rainwater to the nearby water bodies.

- **Occupational Health and Safety Hazards**

The demolition works and reinstating the site close to its natural condition will result in various occupational health and safety hazards which if care is not taken might result in long-term health effects, injuries, fatal and loss of life as well as damage to properties. Some of the hazards are obvious and require some management; issues like excessive noise levels from the machinery, and excessive dust emission from earthworks. Injuries to construction workers may result from moving equipment. Causes of accidents include but are not limited to poor site layout; poor erection and improper use of scaffolds; falling objects from high levels such as poles; improper method of lifting; sharp edges; improper use of Personal Protective Equipment (PPE); inadequate provisions of PPE; falling through uncovered openings, especially at upper floor levels and carelessness of workers.

CHAPTER SIX

MITIGATION MEASURES FOR ASSOCIATED AND POTENTIAL IMPACTS

6.0 Introduction

This Chapter is designed to ensure that suitable procedures or mitigation measures are provided to corresponding manage/reduce the identified associated and potential impacts of the proposed project to a level as low as reasonably practicable throug1hout the life cycle of the project. The identified potential and associated impacts of the proposed power project have been identified and evaluated while the impacts significance (adverse and beneficial) have also been discussed in chapter five. Consequently, the mitigation and enhancement measures for the adverse and beneficial impacts of the proposed project are presented in this chapter. This chapter therefore presents the mitigation, enhancement and/or alternative measures for the adverse and beneficial impacts of the proposed climate smart in pond raceway systems and aquaculture/fisheries farmers livelihood project

6.1 Mitigation Hierarchy

Mitigation Measures come with a variety of levels, and these are commonly called "mitigation hierarchy. "The mitigation hierarchy consists of steps aimed at preventing, eliminating or minimizing the environmental and social impacts of a proposed project to levels that are considered as low as reasonably practicable (ALARP). In proffering mitigation measures, the primary objectives are summarized in Table 6.1 below:

Table 6.1: The Mitigation Hierarchy

Step	Focus
Avoidance	Methods aimed at impeding the occurrence of negative impacts, and/or preventing such occurrence from having harmful environmental/ social outcomes.
Minimize	Impact cannot be completely side-stepped; so, take steps to ensure minimal damage is done to the environment.
Rectify	Implies that the impact has already happened so do damage control

Reduce	Reduce the extent of the impact through management practices and/or change
Environmental Offset	Actions taken outside of the development site to compensate for the impacts in the development site. In effect, this means that the development undertaker carry out environment conservation activities to compensate for what they do in order to achieve "no net environment loss", or more specifically "no net biodiversity loss".

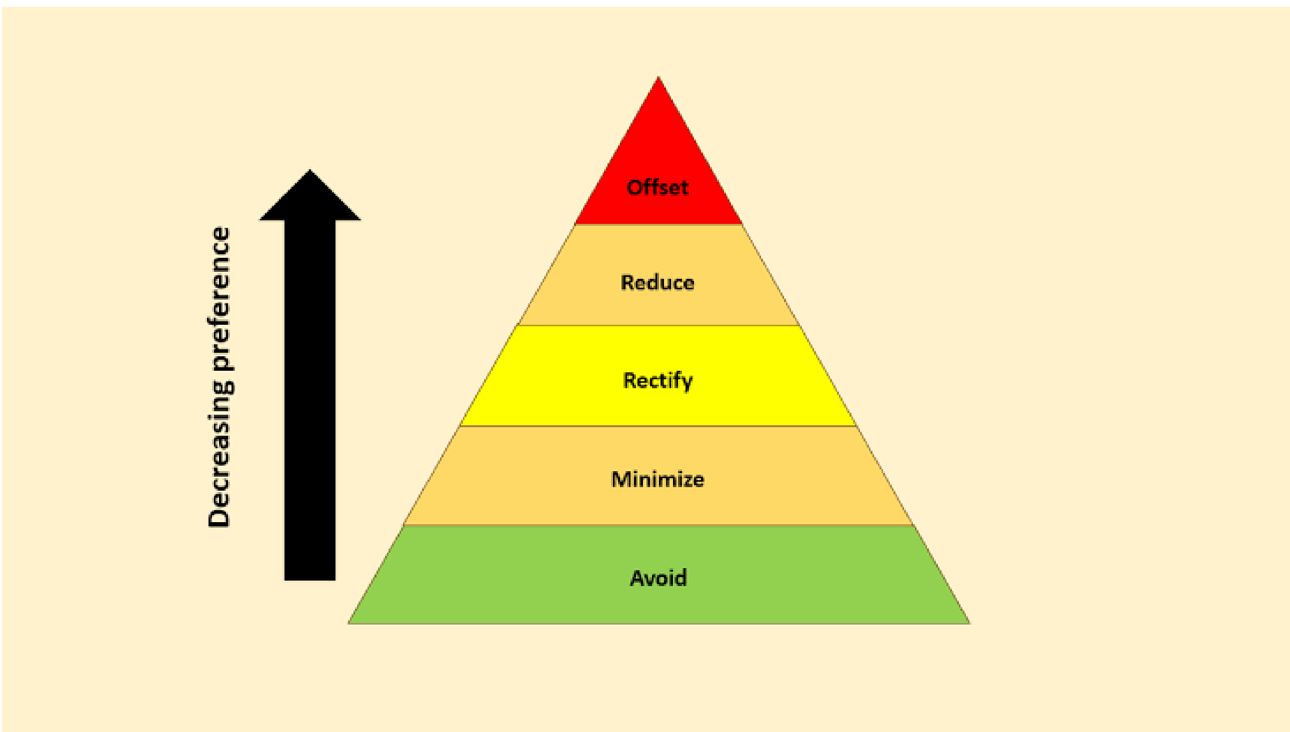

Figure 6.1: The Elements of Mitigation

The framework for determining the form of mitigation measures to be applied for the significant impacts identified for the project is shown in Figure 6.1 below. The frequency, severity, sensitivity, scale, magnitude and nature of the impacts were taken into consideration in the assessment.

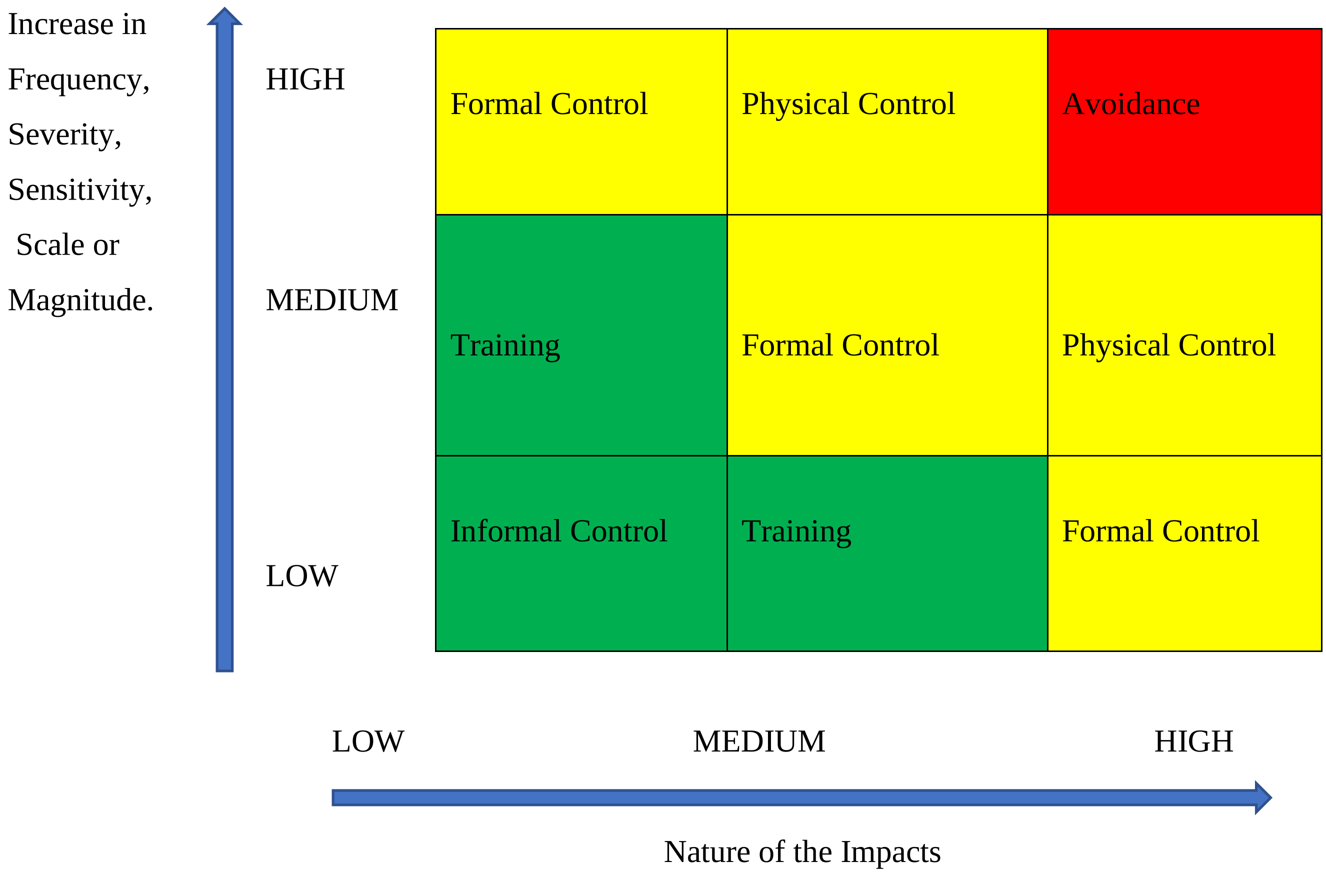

Figure 6.2: Mitigation Definition Criteria for negative impact

Informal Control

This involves the application of sound judgment and best practice in mitigating the impacts of the of the project activities.

Formal Control

This involves the application of documented policy, process or procedure in mitigating the impacts of the project activities. It ensures that residual associated impacts are reduced to an acceptable level.

Physical Control

This involves the application of physical processes, barriers or instruments (pegs, fence, gates, sign post etc.), not necessarily requiring any special technology in order to mitigate the impacts of the project.

6.2 Proffered Mitigation Measures

Accordingly, this section presents the mitigation measures proffered for the identified impacts of the proposed CNG and Power Plant Project. The measures also considered the environmental laws in Nigeria, and internationally and the principles of sustainable development and best available technology. Most of the likely impacts due to the proposed project have been considered in the design and selection of equipment. The mitigation measures recommended in this section may not be exhaustive. However, they are considered adequate to effectively ameliorate or in some cases, eliminate the negative impacts that may arise in this project. From the assessment undertaken, if the measures are applied, all minor and moderate negative impacts will be reduced significantly and will leave, in most cases, negligible and minor residual impacts. However, for accidental occurrences such as fire outbreak and electrocution, the residual impact would still remain major, given the costly and sometimes irreversible effect of its occurrence. In order to verify these assertions, and to ensure that the measures are effective, it is necessary to have in place a sound and cost-effective Environmental and Social Management Plan (EMP), presented in Chapter Seven of this report. The proffered mitigation measures for the identified potential and associated impacts are presented in Table 6.2 below.

Table 6.2: Proffered Mitigation Measures for the proposed Project.

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
Pre-construction	Land Acquisition	• Community agitation over compensations, land disputes, wrong stakeholder identification and leadership tussles.	**MEDIUM**	Obodofei shall: • Ensure relevant stakeholders are identified. • Ensure that early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed.	**LOW**
		• Lobbying, agitations for jobs, employment and contractual agreement by local workers.	**MEDIUM**	Obodofei shall: • Ensure that project will develop a community relations and engagement plan that identifies fair strategies of engagement for all communities • Ensure that early stakeholders' engagement sessions are held, and all agreed issues properly documented and signed.	**LOW**
		• Exclusion of vulnerable groups from consultations which may lead to strife.	**MEDIUM**	Obodofei shall: • Establish and publicize grievance procedure. • Maintain good cooperative relation with the local community.	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
	Employment of both Skilled and Unskilled workers	• Conflicts/community agitations over employment issues (quota and methods).	**MEDIUM**	Obodofei shall : • Implement grievance procedure. • Ensure Pay due wages for worked period and settle all financial commitments to workforce.	**LOW**
		• Increase in social vices (crime rate, prostitution, device, polygamous marriage etc),	**HIGH**	Obodofei shall: • Maintain ongoing cordial relationships with the stakeholder communities. • Sex education and danger of multiple sex partners' awareness shall be created. • Certify government approved security could engage to coup crime rate.	**MEDIUM**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
	Mobilization of equipment and personnel to site	• Increase of dust particles and vehicular emissions Nuisance (noise and vibrations) due to movement from heavy duty equipment and vehicles affecting site workers	**MEDIUM**	Obodofei shall: • Ensure that noise attenuation measures such as installation of acoustic mufflers on large engines • Raise public awareness of unusual activity • Ensure that any Plan activities does not exceed Regulatory limits. • Use fuel efficient and well-maintained haulage trucks with proper exhaust system. • Ensure that vehicles on the site with engines turned off; • Service vehicles as at when due and stick to manufacturers‟ specifications in use • Develop and follow a controlled fuelling, maintenance and servicing protocol • Ensure that covering of vehicles carrying fine grade materials • Ensure releases are in compliance with National and International Regulation	**LOW**
		• Increased pressure on existing social infrastructure	**MEDIUM**	Obodofei shall: • Provide basic amenities and also perform CSR	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		• Increased social vices.	**HIGH**	Obodofei shall: • Maintain ongoing cordial relationships with the stakeholder communities. • Sex education and danger of multiple sex partners' awareness shall be created. • Certify government approved security could engage to coup crime rate.	**MEDIUM**
		• Increase of communicable diseases due to influx of people	**MEDIUM**	Obodofei shall: • Carry out health awareness program (malaria, corporate stop AIDS program, etc.) • Provision of site medical personnel to attend to emergency situations • Engage the services of retainer clinics to manage health issues • Educate workforce on the prevention of malaria as well as encourage the use of mosquito nets in construction camp • Ensure its personnel and contractors undergo pre-employment background screening as required Periodically discuss health and social education issues during toolbox/SHE meetings	**LOW**

Project Phase	Project Activities	Potential/Associated Impacts	Rating before mitigation measures	MITIGATION MEASURES	Rating after mitigation measures
		• Increased traffic during mobilization on road with risk of accidents leading to injury/death and loss of asset	**MEDIUM**	Obodofei shall: • Develop a traffic management and provide adequate safety and caution signs e.g. speed control, warning signs, etc. • Defensive driving training and brief workers on safety precaution, their responsibility for their safety and the safety of others; • Provide adequate instructional and warning HSE signs;	**LOW**
	Clearing of vegetation and other debris	▪ Loss of vegetation in the project area.	**MEDIUM**	Obodofei shall: • Ensure clearing of vegetation is systematically carried out in areas where work is to be done. • Ensure conservation of endangered and medicinal/economic plant species. • Ensure adequate percentage of the tree/plant are left to serve as carbon sink. • Ensure that removed vegetation and earth should be piled up for later return during demobilization.	**LOW**
		▪ Loss of wildlife, their habitat and migration of wildlife.	**MEDIUM**	Obodofei shall: • Avoid damage to flora and fauna by machinery and workers. • Ensure conservation of endangered species and slow crippling animals.	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		• Exposure of soil surface to the climatic elements and triggering of erosion.	**MEDIUM**	Obodofei shall Ensure prompt landscaping and planting of vegetation (native species).	**LOW**
		• Soil degradation e.g. compaction of soil as a result of the movement of earth moving equipment	**MEDIUM**	Obodofei shall: • Control the earth works and ensuring the management of excavation activities. Compacting areas with loose soil • Prevent pollution from construction wastes by installation and configuration of drainage structures to ensure their efficiency	**LOW**
		▪ Injuries from animal attacks (snakes bites and insects stings).	**MEDIUM**	Obodofei shall: • Ensure that approved safe work procedures are provided and complied with at all times • Ensure that the use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site Limit work activities to daytime only.	**LOW**
		▪ Injury from equipment usage during vegetation clearing.	**MEDIUM**	Obodofei shall: • Ensure that approved safe work procedures are provided and complied with at all times • Ensure that the use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		▪ Domestic and Sanitary Waste Generation	**MEDIUM**	Obodofei shall: • Develop project specific waste management plan and ensure proper implementation • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory waste management requirements.	**LOW**
Construction/Installation	Civil works activities such as construction of buildings, Installation of public utilities, Installation of electricity power and	• Increased cost of living due to inflation arising from increased demands.	**MEDIUM**	Obodofei shall: • Provide basic amenities and also perform CSR.	**LOW**

Project Phase	Project Activities	Potential/Associated Impacts	Rating before mitigation measures	MITIGATION MEASURES	Rating after mitigation measures
	CNG Processing infrastructure , transportation and logistics etc.	• Increase in social vices	**HIGH**	Obodofei shall: • Maintain ongoing cordial relationships with the stakeholder communities. • Sex education and danger of multiple sex partners' awareness shall be created. • Certify government approved security could engage to coup crime rate. •	**MEDIUM**
		▪ Decrease in air quality as a result of emissions/dust from vehicles and equipment.	**MEDIUM**	Obodofei shall: • Ensure that vehicles on the site with engines turned off; • Service vehicles as at when due and stick to manufacturers‟ specifications in use • Develop and follow a controlled fuelling, maintenance and servicing protocol • Ensure releases are in compliance with National and International Regulation	**LOW**
		▪ Loss of flora and fauna	**MEDIUM**	Obodofei shall: • Ensure inclusion of threatened and endangered species management strategies in the site specific Environmental Management Plan to be developed by contractors to ensure appropriate flora and fauna management. • Ensure that vegetation clearing will be limited to minimum area required for work	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		▪ Noise nuisance (including impulsive noise) from construction activities, resulting to temporal migration of sensitive mammals and rodents	**MEDIUM**	Obodofei shall: • Ensure that noise attenuation measures such as installation of acoustic mufflers on large engines • Raise public awareness of unusual activity • Ensure that any Plan activities does not exceed Regulatory limits.	**LOW**
		▪ Groundwater contamination resulting from accidental leakages and spill of hazardous substances (diesel, lubricants ,hydraulic oil etc)	**MEDIUM**	Obodofei shall: • Develop project specific waste management plan and ensure proper implementation • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory waste management requirements.	**LOW**
		▪ Workplace accidents from burns, cuts, bruises, trips and falls, object at height leading to injury of fatalities.	**MEDIUM**	Obodofei shall: • Ensure that approved safe work procedures are provided and complied with at all times • Ensure that the use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site Limit work activities to daytime only.	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		▪ Risks injury/death and loss of assets resulting from accidents associated with road transportation to and fro construction sites	**MEDIUM**	Obodofei shall: • Develop a traffic management and provide adequate safety and caution signs e.g. speed control, warning signs, etc. • Defensive driving training and brief workers on safety precaution, their responsibility for their safety and the safety of others; • Provide adequate instructional and warning HSE signs;	**LOW**
		▪ Reduction in environmental aesthetics value due to indiscriminate disposal of wastes.	**MEDIUM**	Obodofei shall: Ensure compliance with contract General Health, Safety, and Environment code of contract code and relevant regulations.	**LOW**

Project Phase	Project Activities	Potential/Associated Impacts	Rating before mitigation measures	MITIGATION MEASURES	Rating after mitigation measures
		▪ Soil degradation and possibly accelerated erosion	**MEDIUM**	Obodofei shall: • Control the earth works and ensuring the management of excavation activities. Compacting areas with loose soil • Prevent pollution from construction wastes by installation and configuration of drainage structures to ensure their efficiency • Install cascades to break the impact of water flowing into the drains • Adequate landscaping in the project site. • Provide soil erosion control structures on the steeper areas of the site & controlling activities during the rainy season.	**LOW**
		▪ Reduction in structural stability and percolation ability of the soil.	**MEDIUM**	• Obodofei shall: • Install cascades to break the impact of water flowing into the drains • Adequate landscaping in the project site. Provide soil erosion control structures on the steeper areas of the site & controlling activities during the rainy season.	**LOW**
		▪ Traffic congestion during transportation of demobilized equipment and personnel	**MEDIUM**	Obodofei shall: • Develop journey management for trucks and other vehicular movement. • Ensure Movement shall be carried out off-peak period. • Ensure that all personnel are qualified and certified for their relevant works	**LOW**

Project Phase	Project Activities	Potential/Associated Impacts	Rating before mitigation measures	MITIGATION MEASURES	Rating after mitigation measures
		▪ Restriction of access roads to prevent unauthorized uses	**MEDIUM**	Obodofei shall ensure road traffic personal/flag men at strategic locations	**LOW**
		▪ Potential collapse of civil structures on land as a result of unstable geotechnical conditions	**HIGH**	Obodofei shall: • Conduct proper geotechnical survey • Conduct proper risk assessment prior to commencement of work • Prioritize HSE	**MEDIUM**
		▪ Increase in social vices and kidnapping	**HIGH**	Obodofei shall: • Ensure implementation of project security plan during decommissioning • Maintain ongoing cordial relationships with the stakeholder communities. • Certify government approved security guards are used on demobilization vehicles when warranted • Implement effective journey management plan	**MEDIUM**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		• Visual intrusion as a result of alterations from accidental ignition of onsite diesel storage tanks.	**MEDIUM**	Obodofei shall: • Ensure that approved safe work procedures are provided and complied with at all times • Ensure that the use of appropriate personal protective equipment (PPE) e.g. rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site	**LOW**
Operation	Operation and Maintenance	Noxious gas emmison	**MEDIUM**	Obodofei shall: • Install continuous emission monitoring systems (CEMS) • Optimize combustion processes to ensure efficient fuel utilization. • Consider adopting advanced combustion technologies such as lean-burn combustion or selective catalytic reduction (SCR) systems. • Implement effective air inlet filtration systems to prevent the ingress of particulate matter into the gas turbine. • Conduct regular maintenance and inspections of the gas turbine components to ensure optimal performance. • Implement efficient cooling systems for various components of the gas turbine to reduce the amount of water vapor released into the atmosphere, which contributes to visible plumes and potential environmental impacts.	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		• OHS Risk	**HIGH**	Obodofei shall: • Train and brief workers on safety precaution, their responsibility for their safety and the safety of others; • Provide adequate instructional and warning HSE signs; • Ensure compliance with contract General Health, Safety, and Environment code of contract code and relevant regulations. • Develop a traffic management and provide adequate safety and caution signs e.g. speed control, warning signs, etc.	**MEDIUM**
		▪ Increase of human interactions leading to diseases/ infections such as transmission of sexually transmitted diseases (STI's) and other communicable diseases	**MEDIUM**	Obodofei shall; • Enhancing education and sensitisation of workers and the local communities on the dangers and prevalence of disease; Regular sensitisation campaigns and monitoring of the spread diseases • Promote public health and education;	**LOW**

Project Phase	Project Activities	Potential/Associated Impacts	Rating before mitigation measures	MITIGATION MEASURES	Rating after mitigation measures
		Noise Generation	**MEDIUM**	Obodofei shall: • Ensure that noise attenuation measures such as installation of acoustic mufflers on large engines • Raise public awareness of unusual activity • Ensure that any Plan activities does not exceed Regulatory limits.	**LOW**
		Pressure on existing infrastructure.	**MEDIUM**	Obodofei shall: Provide basic amenities and also perform CSR	**LOW**
		▪ Increased social vices.	**MEDIUM**	Obodofei shall: • Maintain ongoing cordial relationships with the stakeholder communities. • Sex education and danger of multiple sex partners' awareness shall be created. • Certify government approved security could engage to coup crime rate. • When necessary Obodofei shall activate its emergency response procedure • Implement effective journey management plan	**LOW**

Project Phase	Project Activities	Potential/Associated Impacts	Rating before mitigation measures	MITIGATION MEASURES	Rating after mitigation measures
Decommissioning and closure	Demobilization of equipment and personnel from site after project lifespan.	▪ Loss of employment	**HIGH**	Obodofei shall: • Ensure skills acquisition and enhancement programs to further empower the workforce for meaningful employment opportunities after the project • Establish and publicize grievance procedure to pay due wages for worked period and settle all	**MEDIUM**
		▪ Risk of accident and injury to workers during demolition of structures	**HIGH**	Obodofei shall: • Ensure that approved safe work procedures are provided and complied with at all times • Ensure that the use of appropriate personal protective equipment (PPE) e.g., rubber hand gloves, hard hats, safety boots, etc. by all personnel at the project site.	**LOW**
		▪ Traffic obstruction from transportation of decommissioned structures and equipment.	**HIGH**	• Obodofei shall: Develop journey management for trucks and other vehicular movement. • Ensure Movement shall be carried out off-peak period. • Ensure that all personnel are qualified and certified for their relevant works	**MEDIUM**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		▪ Waste generation and management.	**HIGH**	S Obodofei shall: • Develop project specific waste management plan and ensure proper implementation • Provide adequate containers for waste collection • Periodically assess contractor activities to check the level of compliance to regulatory waste management requirements.	**MEDIUM**

Project Phase	Project Activities	Potential/Associated Impacts	Rating before mitigation measures	MITIGATION MEASURES	Rating after mitigation measures
		▪ Emission of dust, exhaust fumes/noxious gases from vehicles, and increased ambient noise level.	**HIGH**	Obodofei shall: • Sprinkling water on soil before excavation and periodically when operations are under way to prevent raising of dusts. Increase frequency of sprinkling during windy days. Enclosing the structures under construction with dust proof nets. • Minimize vehicular movement with a planned scheduling to reduce the emission of pollutants. • Ensure the use efficient machines with low emission technologies for the ones that burn fossil fuels. Controlling the speed and operation of construction vehicles. • Ensure the reuse of excavated material within the boundary of project site while limiting the movement of cut and fill material. • Ensure sprinkling water on the soil to prevent dust from rising. Creating specific paths for the truck • Ensure that vehicles on the site with engines turned off; • Service vehicles as at when due and stick to manufacturers" specifications in use	**LOW**

Project Phase	**Project Activities**	**Potential/Associated Impacts**	**Rating before mitigation measures**	**MITIGATION MEASURES**	**Rating after mitigation measures**
		• Loss of revenue earner for state and federal government.	**HIGH**	Obodofei shall: • Ensure skills acquisition and enhancement programs to further empower the workforce for meaningful employment opportunities after the project thereby serve as revenue for government.	**MEDIUM**

6.3 SUMMARY

To mitigate the potential air emissions from the proposed CNG processing and power plant project, advanced emission control technologies will be employed. These include low-NOx burners and efficient combustion systems to minimize the release of nitrogen oxides, sulfur oxides, and carbon monoxide during operations. Regular maintenance of equipment and monitoring of emissions will ensure compliance with environmental standards.

To address greenhouse gas (GHG) emissions, the plant will adopt energy-efficient designs, implement flaring minimization strategies, and use leak detection and repair (LDAR) programs to control methane emissions. Additionally, carbon offset initiatives, such as reforestation or investment in renewable energy projects, will be explored to further reduce the plant's carbon footprint.

Noise and vibration impacts will be mitigated by installing noise barriers and using equipment with lower noise profiles. Operating schedules will be optimized to reduce the impact on nearby communities. Vibrations from heavy machinery and operations will be managed by isolating vibrating equipment and conducting periodic assessments to ensure compliance with safety limits. The plant will also engage with local stakeholders to communicate expected noise levels and seek feedback to improve mitigation strategies.

To reduce the risk of accidents and hazards, the project will implement comprehensive safety measures, including the development of an Emergency Response Plan (ERP) and regular safety drills. Storage and handling protocols for hazardous materials, such as fuel and chemicals, will follow international safety standards. Spill containment systems and fire suppression equipment will be installed on-site. Training programs for workers on safety protocols, hazard awareness, and emergency response will be conducted regularly. Additionally, the influx of people to the area will be managed through community engagement initiatives to minimize social risks and ensure the safety of both workers and local residents.

The future integration of a combined-cycle configuration with a steam turbine will improve the power plant’s thermal efficiency, reducing CO_2 emissions per unit of electricity generated. Additionally, advanced systems for methane monitoring and leak detection can help minimize CH_4 emissions, which have a much higher global warming potential than CO_2. Using AI-driven optimization technologies and energy-efficient equipment further reduces GHG emissions by enhancing operational efficiency and reducing energy wastage.

CHAPTER SEVEN
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 Introduction

This Environmental and Social Management Plan (ESMP) has been developed for the proposed Power Plant project by Obodofei Integrated Services Limited (OISL). The ESMP includes the set of mitigation, monitoring and institutionalized measures to be carried out in the course of the proposed project implementation.

The ESMP developed for the proposed project is a "living document" that shall be reviewed periodically with the incorporation of various mitigation measures for potential impacts and shall form the basis for the actual project implementation. It outlines management strategies for safety, health and environment stewardship in the proposed project implementation. It states in specific terms how the project proponent's commitments will be implemented to ensure sound environmental practice.

The ESMP assures that the mitigation measures are adequate to reduce the effects of potential adverse impacts to *As Low As Reasonably Practicable (ALARP)* as well as enhance the proposed beneficial impacts throughout the project lifecycle. Compliance with the legal standards on safety and environment is regarded as the minimum requirement and must be satisfied during all phases of the Project development. To reduce the risk of an adverse effect on the environment to the lowest level that is reasonably practicable, the engineering design objective will apply to the ALARP principle. Figure 7.1 illustrates this principle in detail.

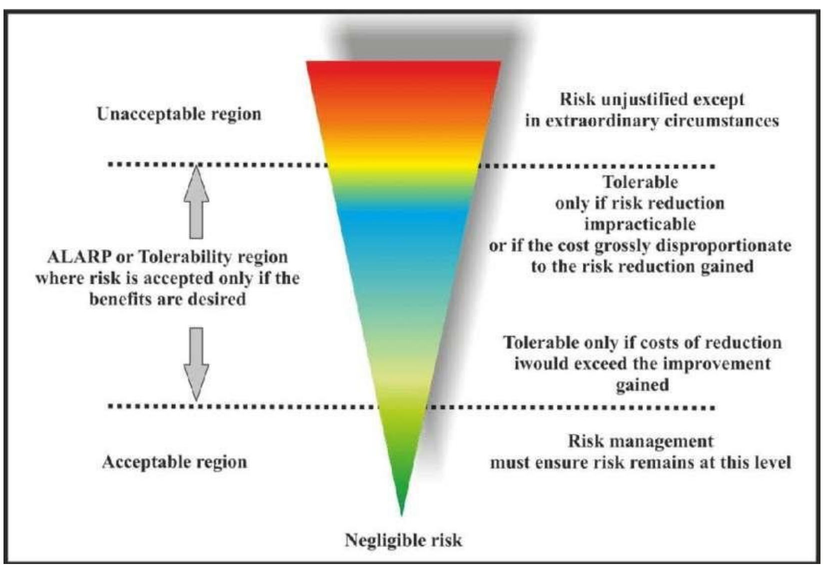

Figure 7.1: Level of Risk and ALARP

The ESMP for the construction and operations of the proposed project is designed in line with its Environmental & Social Governance (ESG) policy and in accordance with ISO 45001 Occupational Health and Safety Management. The ESMP is, therefore, an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of construction, operation and decommissioning are prevented and that the positive benefits of the projects are enhanced. Having this framework in place ensures a systematic approach to bringing environmental and social considerations into decision-making and day-to-day operations. It establishes a framework for tracking, evaluating and communicating environmental and social performance and helps ensure that environmental risks and liabilities are identified, minimised and managed effectively.

7.2 Objectives of the ESMP

The ESMP is designed to:

- Ensure progressive reduction of the impacts of the project activities on the biophysical, socioeconomic and health environment with the ultimate aim of eliminating them;
- Ensure that all mitigation and enhancement measures prescribed during the impact assessment process for eliminating or minimizing the adverse project impacts as well as optimally enhancing the beneficial impacts are fully implemented; and
- Provide part of the basis and standards needed for overall planning, monitoring, auditing and review of environmental and socio-economic performance throughout the project life cycle.

These objectives shall be achieved by:

- Ensuring compliance with all stipulated legislation on the protection of the environment and health, safety and environment policies;
- Integrating environmental issues fully into the project development and operational philosophies;
- Promoting environmental management awareness among workers;
- Rationalizing and streamlining existing environmental activities to add value to efficiency and effectiveness;
- Ensuring that only environmentally sound procedures are employed during the project;

- Continuous consultations with the relevant regulatory bodies, community leaders, youth leaders, community-based organizations (CBOs), and other stakeholders throughout the project's lifecycle.

7.3 Scope of ESMP

Obodofei Integrated Services Limited recognizes the need for the development of an effective ESMP to facilitate better achievement and demonstration of sound environmental performance. Furthermore, environmental management is seen as the means to ensure that the commitments specified in this report are properly managed and that unforeseen or unidentified impacts of the proposed development are detected. Thus, Obodofei Integrated Services Limited has designed the ESMP for the proposed project in line with its Environmental & Social Governance (ESG) policy and in accordance with *ISO 14001:2015* Environmental Management System specifications.

The principles adopted for developing the project ESMP are:

Protect and Enhance the Environment

- Value and protect the diversity of nature, including limiting pollution to levels which do not damage natural systems;
- Use energy, water and other natural resources efficiently and with care, including minimizing, re-use or recovering through recycling of waste and sustainable disposal of waste

Promote Economic Success

- Create a vibrant local economy that provides satisfying and rewarding work without harm to the local, national or global environment;
- Encourage necessary access to facilities, services, goods and other people in ways that minimize impacts on the environment

Meet Social Needs

- Protect human health and amenities through safe, clean, pleasant environments and emphasize health services focused on prevention as well as care;

- Empower all sections of the community to participate in decision-making and consider the social and community impacts of the decision.

Thus, the ESMP is a dynamic working tool and shall take into consideration possible changes in prevailing circumstances, environmental regulations, guidelines and policies. In the event of new policies or guidelines from the Regulators such as the Federal Ministry of Environment (FMEnv), the Ministry of Power as well as other relevant Federal or State government agencies, this document shall be reviewed to reflect these changes. The ESMP shall be updated and revised, if necessary, during the project life cycle to incorporate better environmental technologies, management systems and economic policies.

7.4 ESMP Responsibility and Structure (Management Organization)

OISL is committed to providing resources (both human and capital) essential to the implementation and control of the ESMP. The proposed project activities are based on OISL Construction operations, maintenance and ESG/HSE philosophies as well as relevant technical specifications, in accordance with standard organizational arrangement. OISL shall work closely with the Federal and State Ministry of Environment to ensure that all environmental standards are upheld as agreed upon.

The roles and responsibilities for the implementation of the ESMP are presented in Table 7.1 below:

Table 7.1: Roles and responsibilities for the implementation of the ESMP

S/N	Responsible Parties	Roles and Responsibilities
1.	Obodofei Integrated Services Limited	Responsible for assuring that all the workers involved in the project have the resources, information and authority to implement the management measures described in this ESMP.
2.	Environmental Consultant	Responsible for undertaking the ESIA study of this project; and guiding for implementing the ESMP.
3	HSE Manager	Responsible for the corporate environmental and social responsibilities of the proposed project.

S/N	Responsible Parties	Roles and Responsibilities
4.	Community Liaison Officer (CLO)	Responsible for stakeholders' engagement on issues relating to this project.
5.	Contractor(s)	• Responsible for implementation of the ESMP while carrying out the various activities of the project. Furthermore, the contractors shall conduct safety inspections of equipment as well as the working conditions of the contracted workers. • Responsible for Supervising all the activities in the departments/project area for a good working environment.
6.	External Regulators (FMEnv, SMEnv)	Responsible for monitoring the implementation of ESMP.

7.5 Framework for Implementing the ESMP

The framework for the implementation of this ESMP is strongly based on a repeated process of continuous improvement which comprises eleven (11) elements, each with underlying principles and set expectations. An overview of each of the eleven primary elements is presented as follows.

- Management Leadership, Commitment, and Accountability: Ensures that the workers understand the goals and management commitment to excellence in safety, health, environment and operational integrity.
- Risk Assessment and Management: Ensures that risks involved in operations are recognized so that they can be appropriately addressed through facility design and/or operating practices.
- Facilities Design and Construction: Ensures elements for the protection of people and the

environment are incorporated into the design of facilities and the plans for installation and operation.

- Facilities Information/Documentation: Ensures that the systems designed to protect people and the environment are appropriately documented.
- Personnel and Training: Ensures that personnel understand the systems that are in place and are appropriately trained to perform required roles with respect to their functions.
- Operations and Maintenance*:* Ensures that facilities are maintained and operated in ways that ensure the protection of people and the environment.
- Management of Change: Ensures that new personnel are informed of existing systems and all affected personnel are informed of changes in the systems, as well as safety and environmental aspects are considered when making changes.
- Third-Party Services: Through contract, oversight and other mechanisms, third-party contractors are held to the same standards as OISL.
- Incident Investigation and Analysis: Seeks to understand the causes of any incidents so that effective controls or systems can be implemented to prevent recurrence.
- Community Awareness and Emergency Preparedness: Ensures appropriate outreach and awareness programmes are implemented to establish effective emergency procedures and to allay concerns.
- Operations Integrity Assessment and Improvement: Ensures that the safety and environmental performance is monitored against targets to ensure OISL meets its goals to protect people and the environment and seeks the means to improve the systemsand processes, particularly when goals are not being met.

7.6 Environmental Management Plan Guidelines

Obodofei Integrated Services Limited has set objectives and targets in managing significant environmental aspects in line with ISO 14001:2015 Environmental Management System requirement for the proposed projectduring construction, operation and decommissioning phases. Specific plans with commensurateresources shall be allocated to meet these plans. These plans shall be reviewed yearly by OISL's top management.

The Environmental & Social Management Plan Guide presented below (Table 7.2) reflects the project phases, activities associated with each phase, impacts related to these activities, mitigation measures, responsible action personnel/group and implementation time frame.

Table 7.2: Environmental and Social Management Plan (ESMP) of the Proposed Project

Project Phases	Project Activities	Identified Impacts	Mitigation Measures	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
Pre-Construction Phase	• Permitting • Community consultations and Engagements • Recruitment and hiring of man-power and labour • Mobilisation of machinery and material to the site • Vegetation clearing & soil stripping	Conflicts/ community agitations over employment opportunities (methods)	• Ensure early stakeholders' engagement and that all agreed issues are properly documented and signed. • Ensure due consultation of relevant groups within the host communities at all phases of the project. • Ensure transparent communication on hiring policies amongst local communities. • Explore ways of encouraging goodwill and friendly relationships between its workers/contractors and members of the community. • Work closely with local communities to identify opportunities for employment. • Will encourage the development of a community-based local business that benefits both the local community and Project by maintaining a vendor list of local businesses and personnel who are qualified to provide services • Establish and publicise grievance procedures.	Number of locals employed	Monthly	OISL's Community Liaison Officer
		Influx of people (workers, contractors and suppliers) and increased pressure on existing social	• Encourage workers to participate in community development affairs. • Ensure that workers are educated on sexual health and related issues		Biannually	OISL's Community Liaison Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
		Infrastructure				
		Increase in social vices (like theft, and prostitution) from the influx of job seekers to the area		numbers of sexual harassment report and number of theft cases	Quarterly	OISL's Community Liaison Officer
		Community agitations over land, wrong stakeholder identification, compensation for crops, etc.	• Ensure early stakeholders' engagement and all agreed issues are properly documented and signed. • Transparent communication on hiring policies amongst local communities • Accord the local people the first priority in terms of employment.	• Number of locals employed • Land title document	As the need arises	OISL's Community Liaison Officer
		• Loss of fauna and flora • Fauna disturbance and Habitat degradation	• Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed further •	Footprint outside project Area conserved	Monthly	HSE Officer
		Increase in road traffic volume and risks of accidents leading to injury/ death and loss of assets during mobilisation.	• Develop and maintain an effective journey management schedule • Enforce adherence to speed limits. • Ensure drivers undergo competency training on defensive driving and safety-on-wheel ethics • Ensure road signs are visibly placed at strategic points along the road • Ensure all its vehicles are certified	Records of accidents; Numbers of road traffic signs;	Monthly	HSE Officer/Chief Security Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
			roadworthy and in good maintenance state • Large and slow-moving vehicles carrying heavy equipment are scheduled during off-peak periods. • Ensure night trips are avoided • Contract traffic police to provide traffic control on the relevant road(s) during periods of movement of heavy equipment			
		Risks of armed robbery attack and hostage-taking while moving equipment and machinery	• Ensure a detailed security plan is developed and communicated to workers/drivers. • Support local law enforcement agencies to combat crime	Number of reported incidents	Monthly	HSE/Security Officer
		Nuisance (noise and vibrations) from movement of heavy-duty equipment and vehicles	• Maintain all its equipment at optimal operating conditions • Ensure equipment with low noise and vibration capacity is used on-site • Ensure all personnel wear appropriate PPE • Carry out routine HSE awareness training for workers • Maintain positive community relations by keeping the public informed of periods when noise levels will be noticeably higher	Noise Level (dBA) at selected sites; Records of consultation.	Weekly	HSE Officer
		• Dust particles from increased vehicular movement. • Emissions from vehicle exhaust	• Ensure dust along unsurfaced support roads and exposed surfaces will be managed by wetting with water or approved dust suppressants during dry periods • Ensure machinery and equipment are turned	Measured concentration NOx, SOx and SPM ($PM_{2.5}$ & PM_{10})	Weekly	HSE Officer

Project Phases	Project Activities	Identified Impacts	Mitigation Measures	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
			off when not in use • Set Speed limits for vehicular movement to minimise the generation of fugitive dust within the project area • Maintain all work equipment at optimal operating conditions. •			
Construction/Installation Phase	• Vegetation clearing and soil stripping • Development of haul and support roads • Excavation of drainage ditches	• Loss and disturbance of fauna and flora • Direct loss of native species diversity • Changes in the composition or distribution of natural habitat • Changes in habitat structure- habitat fragmentation or increased access for non-native or opportunistic species into natural habitat • Loss and disturbance of riparian ecosystem	• Limit vegetation clearing outside the footprint earmarked • Integrate project development with other existing land use activities in the area to minimise disturbance and cumulative habitat loss, including the use of existing access or utility corridors whenever possible. • The timing between the clearing of an area and subsequent development must be minimised to avoid fauna from re-entering the site to be disturbed;	Area of vegetation cleared	Monthly	HSE Officer
			•			
		Generation of waste and risk of Soil/ groundwater contamination resulting	• Create fuel and chemical spill contingency and response plan • Encourage workers to maintain good	Amount of waste generated	Monthly	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
		from accidental leakages and spills of hazardous substances (diesel, petrol, lubricants, hydraulic oil, etc.)	housekeeping • Waste must be removed from the area weekly to prevent pest infestation • Re-fuelling of the vehicle and heavy-duty equipment shall be done at a dedicated dispersing area and on a concrete paved area with a small channel towards the oil scooping chamber • Ensure no servicing of equipment on site unless necessary; • Ensure drilling of boreholes for adequate monitoring of groundwater quality; •			
		Nuisance (noise and vibrations) from movement of heavy-duty equipment and vehicles	• Ensure workers wear appropriate PPE • Ensure machinery and equipment are turned off when not in use • Ensure drilling and excavation activities are carried out during the time only. • Maintain positive community relations to keep the public informed of operations when noise levels are noticeably higher •	Amount of Noise	Weekly	HSE Officer
		• Generation of dust from heavy-duty equipment usage and hauling of materials • Emissions from operations and	• Maintain all heavy-duty equipment at optimal operating conditions • Ensure dust along unsurfaced support roads and exposed surfaces will be managed by wetting with water or approved dust suppressants during dry periods	Measured concentration of NOx, SOx and SPM ($PM_{2.5}$ & PM_{10})	Weekly	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
		movement of heavy-duty vehicles and machinery	• Limit drop heights from excavators to minimise the generation of dust. • Ensure machinery and equipment are turned off when not in use • Set Speed limits for vehicular movement to minimise the generation of fugitive dust within the project area			
		Insecurity	• Consult with the Local Government Council and seek their support in reaching out to the host community. • Accord the local people the first priority in terms of employment.	Number security of incidents	Monthly	HSE Officer
		Cultural Heritage and Sacred Sites	• Identification of any culture heritage/burial site before construction in consultation with local communities • Avoidance and protection of known heritage features/burial sites • Workers are sensitised on the procedures to be followed in case of discovery and the potential presence of archaeological resources/burial sites that may be discovered during land-clearance and mechanical excavation activities • Ensure safe access for community members to any identified grave/burial sites within the project site. •	Records of preserved heritage	Monthly	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
	• Movement of man-power, machinery and materials • Civil works around the project sites • Recruitment and hiring of man-Power and labour	Generation of dust from the movement of heavy-duty vehicles and equipment	• Wet exposed surfaces and unsurfaced haul roads with water to minimise wind-blown dust • Set speed limits to minimise the creation of fugitive dust within the site boundary. • Limit drop heights from excavators and payloaders to minimise the generation of dust. • All equipment are maintained in good working order and is not left running when not in use. • Outdoor stockpiles above ground level are covered, except stockpiling has been undertaken to dry the materials.	Concentration of SPM ($PM_{2.5}$ & PM_{10})	Bi-annually	HSE Officer
		Generation of domestic, human and construction wastes such as scrap metal, wood, concrete, paper, domestic waste etc.	• Ensure all generated waste is separated at source to enhance efficiency in waste handling and disposal at a licensed disposal facility • Encourage workers to maintain good housekeeping • Ensure workers are trained in the handling and management of wastes • Waste management must be a priority and all waste must be collected and stored effectively • . Portable toilets must be pumped dry to ensure the system does not degrade over time and spill into the surrounding area;	Visual inspection	Weekly	/HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
			• Ensure the safe transportation, handling, storage and disposal of all waste in accordance with regulatory (FMEnv) requirements and in line with OISL waste management procedure/ plan •			
		Disturbance and displacement of fauna species as a result of construction activities	• Ensure that machinery, vehicles and equipment that produce high levels of noise are optimized to reduce the overall impact. •	Area cleared	Monthly	HSE Officer
		Soil/ groundwater contamination resulting from accidental leakages and spills of hazardous substances (diesel, petrol, lubricants, hydraulic oil, etc.)	**OISL shall:** • Ensure that fuel storage facilities are leak-free and have bond wall protection to hold fuel in case of spillage • Ensure only competent and trained personnel are used in handling fuel and chemicals • Equip all trucks and equipment carrying fuels or oil with spill response materials and train personnel in the use of such materials • Hydrocarbon/chemical spill containment and prevention measures and equipment are functional and effective on-site • Vehicles shall be refuelled at the dedicated dispersing area	Visual Inspection	Monthly	HSE Officer

Project Phases	Project Activities	Identified Impacts	Mitigation Measures	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		Increased risk of accidents to workers, community members leading to injury/death	• Ensure vehicle drivers undergo competency training on driving, and identification of road signs and traffic codes before mobilisation • Use road signs at strategic points, sirens and public announcements where necessary to warn people of oncoming heavy-duty vehicles • Enforce adherence to speed limits and introduce speed bumps to reduce the speed of vehicles • Ensure all its vehicles are certified roadworthy and in good maintenance state	Records of reported accidents	Weekly	HSE Officer
		Noise nuisance from construction activities resulting in disturbance to humans and temporary migration of fauna species	• Ensure machinery, vehicles and equipment that produce high levels of noise are operated in optimal level. • Personnel working with machinery, vehicles and instruments that produce high levels of noise are supplied with ear plugs • Plan work activities to avoid heavy-duty movement during peak hours • Ensure construction works are avoided at night time • Maintain positive community relations to keep the public informed of operational activities when noise levels are noticeably higher	Noise Level (dBA)	Weekly	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
		Occupational Safety and health hazards from increased potential for injuries to workers during construction activities.	• Regular maintenance and checks of machinery to minimize accidents and hazards during construction. • Safety, Health and Environment (SHE) induction course and daily toolbox meetings for workers. • Provision of adequate signage and availability of functional First Aid Kit on-site. • Adequate and relevant training of all workers especially local hands-on safety issues related to their activities. • The use of well-trained personnel and provision • Enforcement of the use of appropriate PPEs on site.	Number of accidents	Weekly	HSE Officer
			•			
		Stormwater generation and impact on drainage	• Paving in dry weather to prevent runoff of cement materials. • Regular inspection and maintenance of permanent erosion and runoff control features.	Visual Inspection	Monthly	HSE Officer
		Potential increase in cases of sexually transmitted disease including HIV/AIDS resulting from influx of workers/strangers to the project area.	**OISL shall ensure**; • Step up health education and sensitisation activities before commencing construction activities. • Organize awareness sessions on sexual behaviour and HIV/AIDS for workers and local hands that will be employed. • Support for HIV/AIDS prevention campaigns	Number of reported cases of STDs as well as HIV/AIDS infection	Bi-annually	CLO

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
			as required by the Strategic Plan through educating the local communities on HIV / AIDS and STIs prevention as well as support condom donation initiatives. • Monitoring of substance abuse (alcohol and drugs) at the workplace.			
		• Employment opportunities arising from the recruitment of workers • Opportunities for local business development	• Transparent communication on hiring policies amongst local communities • Participation of locals during construction will be maximised through direct contracting to local businesses and encouraging main contractors to hire local workers • Local purchase during construction will be encouraged where price, quality and deliverability are equal to that available outside the local area • Will encourage the development of a community-based local business that benefits both the local community and Project by maintaining a vendor list of local businesses and personnel who are qualified to provide services • As many qualified local people as possible are hired from neighbouring communities • Build, enhance and maintain positive relations with local community members	Number of locals employed	Monthly	CLO

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
Operation Phase	• Operations of the power plant and CNG Plant • Routine maintenance and servicing of the Power Plant and CNG plant and other facilities • Employment of workers • Emergency Preparedness • Vehicular movements • Wastes generation	Loss and degradation of habitat	• Workers are educated about the sensitivity of faunal species and measures should be put in place to deal with any species that are encountered during the operational process	Monitoring records Visual Inspection Records of faunal species	Monthly	HSE Officer
		Erosion and loss of topsoil	• Only the designated access routes are to be used to reduce any unnecessary compaction; • In cases of erosion, erosion berms must be implemented to minimise any further erosion; •	Visual inspection	Monthly	HSE Officer
		Increased waste generation	• Temporary storage of domestic waste shall be covered with waste skips. • Waste management must be a priority and all waste must be collected and stored effectively. This includes litter, spills, fuels, chemicals and human waste in and around the project area; • Waste must be removed from the area every week to prevent the nuisance of insect pests; • Identification and classification of waste into different waste classes; • Define a waste hierarchy and waste minimization strategy; • Define and implement procedures for waste handling (i.e. collection, segregation, storage, transport, disposal, and	Waste management records	Monthly	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
			documentation); • Establishment of dedicated area(s) for the sorting and storage of waste • Safe transportation, handling, storage, and disposal of wastes; • Monitoring, verification and reporting of wastes.			
		Increased traffic within the area	• Drivers have quarterly training; • Inspection of vehicles for compliance with Federal Road Safety requirements twice per year and ensure compliance; • All vehicles fitted with speed limiting devices to limit speeds to 60 km/hr; • Reduce driving after 6 pm and before 6 am • Conduct driver alcohol/drug tests.	Records of accident	Weekly	HSE Officer
		Air pollution and Greenhouse Gases from the operation of power plants and vehicles. Air pollution due to the emission of particulate matter (dust)	• Make use of higher energy-efficient systems • Maintain plant system at optimal operating conditions • Frequent monitoring to ensure the initial design emissions remain the same throughout and if not immediate corrective actions can be taken • Periodic maintenance shall be done as per machinery specifications	SO_X, NO_X, CO_X, SPM ($PM_{2.5}$ & PM_{10}), etc.	Monthly	HSE Officer
		Workplace accidents/ incidents (cuts, trips,falls etc.) leading to	• Ensure HSE briefings are conducted before work commencement • Enforce the use of appropriate PPE while at	Number of recorded casualties	Daily	/ HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
		injury/ death of workers during project operations	work • Design work area to meet industrial standards recognizing all ergonomic factors • Encourage employees to maintain good housekeeping within the work site at all times • Equipment operators are trained and follow equipment operational procedures.			
		Water and land pollution from hydrocarbons	The hydrocarbons mainly from servicing and maintenance works shall be handled in the following matter; - • Used oil shall have a dedicated storage area with concrete surface, bund wall and a roof to contain only used oil in case of leaks or spills from the containers used to keep it. • Maintenance team shall be equipped with absorbent materials in case of spill to contain and scoop the contaminated oil onto the surface	TDS, TSS, COD, BOD, DO, THC, Turbidity, pH, Heavy Metals, Conductivity, Nutrients	Monthly	HSE Officer
Decommissioning Phase	• Mobilisation of personnel and equipment • Dismantling/ restoration	Loss of employment, business opportunities and decreased economic activity	• As part of training and awareness programmes, local workers are adequately trained with skills to sustain livelihood.	Public perception survey	Prior to decommissioning	HSE Officer
		Risk of accident and injury to workers during demolition of structures	• Ensure that HSE briefings are conducted before demolition activities • Ensure personnel wear adequate PPE while carrying out demolition	Number of recorded incidents	Monthly	HSE Officer

Project Phases	Project Activities	Identified Impacts	Mitigation Measures	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
			• Encourage employees to maintain good housekeeping within the worksite •			
		Increased dust and vehicular emissions from decommissioning activities	• Demolition activities are conducted after sprinkling water to prevent dust build-up • Workers wear adequate PPE while carrying out demolition	SO_X, NO_X, CO_X, SPM ($PM_{2.5}$ & PM_{10}), etc.	Daily	HSE Officer
		Air pollution due to exhaust emission	• Maintenance of all its vehicles at optimal working conditions • Trucks will be washed each morning to remove mud on the mudguard and tires to reduce dust on routes • Dry excavated areas are watered to reduce fugitive dust • Enforce speed limits by drivers, especially along routes passing through community areas. • Covering stockpiles that have the potential to generate fugitive dust at the site • Equipment maintenance is to be undertaken in accordance with the manufacturer's instructions and at the specified maintenance interval to reduce exhaust emission; • Load limit shall be specified to the type of vehicle to avoid overloading that causes excessive exhaust emission • Timely maintenance of the trucks through	SO_X, NO_X, CO_X, SPM ($PM_{2.5}$ & PM_{10}), etc.	Daily	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
			regular inspection on the need for maintenance.			
		Noise pollution from demolishing works	• Activities that will generate excessive/disturbing noise conditions will be restricted to daytime hours only. • All vehicles and noise-emitting machines shall have properly functioning exhaust mufflers • Speed limits will be instituted for drivers, especially on routes passing in community centre areas.	Noise Level (dBA)	Daily	HSE Officer
		Waste pollution from hydrocarbons (oil, fuel, lubricants, transformer oil)	• Re-fuelling of big machines shall be done on a concrete paved area with a small channel towards the oil scooping chamber • Vehicles shall be refuelled at the dedicated dispersing area • All services for vehicles & machinery shall be done at the workshop area with a proper system of oil/spill management • Emergency response measures will be put on site in case of accidental oil spills which will include having absorbent materials and sand kits. • Hydrocarbons including oil, grease and Fuel are stored in a designated area that will have concrete surfaces with the containment bund.	Visual inspection	Weekly	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
		Increased sediment load due to erosion & spoils	• All water draining from cleared areas will be properly channelled road • All unwanted materials will be stockpiled in a dedicated area away from drainage features. • A site waste management plan (WMP) shall be prepared by the contractor before the commencement of the works. This will include the designation of appropriate waste storage areas collection and removal schedule, and a system for supervision and monitoring.	Visual inspection	Weekly	HSE Officer
		Traffic accidents	• Only qualified drivers with appropriate driving licenses shall be engaged. • An induction course shall be done for all drivers prior to starting driving • Drivers shall be sensitized on maintaining speed limits for main roads and on access roads. • Promoting safe drive • Haulage of the materials shall be done during the daytime • Provision of road and safety signs on-site and surrounding areas that are to be followed by drivers and the public in collaboration with the local authority.	Number of recorded accidents	Daily	HSE Officer
		Workers' Campsite, Workshops and other associated facilities.	• The workers' campsite and other facilities should be removed at the end of the	Facility end use	Monthly	HSE Officer

Project Phases	**Project Activities**	**Identified Impacts**	**Mitigation Measures**	**Indicator Parameters**	**Frequency of Monitoring**	**Responsible Action Party**
			Decommission phase. • The removed materials shall be transported and kept in a safe place for use by the Contractor in other works. • Retainership of the buildings for use by the local communities as a school, technical institute/college or dispensary as appropriate. • The area should be cleaned and all domestic wastes, debris/waste metals, grease and oils must be disposed of by an approved waste collector.			

7.7 Environmental Management Programs

As part of the Environmental and Social Management Plan for the project, the following guidelines have been developed by OISL to meet the national requirements.

7.7.1 Awareness Creation and Training

During the construction phase of the project, the following environmental awareness and training shall be conducted:

Induction Briefing

An induction briefing for every construction worker to be engaged in the project shall be provided by the contractors. The briefing shall include:

- The proposed tasks for new workers;
- Worker and safety consciousness;
- Importance of the use of personal protective equipment and warning notices;
- Personal hygiene and site sanitation issues;
- Environmental protection concerns; and
- Hazard recognition and incident reporting.

Weekly Safety and Environmental Forum

There shall be a weekly environmental and safety awareness forum for construction workers during the activities at the project site. Contractor shall be responsible for coordinating these meetings.

During the operation phase of the project, OISL shall educate all its workers on environment, health, and safety issues using the following means to disseminate information to staff and workers:

- Staff and workers meetings;
- Local area network and the internet; and

7.7.2 Communication Guideline

An effective two-way communication of Health Safety and Environment (HSE) issues shall be maintained by OISL and its contractors at all phases of the proposed project. This will includean awareness programme to motivate staff and contractors. The project HSE officers shall make available to the entire project team necessary HSE and security information and expectations to facilitate improvement in HSE performance.

OISL personnel at all levels shall be aware of the importance of compliance with the HSE policy and objectives, and their roles and responsibilities in achieving it have been specified. They shall be aware of the risks and hazards of their work activities the preventive and mitigation measures and the emergency response procedures that have been established. They shall also be aware of the potential consequence(s) of deviation from laid down procedures.

There shall be an established HSE performance scheme to promote individual HSE performance improvements e.g. personal recognition, suggestion schemes, HSE performance bonus schemes for specific performance or at the end of a recognizable milestones or awards for recognizable performance. These shall apply during the proposed project.

Environmental issues will be communicated to the workforce. Weekly project meetings, which follow a set agenda incorporating Health, Safety and Environmental issues, will be held and a weekly report will be generated and distributed. All staff and sub-contractors involved in all phases of the project will be encouraged to report environmental issues.

Environmental Reporting: The contractor will report the status of project environmental activities to OISL regularly. These reports will summarize the key environmental issues in theperiod and identify any non-conformances and the status of corrective actions.

Communication of Initiatives and Project Information: Communication of initiatives and project information will be developed as the project progresses. Typically, these will include campaigns to raise environmental awareness, and circulars to inform staff of key environmental issues such as lessons learnt from incidents or accidents.

Subcontractor Environmental Reporting: All external communications with local interest groups, and external agencies and also the response to any complaints will be conducted by OISL which shall notify the onsite OISL representative if any communications are received from external stakeholders.

Environmental Social and Governance (ESG) Reporting: Environmental, Social, and Governance (ESG) considerations are integral to OISL's commitment towards responsible and sustainable business practices. By transparently communicating OISL's efforts in environmental, social and governance, OISL aims to foster trust, engage stakeholders, and contribute positively to the communities and environment impacted by its operations. The ESG reporting serves as a means to disclose and measure the performance of OISL in keyenvironmental, social, and governance aspects. It will also provide stakeholders with clear insights into its efforts to mitigate environmental impacts, uphold social responsibilities, and maintain high governance standards.

7.7.3 Worker Safety and Health Plan

Operations within the work site shall be subjected to the ISO 45001 (Occupational Health and Safety Management System) and in line with the OISL Environmental, Health, and Safety Policy. All OISL and contractor staff shall be well-informed and trained on the policies and guidelines. The facility will be designed to enhance safety planning.

Contractors shall provide adequate health services as well as first aid services for their workforce. The first aid services shall be extended to visiting personnel and temporary (casual) workers. All construction activities shall be properly managed through careful planning and application of relevant HSE policies including the following:

- Use of permit-to-work;
- Job hazard/ safety analysis and toolbox meetings;
- Use of PPE in designated hazard areas;
- Prohibition to the drinking of alcohol during work hours at work sites and within facilities;
- Prohibition to night trips;
- Regular emergency drills; and
- Prohibition to smoking in plant (fire hazard) areas.

Integrity of Workplace Structures

- All plant surfaces, structures and installations would be designed to enable easy cleaning and repair, and limit the accumulation of hazardous compounds;
- Plant buildings will be structurally safe, provide appropriate protection against climate change and have acceptable light and noise conditions;
- Plant design would ensure that fire-resistant, noise-absorbing materials are used, to the extent feasible, on ceilings and walls;
- Floors would be level, even, and non-skid to prevent trips and falls; and
- Plant-heavy oscillating, rotating equipment would be in dedicated buildings or structurally isolated sections within the plant site.

Workspace and Exit

- Space to be provided for each worker would be adequate for the safe execution of all activities, including storage of materials and products; and

- All emergency exit routes would be unobstructed at all times. Exits would be marked.

The number and capacity of emergency exits would be sufficient for a safe and orderly evacuation of the people during emergencies.

Fire Precautions

- OISL shall equip the plant facility with fire detectors, alarm systems, and fire-fighting equipment.
- The equipment would be maintained in good working condition and be readily accessible; and
- Provision of manual fire-fighting equipment that is easily accessible and simple to use.

Other requirements to be met by OISL include:

- Water supplied for the purpose of personal hygiene (washing or bathing) would meet the national drinking water quality standards;
- Equipment and installations requiring servicing, inspection, and/or cleaning would have unobstructed, unrestricted, and ready access;
- Hand and foot railings would be installed on stairs, platforms, permanent and interim floor openings, offices and plant buildings;
- Ensure that well-equipped first-aid is provided at designated areas at the site. First-aid stations would be easily accessible throughout the place of work;
- Sufficient fresh air (ventilation) would be supplied for indoor and confined work spaces;
- Temperature in plant and office areas would, during service hours, be maintained at a level appropriate to the facility;
- Fall prevention and protection measures would be implemented whenever a worker is exposed to the hazard of falling height;

7.7.4 Manpower Development Guidelines

Training is an investment in the wellbeing of the project. To ensure high HSE competence and awareness, the project management team shall ensure that the company employees and other parties that will be engaged throughout the project lifespan undergo appropriate and competency training for various aspects of the projects, especially in HSE critical activities such as drilling, fuel loading activities, product loading and dispatch etc. The competency requirements for contract staff shall be stipulated in the contract document. The project team shall be subjected to periodic competence gap analysis from which training needs can be derived for the current/future phases of the project. The development programme shall be reviewed by the HSE and Human Resource Manager (based on reports from site supervisors and HSE officer) on an ongoing basis as the project progresses such as:

- HSE induction course;
- Emergency response drill including fuel/ oil spill clean-up;
- Escort Vehicle Operator Training;
- Electrical maintenance Training;
- Detection and Control of Flammable Substance Training;
- Emergency First Aid Training;
- Fall Protection - General Training;
- Incident and Accident Investigation Training;
- Conflict resolution/management; and
- First aid administration.

All Contractor employees and subcontractors involved in the project will be given a comprehensive induction before they start work. This environmental training will take place in conjunction with safety awareness training.

The environmental aspects will include:

- An overview of the Environmental Management Plan, goals and objectives.
- Awareness in relation to the risks, consequences and methods of avoiding noise pollution, oil/diesel spills, disturbance to wildlife.
- Awareness of individual environmental responsibilities and environmental constraints to specific jobs.
- Location and sensitivity of the proposed project area.

All personnel who have attended the Environmental Induction will sign a Register which will be kept on the Project Files. Toolbox talks, based on the specific activities being carried out, will be given to personnel by the nominated project representative. These will be based on the specific activities being carried out. These talks will take place either at the appropriate accommodation facility on-site and will include environmental issues particular to the proposed project, namely:

- Oil/diesel spill prevention including safe refueling practices.
- Emergency response procedures are used to deal with an oil/diesel spill.

- Minimizing disturbance to wildlife.

7.7.5 Grievance Redress Mechanism (GRM)/Conflict Resolution (CR)

A Grievance Mechanism is an adaptive conflict resolution tool. It is an important component of stakeholder engagement and should be easy to interpret by all stakeholders. The following section provides such a mechanism, which should be implemented by the CROs, and managed through the functions of the CRCs.

The following section provides an external Grievance Mechanism to be adopted and implemented by OISL. Elements of the mechanism will be adapted and refined to enhance functionality andalso take into consideration cultural sensitivities. All reasonable efforts will be made by OISLto ensure that the vulnerable (and particularly women) have the opportunity to express to OISLtheir concerns freely and directly regarding the project.

- **Objectives and Scope**

The purpose of this Grievance Management procedure is to provide a clear description of the formal process whereby stakeholders can submit a grievance or report an incident regarding the OISL project, through a defined process, and within a predictable timeframe, receive a response and a resolution (where possible) to the grievance.

This mechanism aims to:

- Ensure that unwanted events with negative impacts on external stakeholders are dealt with swiftly and appropriately;
- Ensure that incidents, complaints and grievances are logged and managed consistently to build trust in the legitimacy and efficiency of the procedure and system;
- Allow OISL to identify and correct problems before they recur or escalate into more serious problems;
- Allow OISL to monitor and track stakeholder concerns, issues and complaintsproviding insight into how OISL is perceived by its external stakeholders;
- Provide an efficient and low-cost means of resolving disputes and providing control measures where appropriate; and
- Elevate the credibility and reputation of OISL by efficiently demonstrating that the concerns of external stakeholders are taken seriously.

The mechanism applies to OISL in addressing complaints, grievances and issues voiced by stakeholders due to perceived OISL impacts and/or incidents including, but not limited to social-economic, environmental, health or safety aspects. It may be used by all stakeholders. A separate Grievance Mechanism will be used for OISL employees and labour-related issues.

- **Grievance Mechanism**

The Grievance Mechanism should involve the following steps:

Step 1: Lodging complaints/comments

Any stakeholder will be allowed to make a formal statement of dispute or claim (verbally or written) to the selected representatives acting on a CRC, directly to the CROs, or to a recognised community leader. The CROs should ultimately receive all complaints and shall be tasked with completing a grievance form and logging the grievance in a central grievance database.

The complainant should be registered by the CROs. The grievance form to be completed by the CROs should include the date, and description of the grievance, as well as the details of the complaint and the person who lodged it (full name and position). An example of such a form is provided in Appendix B. The person who submits this claim should sign this completed form and must receive a receipt of this complaint from the CROs upon submission. The form also needs to indicate the date on which the grievance will be addressed by OISL and when feedback will be received.

It will be the responsibility of the CROs to receive complaints and to enter these in the register (an electronic register should also be kept). Three copies will be made of the form: one copy to be provided to the person submitting the complaint (to be provided to the claimant), one to be used to implement the corrective action and for document control, and one copy to remain in the grievance file to be kept and maintained by the CROs. The comment/complaint will then be entered into a database that will be created for this purpose. The complainant will have the option to remain anonymous.

Step 2: Grievances in the grievance form

Upon completion of the grievance statement form, the CROs shall ensure that OISL receivesa copy of the form within 48 hours of submission. An electronic database should also be kept of each grievance. A template of such a form is provided in the Appendix. The grievance statement form shall be managed and maintained by the CROs who will bear the responsibility for ensuring that all records are up-to-date and accurate *(See appendix for Grievance Form Template).*

Step 3: Assessment and resolution

The grievance will be assessed by the HSE Officer, who will be supported by the CRO. From there, and depending on the complexity of the grievance, a Grievance Committee shall assess the grievance/comment. Should this not be possible, the grievance/comment will be communicated to the relevant government authorities to formulate preliminary recommendations. The CRO/grievance committee shall provide his/her recommendations to OISL promptly and at least within 96 hours. All grievances will need to undergo some degree of review and investigation, depending on the type of grievance and clarity of circumstances.

Step 4: Grievance response

OISL shall draft a written response within 15 days of the date on which the grievance form was lodged and recorded in the grievance statement form. This should include OISL recommendations to be taken into consideration. This formal feedback response letter needs to besubmitted by OISL to the complainant in person. The letter needs to be verbally communicatedto the complainant. Should the complainant accept the response, this decision shall be documented with the complainant's signature on the grievance response letter. Thereafter, the latter response letter shall be returned to OISL for recording into the grievance statement form (to be attachedto it).

Step 5: Rejection of a response

Should the complainant reject the response, the merits of the rejection shall be investigated by OISL. Should the complainant reject the response, the complainant shall have the right to consult the relevant government authorities, after which a formal meeting can be arranged betweenthe relevant government authority, OISL, the complainant, and any other stakeholder groups involved in the process. Formal meeting minutes shall be drafted for this meeting and will be issuedand signed by all parties involved.

The outcomes of the meetings shall be recorded by OISL, and if an agreement is reached, suchan agreement will be captured in the grievance statement form with the signature of the complainant.

Step 6: Closure

Once the investigation has been completed and necessary measures have been taken, the results will be communicated by OISL to the complainant and entered in the grievance statement form and electronic database, as explained. Regardless of the outcome, a response should be provided to all complainants.

Step 7: Monitoring the grievance process

The Grievance Mechanism set out in this plan shall be annually reviewed by OISL for its adequacy and appropriateness to the lifecycle of the project. The number and nature of grievances,as recorded in the grievance database, will be reported to the OISL Head Office every quarter.For effective monitoring of the grievance process.

- **Awareness training**

In some cases, employees, or especially contractors, working in proximity to communities may receive grievances or complaints. Employees should therefore be familiar with the mechanism and the contact details of the CROs. It is necessary to train those who are likely to be involved in these situations on how to respond to aggrieved stakeholders with respect and to ensure they are given the correct information.

All employees and contractors must be well-informed of the grievance procedure so that they can advise stakeholders accordingly if the need arises. Awareness-raising must be done through various means, such as the inclusion of the grievance procedure in employee and contractor induction processes, ,. Bi-annual grievance process awareness communication meetings must be scheduled with stakeholders of OISL. During these meetings, the process must be explained, including the escalation system, and stakeholders must be made aware of their right to log a grievance without fear of retribution.

- **Roles and responsibilities**

The CROs, will be responsible for the coordination and functioning of the grievance mechanism and for communicating responses and resolutions to stakeholders. Relevant OISL department managers will be responsible for the investigation and resolution of assigned incidents or delegating investigations to an appropriate team member. Department managers will be responsible for assessing the effectiveness of complaint responses, signing off on agreed resolutions, and communicating these to stakeholders in association with community development.

. All OISL employees and contractors will be responsible for understanding the Grievance Mechanism and upon notification of a complaint advising stakeholders of the available channels for grievance submission.

Table 7.3: Roles and responsibilities

Role	**Responsibility**
Conflict Resolution Committee(s)	Receive formal grievance and record in a grievance form to be provided to OISL
OISL Conflict Resolution Officer	Receive and analyse grievances. Records grievance and response in an electronic grievance registry.
Grievance committee	Depending on the complexity of the grievance, a committee shall be established to review and analyse the grievance. Records grievance and response in an electronic grievance registry.
OISL Managing Director	The grievance committee/CRO shall report the grievances in the registry to the OISL quarterly

- **Monitoring and evaluation**

The grievance mechanism and its effectiveness shall be reviewed by the CRO and OISL Management quarterly. Depending on the outcome of the review, the mechanism will be amended and disclosed to the CRC(s) in a formal meeting.

7.7.6 Social Impact Management Plan

Construction Phase:

- **Child Labor Mitigation:**
  - Implement strict labour policies that prohibit the employment of minors.
  - Conduct regular inspections and audits to ensure compliance with child labour regulations.
- **Forced Labor Prevention:**
  - Establish clear recruitment procedures and contracts to prevent forced labour.

- Conduct thorough background checks on labour contractors and sub-contractors.

- **Gender-Based Violence Prevention:**
    - Develop and communicate a zero-tolerance for gender-based violence.
    - Provide gender sensitivity training for all project staff.
    - Establish safe reporting mechanisms and support services for victims of gender-based violence.
- **Workforce Accommodation and Health:**
    - Ensure suitable living conditions for workers, including safe and sanitary accommodation.
    - Implement health and safety protocols to protect workers from occupational hazards.
    - Conduct regular health check-ups and provide access to healthcare facilities.

Operational Phase:

- **Child Labor and Forced Labor Mitigation:**
    - Continue strict adherence to labour policies prohibiting child and forced labour.
    - Regularly audit and monitor labour practices to identify and address any violations.
- **Gender-Based Violence Prevention:**
    - Maintain a zero-tolerance for gender-based violence.
    - Provide ongoing gender sensitivity training for all employees.
    - Ensure a safe and supportive work environment for all workers.
- **Healthcare Accessibility:**
    - Collaborate with local healthcare providers to ensure access to healthcare services for workers
    - Conduct health awareness campaigns to promote preventive healthcare measures.
- **Cultural Understanding and Community Engagement:**
    - Foster cultural understanding through regular dialogue and engagement with local communities.
    - Promote cultural sensitivity among the workforce and management.

7.7.6 Pollution Control Guidelines

Air Quality Management Plan

In operating equipment, all practical methods and devices available to control, prevent and otherwise minimise atmospheric emissions or the discharge of air contaminants from machinery shall be utilised. Good engine efficiency of equipment and vehicles shall be maintained. Indiscriminate burning of materials resulting from the clearance of trees, bushes and combustible materials shall also not be permitted.

OISL intends to manage air emissions from its facility by ensuring:

- Emissions do not result in pollutant concentrations that exceed the FMEnv ambient quality limits;
- Implementing a leak detection and repair (LDAR) program that controls fugitive emissions by regularly monitoring to detect leaks, and implementing repairs within a predefined period;
- Use of dust control methods, such as covers, water suppression, or increased moisture content for open materials storage piles;
- Use of water suppression for control of loose materials on paved or unpaved road surfaces during construction;

Water and Soil Pollution

All excavation, construction and surfacing activities shall be performed by methods that will prevent pollution of the water and soil media by accidental spills of contaminants, debris, and other objectionable pollutants. Regular checks shall be conducted on on-site equipment to minimise minor lube oil and combustible leaks from engines.

Groundwater from boreholes for drinking purposes shall be monitored in line with WHO drinking water quality limits.

Noise Pollution

OISL shall comply with all noise control requirements pertaining to FMEnv. All equipment shall be maintained at optimal working conditions and recommended work practices shall be employed to minimise noise. Ear muffs shall be provided for all workers and any other person present within the vicinity of high noise-generating equipment or operations. Safe separation distances and buffer zones shall be established between facilities, work sites and neighbouring communities to reduce the impact of high noise levels from the facilities.

OISL intends to manage the impact of noise by ensuring that:

- Equipment with lower sound generator levels is used;
- Project execution is done during the day to limit noise impact at night;
- Noise control by installing suitable mufflers on engine exhausts and compressor components;
- Acoustic enclosures are installed for equipment casing radiating noise;
- Installation of vibration isolation for mechanical equipment;
- Reduced project traffic routing through community areas wherever possible;

7.7.8 Emergency Response Management Plan (ERMP)

In the event of an emergency, the OISL emergency plan identifies the actions to be taken. This includes communication facilities to be used, the individual responsibilities of key personnel the procedures for reporting such events to the authorities and the arrangement of logistics for extra labour as may be needed.

The emergency plan is based on the location and level of the event. This takes care of the possibility of an explosion and fire emergency plan. The plan requires that the factory site be designed and facilities put in place in such a manner as to prevent fire outbreaks.

The implementation and operation of any project are faced with possible hazards irrespective of the good intentions of the operator. OISL recognises this fact and has put in place all necessaryplans and measures to ensure compliance with standards, codes and specifications, operations and maintenance activities associated with the proposed project. The probable causes of accidents in the execution of this project are equipment failure, negligence and sabotage. A contingency plan has been put in place to handle such emergency and accidental situations. Emergency Plan, consistent with identified hazardous conditions of OISL, would include the following conditions:

- Fire/explosion
- Serious accidents/fatalities
- Equipment failures
- Infringement of safety zone
- Serious injury or illness;

- Hydrocarbon or chemical spills;
- Land vehicle mishaps; and
- Security issues

The plan would include:

- The response procedures to the above situations
- Reporting requirements
- Post-incident monitoring
- Procedures for personnel briefing exercise and,
- Mechanisms for updating the emergency/contingency plan (if necessary).

Hazard identification and risk assessment programme

OISL will develop a hazard identification risk assessment programme, which will involve a baseline risk assessment of the Project, from construction to decommissioning/closure. OISLwill coordinate the Project emergency response process and will engage communities and local government to inform them of the emergency response planning and processes.

Emergency Communications and Coordination Plan

- In any emergency where there is an immediate threat to communities, personnel or the environment, the OISL General Manager shall be notified immediately. The OISLGeneral Manager will dispatch the Emergency Response Coordinator who will determine the appropriate plan of action depending on the severity of the emergency, the people affected and the need to evacuate.
- If there is a developing emergency or unusual situation, where an emergency is not imminent, but could occur if no action is taken, the OISL HSE Manager is to be informed immediately. Once the emergency or unusual situation has been managed, the correct incident/near miss must be reported to the OISL General Manager.
- If an emergency poses a direct threat to communities in the area, the HSE Manager will advise persons in the vicinity of the emergency to evacuate due to the potential risk. The appropriate authorities will immediately be notified of such an emergency evacuation.

Response to Incidents

The reporting and investigation of all potential and actual incidents that could have a detrimental impact on human health, the natural environment or property is required so that remedial and preventive steps can be taken to reduce the potential or actual impacts as a result of all such incidents. The actions resulting from any formal or informal investigations will be used to update this ERMP.

Environmental Emergency Procedures

These procedures/plans will be documented within the overall Environmental Management System and will be updated to include detailed response management to the following additional emergency events:

- Fire
- Chemical/Fuel Spills.

The following emergency procedures must be implemented during fire occurrence;

- The Emergency Response Coordinator must be notified.
- Personnel near the fire, including the designated Evacuation personnel, must be immediately notified.
- All persons located in the area in which the fire is located must be evacuated.
- All doors and windows of buildings and vehicles that are near the fire will be closed.
- The fire shall be contained with the correct extinguisher only by those trained to do so.
- Those requiring assistance must be assisted and first aid must be rendered only by those trained to do so.

Evacuation Procedure

All staff must be aware of the escape routes before the emergency. Always ensure the safety of the assembly point before evacuation. The procedure associated with an evacuation event is detailed below:

- The Emergency Response Coordinator will give instructions or the alarm will sound to evacuate a specific area.
- Evacuation Officers must assist with the evacuation.
- All personnel onsite must follow the instructions of the Evacuation Officer.
- Personnel must follow the directional pointers to the nearest emergency exit.

- Evacuation must be undertaken in accordance with the emergency layout plan.
- Employees in wheelchairs must be the first to be evacuated followed by the frail and the injured.
- Visitors who are not familiar with the evacuation procedure must be assisted.
- A daily record of staff and visitors must be kept.
- The evacuation officer must be the last one to leave the area.
- All personnel on site must report directly to the allocated assembly point.
- Personnel must not leave the assembly point until it has been deemed safe to do so.

Verification and Monitoring of ERMP

The HSE Manager shall be tasked with the responsibility for auditing the project and implementation of emergency response procedures associated with all phases of the Project. The execution of emergency drills will be included in OISL emergency response procedures.

Reporting and monitoring requirements for the ERMP will include:

- Monthly inspections and audits;
- Monthly report of accidents/incidents;
- Reporting at the time of any environmental incidents;
- Bi-annual emergency response drills;
- Annual reporting on training.

Training on Emergency Response

The HSE Manager shall distribute the ERMP (together with the associated Emergency Evacuation Plan) to all parties in charge of ensuring the implementation of the plan. All relevant information in the ERMP (and associated Emergency Evacuation Plan) shall be communicated to employees and contractors.

Training is to include, but not limited to Firefighting, First Aid, Emergency Evacuation and Medical and Environmental Emergencies.

Fire and Explosion guideline

Sources of ignition within the work site may be as follows; electric sparks, frictional heat, hot surfaces, overheated materials, open flames, spontaneous heating, welding and cutting, combustion particles etc. All possible fire causes shall be considered during design and operation to reduce or eliminate such causes.

As a minimum, the following shall be considered:

- Proper layout of facilities within project site – location of facilities shall be in a manner to allow sufficient physical separation to limit the property, facilities and materials that could become involved in a fire;
- The normal prevailing wind, location of emergency escape routes and accessibility for the firemen; and
- Proper selection of materials for construction to limit the ability of fire to spread combustible materials shall be avoided as much as possible.

Fire Fighting Plan

The overall goal of the fire system shall be to:

- Continuously monitor all processes and be prepared to counter any emergencies;
- Oversee installation such as where the possibility of fire hazard may exist, fuel storage and flammable product storage facilities; and
- Reduce the risk of fire to personnel and equipment by implementing automated firefighting systems.

There will be fire detectors (smoke, heat, flame, fire, gas etc.) alarms and control systems in the event of any fire outbreak to minimize injury and property damage. Fire shall be detected by the quickest and most reliable means. Fire extinguishers shall be provided and positioned in strategic locations within the facilities most especially the fuel/diesel and explosive storage units. The types of fire extinguishers to be used are presented in Table 7.4.

Table 7.4:Fire Extinguisher Specifications

Fire Extinguisher Type	**Fire Type**
CO_2 fire	Electrical and flammable fire
Foam	Flammable liquid
Dry Chemical Powdered Extinguisher	For Class A,B and C fires

Arrangements/ location of muster points shall be made after due risk assessment of the facility layout. The extent of protection required for personnel mustering will be defined based on the hazard scenarios to which personnel could be exposed.

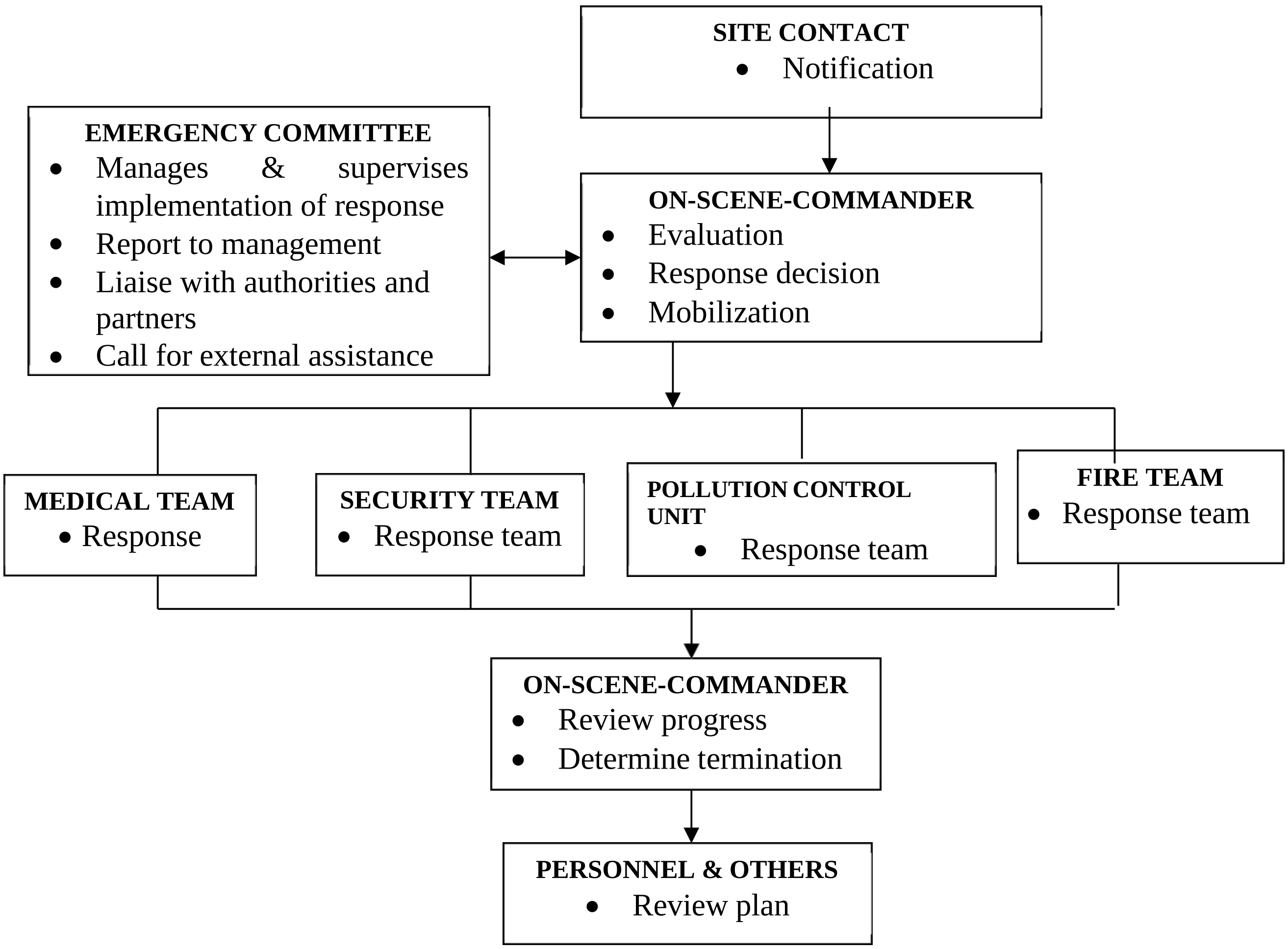

Figure 7.2: Emergency Response Chart

7.7.9 Traffic Management Plan (TMP)

Implementation of the Traffic Management Plan (TMP) will ensure regulatory compliance and the reduction of the significance of impacts related to transport during the construction and operation of the Project. The TMP for the Project includes the transport of materials and supplies to the Project site together with concentrates and wastes generated from the Project site. The plan contains methods that will be used to prevent adverse effects from occurring along transportation routes, monitoring plans to assess potential effects, and determining the effectiveness of mitigation during construction and operation.

The objectives of this plan are therefore:

- Ensure compliance with all legislation regulating traffic and transportation within Nigeria;

- Avoid incidents and accidents;
- Raise greater safety awareness in each driver;
- Avoid the deterioration of roads; and
- Avoid pollution that can be created from noise and emissions related to transport.

A. *Traffic and Transport Management Principles*

The following principles will be adhered to during the applicable phases of the Project:

- Conduct a road condition survey to gauge the damage to the road as a result of the intensive heavy traffic.
- All employees must attend an environmental training programme which will include details of approved access roads and speed limits.
- Adjacent landowners must be notified of the construction and operation schedule.
- Flagging must be provided at access points to the site and must be maintained until construction is completed.
- All vehicles must be maintained in good condition.
- Speed restrictions must be established before the commencement of construction
- The movement of all vehicles within the site must be on designated roadways.
- If abnormal loads are required, the appropriate arrangements will be made to obtain the necessary transportation permits and the route agreed with the relevant authorities to minimise the impact on other road users.
- A designated access point to the site must be created and marked to ensure safe entry and exit.
- Signs must be placed along construction roads and at the entrance to the site to identify speed limits, travel restrictions and other standard traffic control information and road markings.
- Where possible, construction vehicles to avoid travelling on the public roadway during the morning and late afternoon commute time, to reduce the impact on other road users.
- All internal and access roads that will be used during the operational phase of the Project must be maintained.

B. Roles & Responsibilities

- **OISL Contractor** shall be responsible for the integration of these procedures and requirements into their operating procedures and plans;
- **HSE Manager** shall be responsible for ensuring that these procedures and requirements are implemented for all project operations;
- **OISL Contractor** will coordinate all aspects of project transport to ensure efficient and effective transportation services. The **OISL Contractor** will also be responsible for ensuring driver orientation, overseeing regularly scheduled maintenance and mechanical inspection of trucks.

C. Training

All employees of OISL and Contractors to the Project shall be provided with training in the procedures to be followed with respect to transportation issues. Additionally, specialist training shallbe provided to plant operators and key personnel involved in activities which involve transportation of hazardous materials or explosives.

D. Monitoring & Reporting

Transportation monitoring procedures shall be as follows:

- The Contractor shall report every month to the Project HSE Manager on the implementation of this Management Plan during the construction phase, including:
  - Quality of access roads;
  - Number and size of trucks used;

In addition, all trucks shall be inspected for essential systems before each trip. The Contractor shall be responsible for record-keeping.

Regular reporting shall be undertaken via the monthly Monitoring Report that shall be prepared and submitted to the HSE Manager. Reporting shall include:

- A summary of activities undertaken during the reporting period;
- Any material deviations or non-compliance to this Management Plan;
- Planned activities during the next reporting period;
- Any other issues of concern.

7.7.9.1 Transport and Journey Management Guideline

All vehicles to be used for transportation of personnel, equipment and materials for the proposed project shall be pre-mobilized by the Contractor prior to mobilization. The pre-mobilization shall be conducted to confirm the fitness for that purpose and the competency level of the drivers for the job.

Each trip/journey to be undertaken during the proposed project shall be managed in such a manner that it will not result in harm to life or property.

Contractor shall ensure effective management of all transport operations and give utmost priority to safe conditions. The Contractor should place a very high premium on the lives of all employees and, hence is committed to managing the land, air and water transport operations in a manner that will minimize and control the associated Health and Safety hazards.

During the construction phase of the proposed project, all vehicles/trucks to be used for the movement of equipment and materials shall be pre-mobilised by the Contractor. The pre-mobilisation shall be conducted to confirm the roadworthiness of every vehicle, its fitness for a specific purpose and the competence level of the driver. Movement of large loads that could obstruct traffic flows on local roads shall be planned for low traffic periods

As a minimum, movements of heavy equipment shall be as much as possible, limited to the low traffic hours to reduce traffic on the roads while speed limits shall be maintained. Generally, all highway codes shall be abided with at all times.

All operators of passenger/materials haulage vehicle drivers shall be trained, tested and certified before they are engaged in operation.

Other Traffic/Transportation Management Measures include:

Vehicle Pre-Checks

All vehicles for the conveyance of personnel as well as equipment at all stages of the project shall be pre-checked by the HSE Manager/Officer and maintenance officer. This is to confirm the roadworthiness and fitness of the vehicles. Also, all contractors shall ensure that their vehicles are pre-checked and confirmed fit for use.

Consignation

Contractor shall ensure trucks coming into the facility are well parked to avoid road traffic. Also, trucks leaving the facility shall be covered to avoid stones flying on the road.

Monitoring

Contractors must ensure that all vehicles adhere to the speed limits. A speeding register should be maintained which details the offending drivers and the offence.

Safe Use of Public Access Roads

All transportation, construction and project works shall be executed in such a manner that will ensure minimal interference with the use of public access roads. However, if operational safety demands the blockage of public roads, then the Contractor should take necessary permits from law enforcement agencies and communities.

Dumping or storage of litter/debris, tools and equipment on public or private roads shall be prohibited.

7.7.10 Emergency and Contingency Plan

The implementation and operation of any project are faced with possible hazards irrespective of the good intentions of the operator. OISL recognises this fact and has put in place all necessary plans and measures to ensure compliance with standards, codes and specifications, operations and maintenance activities associated with the quarry project. The probable causes of accidents in the execution of this project are equipment failure, run-away reactions, explosion, negligence and sabotage. A contingency plan has to be put in place to handle such emergency and accidental situations. Such emergency planswould include the following conditions:

- Fire/explosion
- Evacuation
- Serious accidents/fatalities
- Equipment failures

The contingency plan would also include:

- The response procedures to the above situations
- Reporting requirements
- Post-incident monitoring
- Procedures for personnel briefing exercise and,
- Mechanisms for updating the emergency/contingency plan (if necessary).

7.7.11 Environmental Monitoring Plan

Contractor shall be required to monitor their performance with respect to environmental and social performance. The OISL HSE Officer shall also undertake monthly, quarterly and yearly environmental assessments and spot checks throughout the plant project lifecycle. Assessment findings shall be reviewed by the Project Management Team (PMT) and where corrective actions are necessary, specific plans (with designated responsibility and timing) shall be developed to ensure continuous performance improvement.

In addition to assessing operational aspects and monitoring, assessments shall also consider compliance with agreed objectives and targets and the effectiveness of the ESMP and its implementation programs. The ESMP shall, therefore, be subject to ongoing review to ensure that it remains appropriate for all aspects of the project.

The objectives of the monitoring programme are to:

- Monitor and control emissions and discharges and ensure compliance with local, and national standards;
- Ascertain whether any detected alterations in the environment are caused by the project.
- Ensure continual interactions and flow of information between the HSE Manger and the stakeholders; provide a basis for recommending additional mitigation/enhancement measures;
- Ensure that the established procedures for carrying out the proposed project are sustained;

The management review process will ensure that the necessary information is collected to allow management to carry out its evaluation and document review. The monitoring programme for the project that will be implemented at all phases of the project is as follows:

Table 7.5 Environmental Monitoring Programme

Environmental components	Impact Indicator Parameters	Monitoring Method	Sampling Location	Frequency	Project Phase	Responsible Personnel
Environmental Components						
Air Quality	Air Pollutants: CO, SOx, NOx, SPM, Hydrocarbons	Point Measurement	Entire Facility	Monthly	Throughout Project Lifecycle	OISL HSE Officer/ BYSMEnv
Soil	Soil Characteristics	Sample collection using soil auger and analyses	Entire Facility	Quarterly	Throughout Project Lifecycle	OISL HSE Officer/ FMEnv/BYS MEnv
Ground and Surface Water	Water quality parameters	Sample collection and laboratory analyses	From installed boreholes within Project site and surface water bodies around.	Quarterly during construction Bi-annually during operation (for the first three years).	Throughout Project Lifecycle	OISL HSE Officer/ FMEnv/BYS MEnv
Noise/Vibration	Noise Level (dBA)	Point and ambient measurements	Entire Facility	Monthly	Throughout Project Lifecycle	OISL HSE Officer/ BYSMEnv/LG A
Social Components						
Socio-economic	Engagement Issues: (Employment, contractors, suppliers, community)	Review of MoU, employment policies	OISL site/ community	Quarterly	Throughout the project	OISL HSE and CLO Officers
	Social Cultural Issues	Feedback, consultation and review of complaints	Community			

Environmental components	**Impact Indicator Parameters**	**Monitoring Method**	**Sampling Location**	**Frequency**	**Project Phase**	**Responsible Personnel**
Health	Community health: (Prevalent diseases in host community)	Collection of health statistics from clinics and hospitals	Hospitals and Clinics	Yearly	Throughout the project	OISL Management
Regulatory Statutory Monitoring Program						
All Environmental Components	Environmental Management Plan	Impact Mitigation Monitoring (IMM)	Project Site	1st during Construction Phase	Construction Phase	FMEnv & BYSMEnv
All Environmental Components	Environmental Monitoring Reports	Environmental Compliance Monitoring	Project Site and environment	Quarterly after Impact Mitigation Monitoring	Operation Phase	FMEnv & BYSMEnv
All Environmental Components	Environmental Audit	Environmental Compliance Audit	Project Site and environment	Every 3 years during project Operation	Operation Phase	FMEnv, BYSMEnv & LGA

In addition to responsible parties that would be involved in the implementation of the proposed monitoring programme, it is necessary to note that relevant regulatory bodies shall oversee the monitoring exercise. See *Table 7.6* for a list of team members and their responsibilities.

Table 7.6: Monitoring Team

Expert/ Regulators	Aspects
OISL	Project Management
FMEnv	Project Supervision/Regulatory Compliance
SMEnv	Project Supervision/Regulatory Compliance
Yenagoa LGA	Social Assessment/Regulatory Compliance
Environheroes Limited	Environmental Consultancy/Services

7.7.12 Waste Management Plan

Waste generated shall be managed in accordance with Federal Ministry of Environment guidelines and OISL waste management procedures. The way wastes are to be handled, stored and disposed of is dictated by the nature of the waste. OISL's Waste Management Plan (WMP) takes into consideration the nature of all wastes that will be generated during the lifetime of the project. The following objectives form the basis for the WMP for the proposed project:

- Progressive reduction of wastes with the target to minimise overall emissions/ discharges, which have adverse impacts on the environment;
- Meet the environmental requirements of FMEnv and Bayelsa State Waste Management Lawon waste management;
- To establish, implement and maintain waste segregation aimed at enhancing recycling;
- To ensure that OISL and its contractors are responsible for effective waste handlingand disposal processes;
- To ensure that the waste management programme is in line with provisions of the Environmental Management Programme of ISO 14001;

The WMP would be binding on all staff and contractors involved in the proposed project implementation with respect to the:

- Emission or release of air pollutants and fugitive gases;
- Management of solid wastes from plant activities;

The waste management principles of OISL are designed to ensure that wastes generated are properly handled and disposed of, in an environmentally friendly manner by adopting the principle of waste source reduction, recovery and reusing. All wastes, which cannot be reused, are managed and disposed of in accordance with OISL HSE policy and line with the company's Environmental Management System (EMS).

OISL Waste Management Plan

OISL has developed a Waste Management Plan containing procedures to be followed in the management of wastes and discharges from its facility.

Waste Handling

For proper handling and disposal, wastes shall be well defined at the source and labels transmitted along with the wastes to the final disposal points. OISL personnel and contractors shall recordand document all wastes generated in the course of work in a Monthly Waste Report, which shallbe used to track/ monitor wastes generated from the plant facility. Basic information that must be provided as a minimum for adequate definition of wastes include:

- Waste type identification;
- Proper waste categorization and segregation (domestic, office, industrial and hazardous wastes);
- Recommended management practices.

Waste Minimisation

Waste minimisation implies the reduction to the greatest extent possible of the volume of waste materials. The four principles of the waste minimisation process are recycled, reduce, reuse and recover, and shall be adopted as applicable in this project.

Waste Segregation

Waste segregation and characterisation shall be carried out on wastes that are similar and may be combined to simplify storage, treatment, recycling and/or effective implementation of appropriate waste disposal methods. Wastes shall be segregated, preferably at source into clearly designated bins at strategic locations within the plant facility. Attention shall be given to work areas and offices where a significant amount of waste including food packaging would be generated. The Site HSE Officer shall be responsible for the maintenance of the waste segregation scheme.

Waste Disposal

All spoilt materials, rubbish and debris shall be cleared from the site and disposed of, at designated areas and facilities as specified in WMP guidelines. Instructions on the material safety handling sheet shall be strictly adhered to and will form the basis for the disposal of hazardous wastes. Wastes in transit shall be accompanied and tracked by Waste Disposal Notes. Specifically, solid wastes are to be collected/ segregated and stored in waste bins placed in strategic locations around the plant facility by OISL personnel. The bins would be transferred into well-labelled bags which would be evacuated and transferred to a waste collection center. Scrap metals are to be neatly arranged until evacuation, this will be coordinated by OISL HSE personnel. Access towaste storage areas would be restricted, except for authorised personnel. This will be carried out by contractors and monitored by OISL's HSE officer.

Liquid wastes such as wastewater and used oil are to be transferred into a collecting tank. This would be evacuated once the storage tank is filled up. Sewage is to be collected in a septic tank which would also be evacuated when the need arises. OISL does not support the discharge ofwaste into the environment and as such the HSE officer and assigned supervisory personnel wouldensure that solid and liquid wastes from its facility are transferred to the treatment site using an acceptable firm.

7.7.13 Climate Change Adaptation Plan

The adaptation plan will focus on ensuring the plant's resilience to the potential impacts of climate change, such as extreme weather events and temperature fluctuations. Infrastructure and equipment will be designed to withstand high temperatures, heavy rainfall, and other climate-related stresses. Cooling water systems will incorporate efficient and sustainable designs to mitigate the risk of water scarcity. The plant will also conduct regular climate risk assessments and update contingency plans to address emerging climate challenges. Community engagement initiatives will be developed to enhance local awareness of climate risks and support the region's adaptation efforts, ensuring that the project contributes to both climate resilience and sustainable development in the host community.

7.7.13.1 Energy Efficiency and Transition Plan

The energy efficiency plan for the proposed CNG processing and power plant project will focus on optimizing energy use across all operations to minimize waste and reduce carbon emissions. Advanced technologies, such as high-efficiency compressors, waste heat recovery systems, and variable frequency drives (VFDs), will be integrated into the plant's design. These systems will ensure that energy-intensive processes like gas compression and power generation operate at peak efficiency. Real-time energy monitoring and AI-driven control systems will track performance and identify areas for improvement, enabling swift corrective actions to reduce energy consumption. Regular equipment maintenance and periodic energy audits will further ensure that operational efficiency is maintained throughout the project's lifecycle.

The energy transition plan will focus on reducing reliance on fossil fuels and gradually incorporating renewable energy sources into the plant's operations. The project will explore integrating solar or wind energy for auxiliary power requirements, reducing dependence on natural gas. The planned future expansion of the power plant into a combined-cycle configuration will enhance thermal efficiency, reducing fuel consumption per unit of energy produced. Additionally, partnerships will be sought with renewable energy developers to diversify energy sources and align with global energy transition goals. By committing to these strategies, the project aims to contribute to a cleaner energy future while maintaining reliable and sustainable operations.

CHAPTER EIGHT

DECOMMISSIONING AND CLOSURE

8.1 Introduction

Decommissioning of the project will be given utmost priority as the project proponent believes in leaving the environment in this project site as close to how it was before operations began. To this end, all activities related to decommissioning shall be initiated ahead of time, before the cessation of project activities. Considerations will be given to ensuring the safety of navigation taking into cognizance all appropriate regulatory and company requirements. In addition, removal of all structures will be carried out with due regard for the protection of the environment and the rights and duties of the government.

Prior to the actual decommissioning activities, a plan shall be drawn. The plan will discuss the effects of the closure and decommissioning on other stakeholders of the project and the economy of Nigeria in general. Decommissioning of the structures and abandonment is the reverse of construction and commissioning. Therefore, detailed HSE studies, engineering and decommissioning plan must be carried out before implementation. Consultations and negotiations with stakeholders, particularly the host communities, employees and regulatory authorities must commence early and be concluded before of the execution of the decommissioning plan. The Federal Ministry of Environment, NESREA and other regulatory bodies shall be informed about the plan. Furthermore, guideline for site restoration and remediation prevailing at time shall be used.

Before decommissioning, the following plans will be developed:

- The choice of environmentally sound methods for removal, re-use, recycling or disposal of special wastes that may arise from the decommissioning process
- Time frame/schedule for the decommissioning and post-decommissioning process.
- Identification of components of the project that will be removed;
- Proper rehabilitation and decommissioning process;
- Appropriate site rehabilitation, remediation and enhancement techniques and technologies; and
- There shall be post-decommissioning assessments to compare ameliorated project-related impacts, relative to the baseline conditions.

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 will be conducted to determine an appropriate restoration and remedial measures.

8.2 Consultation

The project decommissioning and abandonment plan will include consultation with various stakeholders including employees from various departments. The decommissioning team will include competent personnel from various departments as well as the regulatory authorities.

8.3 Decommissioning of Project and Ancillary Facilities/ Equipment Re-Use

At the end of this project lifespan, the project and all ancillary facilities will be decommissioned. All installed facilities on project site will be adequately dismantled and removed to allow for proper remediation of the project site. A Health, Safety and Environmental Management Systems will be implemented to assure safety of personnel and the public during decommissioning as well as minimize negative environmental impacts.

All the components that can be used or recycled will be identified and quantified. Cleared locations will be re-vegetated using fast growing native plant species, which can either be purchased from a nursery plantations/farms or nursery of these seedlings will be developed by capable agronomists contracted by the proponent.

8.4 Reporting

As required by regulations, a post-decommissioning report will be prepared and submitted to the FMEnv. The report will include 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
- State of the surrounding environment
- Waste Management Plan
- Plans for restoration/ remediation where necessary.

Recommended Mitigation Measures for Decommissioning Phase

Some basic mitigation measures that will be required to be undertaken once all operational activities of the project have ceased. The necessary objectives, mitigation measures, allocation of responsibilities, time frames, prevention, minimization and monitoring of all potential impacts associated with the decommissioning and closure phase of the project.

8.5 Decommissioning and Abandonment Plans

8.5.1 Decommissioning of Existing Facilities

Decommissioning of the proposed the proposed 34 MW Gas Turbines Power Plant is not foreseen, however, decommissioning of related facilities especially project site offices and workshops are inevitable. Further, decommissioning of quarries and borrow sites will be done upon completion of construction works. The proponent will prepare a written abandonment plan within 30 days of determining decommissioning. The Plan will detail how the decommissioning will be carried out.

The abandonment plan will be subject to approval by FMEnv/NESREA. An Environmental Protection and Rehabilitation Plan (EPRP) will be prepared prior to implementation of this plan, to assess and minimize potential environmental and social impacts arising from the abandonment operations. This abandonment EPRP Study will be submitted to FMEnv/NESREA for consideration. Upon completion of the abandonment operations, an assessment of contaminated land will be prepared recording the final contamination status of the location of the project facilities.

8.5.2 Products, By-Products and Waste

The construction of the project will generate inert, non-hazardous and hazardous waste over the period of construction. Operation of the proposed project will result in relatively small volumes of routine waste generation for the life of the Project. Maintenance and repair activities conducted during the operational lifetime of the project may generate limited volume of waste.

8.6 Site Remediation and Restoration

Following decommissioning and abandonment, Obodofei Integrated Services Limited Shall carry out site remediation and restoration work as part of the project's Environmental Management programmes. This will entail:

1) A survey of the decommissioned site for contamination as part of a conceptual site model and a strategy plan.
2) Evaluation of the site hydrology and geology.

3) Preparation of a site assessment report to be approved by FMEnv.
4) Interim action or remediation is designed to confirm the applicability and feasibility of one or more potential remedial options.

Finally, the site shall be monitored for compliance and performance to confirm the effectiveness of the remedial measures. At the end of the site abandonment, the following useful documentation shall be reviewed:

1) The initial Decommissioning and Restoration Plan.
2) The abandonment operations conducted in the field, along with changes to plan necessitated by field conditions.
3) Soil test reports.

CHAPTER NINE

CONCLUSION

The Environmental Impact Assessment (EIA) of the proposed project has been carried out in line with statutory requirements for environmental management in Nigeria and as such ensures that potential environmental, social and health impacts of the project are fully appraised. This EIA report has documented the existing environment of the area, potential and associated impacts of the proposed project, proffered cost effective mitigation/ ameliorative measures for impacts and enhancement measures for the beneficial impacts. A management plan that would be effective throughout the projects life cycle has also been put in place to assure environmental sustainability of the project.

This EIA shall serve as a reference platform against which future changes in the environment vis-à-vis the project in view can be monitored. The document shall also provide the necessary information required for the issuance of Approval and Environmental Impact Statement for the proposed project by the FMEnv and other interest groups. The environmental baseline condition of the project area showed that the physical, chemical and biological characteristics as well as meteorological, climatic and hydrological characteristics were generally consistent with previous studies carried out within the environment with some few exceptions. Also documented were unique assemblages of wild flora and fauna species with abundances that relate to the nutrients and chemical composition of the ecosystems.

Multidisciplinary approach was employed in the assessment of the natural environmental status and sensitivities of the various ecological components of the project area with the use of extensive literature survey, field sampling, measurement/testing, analysis and methodologies compatible with national and international standards.

The sensitivity of the environment to element of the proposed project activities were identified and assessed and appropriate mitigation measures were developed to reduce their adverse effects to ALARP on one hand and enhance their beneficial contributions on the other hand.
An Environmental and Social Management Plan (ESMP) covering the biophysical and socio-economic aspects of the project was developed in order to ensure that mitigation measures would be established and maintained throughout the life cycle of the project. Mitigation

measures were based on best available technology, safety, health and environmental considerations.

Socio economic consultations with the project host communities and other relevant stake holders were also carried out and shall continue throughout the life cycle of the project

It is therefore hoped that all data/evidence contained in this report is sufficient in the development of an environmental impact statement (EIS), and afterward in the acquiring of necessary permits for commencement of project.

In consideration of the above therefore, there is no major environmental issue to impede the development of the proposed project.

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APPENDICES

SOCIAL & HEALTH SURVEY QUESTIONNAIRE FOR ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT OF THE PROPOSED CNG AND POWER PLANT PROJECT AT UNPINA BUSH/PULAKU, ETELEBOU ROAD, OGBOLOMA TOWN IN YENAGOA LOCAL GOVERNMENT AREA OF BAYELSA STATE

Instruction: Please, Tick, write or fill in your response/answer to the questions as appropriate.

Questionnaire Number: ……………
Name of Settlement/Community:……………………
Settlement Type: ……………………………
(Town, Village, Fishing Port, Hamlet, other)
L.G.A/State:………………………
Ethnic Group:……………………
Name of Interviewer:………………………
Date of interview:………………………….

Section A: Socio-demographic Data

1. Sex
1.1. Male
1.2. Female

2. Age
2.1 20-29 years
2.2 30-39 years
2.3 40-49 years
2.4 50-59 years
2.5 60-69 years
2.6 70+ and above

3. Marital Status of Respondent
3.1 Single
3.2 Married
3.3 Divorced
3.4 Separated
3.5 Widowed

4. Respondent's highest level of education
4.1 Primary school
4.2 Secondary school
4.3 Vocational/Technical school
4.3 Tertiary school
4.4 No Formal Education
4.5 Any other (please specify) ……………………

5. Educational attainment of respondent's spouse
5.1 Primary school
5.2 Secondary school
5.3 Vocational/Technical school
5.4 Tertiary school
5.5 No Formal Education
5.6 Any other (please specify) …………………

6. If married male:
i. Number of wives (if male): …………………
ii. Number of children: ……… (M: … F: …)
iii. Number of dependants: ……………
iv. Total number of persons in Household: …….

7. Age and Sex structure of household members

Age in years	Male	Female	Total
0-4			
5-9			
10-14			
15-19			
20-24			
25-29			
30-34			
35-39			
40-44			
45-49			
50-59			
60-64			
>65			

8. How many of your children presently attend the following categories of schools?

School	Boys	Girls	Total
Primary			
Secondary	`		
Vocational/Tech			
Tertiary			
Any other			

9. What is your religion? ………………………….

10. How long have you lived in this settlement/community?
10.1 Less than 1 year
10.2 1-5 years
10.3 6-10 years
10.4 11-15 years
10.5 16-20 years
10.6 Above 20 years
10.7 Since birth

11. Are you an indigene of this community?
11.1. Yes
11.2. No

11b. If NO (i.e. non-indigene), please tell me, where do you come from? ……………………………… (Village/LGA/State)?

12. What is your main source of income/Occupation?
12.1 Farming
12.2 Fishing
12.3 Technician/Artisan
12.4 Trading
12.5 Business/Contractor
12.6 Civil Servant
12.7 Retired
12.8 Student/Apprentice
12.9 Unemployed
12.10 Others (specify):………………………

13. Which is/are your other source(s) of income (secondary occupations)?
13.1 Farming
13.2 Fishing
13.3 Trading
13.4 Technician/Artisan (specify): …………
13.5 Others (specify): ……………………….

14 How much do you earn or make in a month?
14.1 Less than 1,000
14.2 1,000-10,000
14.3 10001-20,000
14.4 20,001-30,000
14.5 30,001-40,000

14.6 40,001-50,000
14.7 50,001-60,000
14.8 60,001-70,000
14.9 70,001-80,000
14.10 80,001-90,0000
14.11 90,001-100,000
14.12 Above 100,000

15 If engaged in more than one economic activity, please estimate amount and percentage income from each:

Occupation	Amount	%
Farming		
Fishing		
Trading		
Business/Contract		
Civil Servant		
Technician/Artisan		
Others (please specify)		

16 If you are a farmer, how did you acquire the land on which you farm?
16.1 Family inheritance
16.2 Rented/leased it
16.3 Bought it
16.4 Sharecropping
16.5 Others (Specify) ……………………

17 What crops do you grow in your farm? (Please mention according to importance)
……………………………………………………
……………………………………………………
……………………………………………………

18. How would you describe your crop harvest in the most recent past (five years back)?
18.1 Increasing
18.2 Decreasing
18.3 The same

19 If decreasing, what in your opinion is responsible?
…………………………………………………………..
…………………………………………………………..

20. As a farmer, what constraints do you experience in your farm work?
20.1 Insufficient land to farm
20.2 Inadequate/lack of capital/money
20.3 Poor technology/local tools used
20.4 Insufficient labour hands
20.5 Any other (specify): ……………………………

21 If fishing is your primary/or secondary occupation, where do you fish?
21.1 River/Creek (please name river/creek) ………………………………
21.2 Ponds
21.3 Flooded areas
21.4 Sea/Ocean

22. What fishing gear(s) do you use?
22.1 Net (with canoe)
22.2 Hook
22.3 Trap/basket
22.4 All of the above
22.5 Any other (specify) ……………………………..

23. How would you describe your fish catch/harvest in the past five years?
23.1 Increasing
23.2 Decreasing
23.3 The same

24. If decreasing, what do you think is responsible?
…………………………………………………………
…………………………………………………………

25. Is there any restriction on where you fish?
25.1 Yes
25.2 No

26. If YES, what is/are the restriction(s)?
…………………………………………………
…………………………………………………

27. Which of the following type of house do you own or live in?
27.1 Sticks/bamboo wall with thatch roof
27.2 Mud wall with thatch roof
27.3 Mud wall with zinc roof (indicate if plastered) …………..........................
27.4 Wood/plank wall with zinc roof
27.5 Zinc wall with zinc roof
27.6 Concrete/block with thatch roof
27.7 Concrete/block with zinc roof
27.8 Others (specify). ………………………..

28. How many rooms are in this house, in which you live, (i.e. minus kitchen, bathroom and stores)? …………………………………………

29. Which is your MAIN source of water supply in the DRY SEASON?
29.1 Rain water
29.2 River/Creek/Stream/pond water (please specify) ………………………………………
29.3 Public hand-dug well system
29.4 Own hand-dug well in residence/compound
29.5 Public tap
29.6 Piped water in residence/compound
29.7 Community Bore-hole (provided by whom?) …………………………………….
29.8 Vendor/buys from private borehole
29.9 Others (specify). ………………………

30 Which is your MAIN source of water supply?
30.1 Rain water
30.2 River/Creek/Stream/pond water (please specify which and name) ……………………
30.3 Public hand-dug well system
30.4 Own hand-dug well in residence/compound
30.5 Public tap
30.6 Piped water in residence/compound
30.7 Community bore-hole (provided by whom?) ……………………………………
30.8 Personal borehole/buys from private borehole (please specify which): ………….
30.8 Others (specify). ………………………..

31. Does your household have the following amenities?

1) Electricity	Yes	No
2) Generator	Yes	No
3) Television	Yes	No
3) Radio	Yes	No
4) Refrigerator	Yes	No
5) Electric fan	Yes	No
6) Telephone (mobile/land line)	Yes	No

Section B: Socioeconomic Sensitivity/ Attitudes/Perceptions

B1. Which of the following important environmental resources in your community do you value most?

a) Forest resources
b) River/Creek water
c) Ancestral sites
d) Animals
e) Others (please specify): ....

B2. Please indicate the environmental problems/challenges which your settlement/community is having.

a) Soil infertility
b) Pest attack/invasion
c) Erosion problems
d) Flooding
e) Oil pollution/spillage
f) Others (specify): ………………………….

B3. Would you say your economic activity has been affected in any way in the past 5 years or so?

1. Yes 2. No

B4. If yes, in what specific way(s) have you been affected?

…………………………………………………………………
…………………………………………………………………
……………………………………………………………..

B5. What in your opinion may have caused the situation?

…………………………………………………………………
…………………………………………………………………

B14. Which of the under-listed social problems have your community experienced in the recent past (tick as many as applicable)?

a) Youth delinquency
b) Land dispute
c) Chieftaincy tussle
d) Inter-family problems
e) Inter-village tribal conflicts
f) Unemployment
g) Alcoholism/prostitution

B15. What in your opinion are the reasons/causes of observed behaviors and/or problems?

…………………………………………………………………
…………………………………………………………………
……………………………………………………….

B16. What are your recommended solutions to solving observed community problem(s) as above?

……………………………………………………………….
………..……………………………………………………….
……………………………………………………………….

Thank you for your cooperation

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED CNG AND POWER PLANT PROJECT AT UNPINA BUSH/PULAKU, ETELEBOU ROAD, OGBOLOMA TOWN IN YENAGOA LOCAL GOVERNMENT AREA OF BAYELSA STATE

ATTENDANCE SHEET DATE: VENUE:

S/N	Name	Designation	Office/Organisation	Phone No.	Signature
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4	AJANI HAPPINESS	"	"	09072009138	
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10	EBIZIMOR PREYE RAPHAEL	DIRECTOR PROC. OBODOFEI			
11	Jackson Diamomibo	Officer	BSMEnv	08068279582	
12	ALEIBIRI AMAIARI	Controller	Amenyx BY	08038658031	
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ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED CNG AND POWER PLANT PROJECT AT UNPINA BUSH/PULAKU, ETELEBOU ROAD, OGBOLOMA TOWN IN YENAGOA LOCAL GOVERNMENT AREA OF BAYELSA STATE

ATTENDANCE SHEET DATE: VENUE:

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ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED CNG AND POWER PLANT PROJECT AT UNPINA BUSH/PULAKU, ETELEBOU ROAD, OGBOLOMA TOWN IN YENAGOA LOCAL GOVERNMENT AREA OF BAYELSA STATE

ATTENDANCE SHEET DATE: VENUE:

S/N	Name	Designation	Office/Organisation	Phone No.	Signature
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2	Oweifa Timipa	Ogboloma		08162747410	
3	Hon. Ebiogbo Tebesolei	Ogboloma		08161371920	
4	EPINI Tarikebine Alpha	Ogboloma		08068540991	
5	Edez Jonathan Imoto	Ogboloma		08161108257	
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8	GIGI KI OBED	Efereta		09074657800	AKI
9	GIGI Madu	Efereta		07031324499	
10	Chief Asene Amos	Efereta		08109831095	
11	GABRIEL [illegible]	Ogboloma		07068282462	
12	Ezekiel pere-eloi	Ogboloma		08108887843	
13	KEMEKEDOUMENE PAUL	Ogboloma		07038032638	
14	GABRIEL PAUOUR	Ogboloma		09054928739	
15	Markson Ebizimor	Ogboloma		08121102803	

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED CNG AND POWER PLANT PROJECT AT UNPINA BUSH/PULAKU, ETELEBOU ROAD, OGBOLOMA TOWN IN YENAGOA LOCAL GOVERNMENT AREA OF BAYELSA STATE

ATTENDANCE SHEET **DATE:** **VENUE:**

S/N	Name	Designation	Office/Organisation	Phone No.	Signature
16	Wanipamo Yameh	H. Community	Stakeholder	08038815041	
17	Ekeru Oputari Isaac	H. Community	Stakeholder	09042325824	
19	Andrew Ezekiel	H. Community		07035041486	ezekiel
20	LAIKO OBEKE	H. Community	Stakeholder	09168392020	
21	Moses Kemefabofieghe Julius			08060296461	
22	Belendiçi Adeke			07027550555	

EBIC INTEGRATED SERVICES LTD

Attention: Lawal Ayoola

CERTIFICATE FOR LABORATORY ANALYSIS

Report Date:	13th November 2024
Client:	Environheroes International Limited
Site Name:	CNG & Power PLT
Project Title:	Environmental Impact Assessment (EIA)
Sample/Matrix Type:	Groundwater,Sediment,Surface water & Soil Samples
Delivery Temperature:	4.88°C
Sampled By:	Lawal Ayoola
Date Sampled:	23/10/2024.
Date Delivered:	30/10/2024.
Date/Period of Analysis:	31/10/2024 - 11/11/2024

A total of 3 Sediment, 3 Surface Water, 4 Groundwater and 34 Soil samples were received in the Laboratory on the 30th of October 2024 for Laboratory Analysis of Physio-Chemicals,Hydrocarbons, and Heavy Metals only.

The samples were recorded and stored in a refrigerator at a temperature of ±4˚C before pre-treatment for Hydrocarbon analysis.

Laboratory analysis of the samples were conducted in strict adherence to the best practices approved by the United States Environmental Protection Agency (USEPA); and adopted Federal Ministry of Environment (FMEnv). This process ensured that all regulatory guidelines and environmental standards were met, and that the analyses were conducted with the utmost diligence and care.

Results presented here must be considered in their entirety and applied only to samples submitted to the laboratory for analysis as listed in this test report. Ebic Integrated Services Limited will not be responsible for using less than the complete report.

All Concerns regarding this report should be directed to *Info@eisl-ng.com* and *q.agubamah@eisl-ng.com*; and via our phone numbers 08039377300, 07043181312.

For Ebic Integrated Services Limited

EBIC INTEGRATED SERVICES LTD (EISL) RC 1729377 Date Sign

Queeneth, Agubamah
Laboratory Manager

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Rumuokurushi,
Port Harcourt, Rivers State.
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EISL

Service Request: EISL/EHI/10/2024
Client: Environheroes International Limited
Project Title: CNG & Power Plant (Environmental Impact Assesment)
Sample Origin: Bayelsa State
Sample No/Type: 4 Ground Water

Date Sampled: 23/10/2024
Date Received: 30/10/2024
Date Of Analysis: 31/10/2024 - 11/11/2024
Date of Reporting: 13/11/2024

LABORATORY TEST RESULTS

FIELD ID	TEST METHOD	SAMPLE ID	GW 1	GW 2	GW 3	GW C	NUPRC Target Value	NUPRC Intervention Value
UNIQUE LABORATORY NO.	LAB ID		EISL/5712	EISL/5713	EISL/5714	EISL/5715		
PHYSICAL CHARACTERISTICS								
Colour, TCU	APHA 2120-C		1	1	1	1	-	-
Total Suspended Solids, mg/l	APHA 2540-D		11.093	10.431	17.223	15.314	-	-
Total Alkalinity, mg/l	APHA 2320-B		50.0	10.0	66.0	15.0	-	-
Acidity, mg/l	APHA 2310-B		4.0	3.0	9.0	8.0	-	-
Total Hardness, mg/l	APHA 2340-C		10.0	4.0	18.0	6.0	-	-
Total Organic Carbon, %	USEPA 415.3		<0.10	<0.10	<0.10	<0.10	-	-
HYDROCARBONS								
TPH, µg/l	USEPA 8015		<0.001	<0.001	<0.001	<0.001	50µg/l	600µg/l
PAH, µg/l	APHA 6440		<0.01	<0.01	<0.01	<0.01	0.057µg/l	70µg/l
BTEX, µg/l	APHA 6200		<0.01	<0.01	<0.01	<0.01	0.8µg/l	1,250µg/l
THC, mg/l	APHA 5520-C		<0.001	<0.001	<0.001	<0.001	-	-
TOG, mg/l	APHA 5520-C		<0.001	<0.001	<0.001	<0.001	-	-
PHYSIOCHEMICALS (mg/l)								
Nitrate	APHA 4500-NO_3^--E		0.035	0.012	0.040	0.016	-	-
Sulphate	APHA 4500-SO_4^{2-}-E		0.056	0.022	0.018	0.026	-	-
Phosphate	APHA 4500-PO_4^{2-}-E		<0.001	<0.001	<0.001	<0.001	-	-
Chloride	APHA 4500-Cl^--B		1.90	0.90	0.90	0.90	-	-
Carbonate	APHA 4500-CO_2		<0.1	<0.1	<0.1	<0.1	-	-
EXCHANGEABLE CATIONS (mg/l)								
Sodium, Na	APHA 3111-B		1.026	2.008	4.678	1.011	-	-
Potassium, K	APHA 3111-B		0.242	0.634	0.815	0.162	-	-
Calcium, Ca	APHA 3111-B		1.523	4.271	6.765	1.678	-	-
Magnesium, Mg	APHA 3111-B		0.825	0.656	1.418	0.835	-	-
HEAVY METALS, mg/l								
Cadmium, Cd	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	0.4	6
Barium, Ba	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	-	-
Vanadium, V	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	-	-
Chromium, Cr	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	1	29
Cobalt,Cr	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	-	-
Copper,Cu	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	15	75
Iron,Fe	APHA 3111-B		0.081	0.067	0.035	0.062	-	-
Manganese, Mn	APHA 3111-B		0.056	0.059	0.118	0.078	-	-
Lead,Pb	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	15	75
Mercury,Hg	APHA 3112-B		<0.001	<0.001	<0.001	<0.001	0.05	0.3
Nickel, Ni	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	15	75
Zinc, Zn	APHA 3111-B		<0.001	<0.001	<0.001	<0.001	65	800
BIOLOGICALS								
Chemical Oxygen Demands, mg/l	APHA- 5220-D		3.20	2.80	7.20	0.40	-	-
Total Heterotrophic Bacteria (cfu/ml)	APHA 9215		5.7×10^5	3.1×10^5	3.9×10^5	3.6×10^5	-	-
Hydrocarbon Degrading Bacteria (cfu/ml)	VAPOUR PHASE		3.9×10^3	2.6×10^3	5.3×10^3	7.1×10^3	-	-
Total Heterotrophic Fungi (cfu/ml)	APHA 9215		4.2×10^4	5.8×10^4	2.9×10^4	4.0×10^4	-	-
Hydrocarbon Degrading Fungi (cfu/ml)	VAPOUR PHASE		2.7×10^3	2.5×10^3	4.1×10^3	3.3×10^3	-	-
Total Coliform (MPN/100ml)	APHA 9221		15	23	11	14	-	-
Faecal Coliform (MPN/100ml)	APHA 9221		0	0	0	0	-	-

For Ebic Integrated Services Limited

EBIC INTEGRATED SERVICES LTD (EISL)
Date

PREPARED BY;Ayatmmo,E **REVIEWED BY; Queeneth, A** **APPROVED BY; JUDE, O**

EISL

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Service Request: EISL/EHI/10/2024
Client: Environheroes International Limited
Project Title: CNG & Power Plant (Environmental Impact Assesment)
Sample Origin: Bayelsa State
Sample No/Type: 3 Surface Water

Date Sampled: 23/10/2024
Date Received: 30/10/2024
Date Of Analysis: 31/10/2024 - 11/11/2024
Date of Reporting: 13/11/2024

LABORATORY TEST RESULTS

FIELD ID	TEST METHOD	SAMPLE ID	SW (US)	SW (MID)	SW (DS)	NUPRC Target Value	NUPRC Intervention Value
UNIQUE LABORATORY NO.	**LAB ID**		**EISL/5716**	**EISL/5717**	**EISL/5718**		
PHYSICAL CHARACTERISTICS							
Colour,TCU	**APHA 2120-C**		1	1	1	-	-
Total Suspended Solids, mg/l	**APHA 2540-D**		6.045	9.244	15.218	-	-
Total Alkalinity, mg/l	**APHA 2320-B**		12.0	16.0	12.0	-	-
Acidity, mg/l	**APHA 2310-B**		8.0	10.0	8.0	-	-
Total Hardness, mg/l	**APHA 2340-C**		80.0	120.0	162.0	-	-
Total Organic Carbon, %	**USEPA 415.3**		<0.1	<0.1	<0.1	-	-
HYDROCARBONS							
TPH, µg/l	**USEPA 8015**		<0.001	<0.001	<0.001	**50µg/l**	**600µg/l**
PAH, µg/l	**APHA 6440**		<0.01	<0.01	<0.01	**0.057µg/l**	**70µg/l**
BTEX, µg/l	**APHA 6200**		<0.01	<0.01	<0.01	**0.8µg/l**	**1,250µg/l**
THC, mg/l	**APHA 5520-C**		<0.001	<0.001	<0.001	-	-
TOG, mg/l	**APHA 5520-C**		<0.001	<0.001	<0.001	-	-
PHYSIOCHEMICALS (mg/l)							
Nitrate	**APHA 4500-NO_3^--E**		0.033	0.526	0.021	-	-
Sulphate	**APHA 4500-SO_4^{2-}-E**		47.096	53.102	61.079	-	-
Phosphate	**APHA 4500-PO_4^{2-}-E**		<0.001	<0.001	<0.001	-	-
Chloride	**APHA 4500-Cl^--B**		29.90	49.90	99.90	-	-
Carbonate	**APHA 4500-CO_2**		<0.10	<0.10	<0.10	-	-
EXCHANGEABLE CATIONS (mg/l)							
Calcium, Ca	**APHA 3111-B**		472.697	480.164	514.005	-	-
Sodium, Na	**APHA 3111-B**		304.432	331.147	467.598	-	-
Magnesium, Mg	**APHA 3111-B**		219.389	248.512	391.884	-	-
Potassium, K	**APHA 3111-B**		72.697	80.164	101.005	-	-
HEAVY METALS, mg/l							
Cadmium, Cd	**APHA 3111-B**		<0.001	<0.001	<0.001	**0.4**	**6**
Barium, Ba	**APHA 3111-B**		<0.001	<0.001	<0.001	-	-
Vanadium, V	**APHA 3111-B**		<0.001	<0.001	<0.001	-	-
Chromium, Cr	**APHA 3111-B**		<0.001	<0.001	<0.001	**1**	**29**
Cobalt,Cr	**APHA 3111-B**		<0.001	<0.001	<0.001	-	-
Copper,Cu	**APHA 3111-B**		0.243	0.527	0.151	**15**	**75**
Manganese, Mn	**APHA 3111-B**		10.524	26.715	57.286	-	-
Iron,Fe	**APHA 3111-B**		1.241	2.256	1.956	-	-
Lead,Pb	**APHA 3111-B**		<0.001	<0.001	<0.001	**15**	**75**
Mercury,Hg	**APHA 3112-B**		<0.001	<0.001	<0.001	**0.05**	**0.3**
Nickel,Ni	**APHA 3111-B**		<0.001	<0.001	<0.001	**15**	**75**
Zinc,Zn	**APHA 3111-B**		<0.001	<0.001	<0.001	**65**	**800**
BIOLOGICALS							
Chemical Oxygen Demands, mg/l	**APHA- 5220-D**		0.40	0.80	0.40	-	-
Total Heterotrophic Bacteria (cfu/ml)	**APHA 9215**		5.1×10^5	3.9×10^5	2.9×10^5	-	-
Hydrocarbon Degrading Bacteria (cfu/ml)	**VAPOUR PHASE**		2.9×10^3	4.3×10^3	5.1×10^3	-	-
Total Heterotrophic Fungi (cfu/ml)	**APHA 9215**		6.0×10^4	4.5×10^4	3.0×10^4	-	-
Hydrocarbon Degrading Fungi (cfu/ml)	**VAPOUR PHASE**		2.6×10^3	3.2×10^3	4.5×10^3	-	-
Total Coliform (MPN/100ml)	**APHA 9221**		39	21	28	-	-
Faecal Coliform (MPN/100ml)	**APHA 9221**		7	3	4	-	-

For Ebic Integrated Services Limited

EBIC INTEGRATED SERVICES LTD (EISL) RC 1329377 Date

PREPARED BY; Ayatmmo, E.

REVIEWED BY; Queeneth, A

APPROVED BY; JUDE, O

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Service Request: EISL/EHI/10/2024
Client: Environheroes International Limited
Project Title: CNG & Power Plant (Environmental Impact Assesment)
Sample Origin: Bayelsa State
Sample No/Type: 3 Sediment Samples

Date Sampled: 23/10/2024
Date Received: 30/10/2024
Date Of Analysis: 31/10/2024 - 11/11/2024
Date of Reporting: 13/11/2024

LABORATORY TEST RESULTS

FIELD ID	TEST METHOD / SAMPLE ID	SED 1	SED 2	SED 3
	LAB ID	EISL/5719	EISL/5720	EISL/5721
pH	EPA 9045D	7.24	8.11	6.79
Moisture content (%)	ASTM 2216 D	2.98	8.36	4.22
TOC (%)	EPA 9060A	<0.1	<0.1	<0.1
Color	Mussell Chart	Dull Brown7.5R 6/3	Light Red 2.5YR 7/6	Dark Reddish Gray 10R 3/4
Porosity	ASTM D4404	6.42	12.33	3.51
Permeability	ASTM 2434 D	2.91	6.25	1.26
Bulk Density	ASTM 1895	4.18	2.13	8.39
Sand (%)	ASTM 7928 D	15.96	16.22	2.94
Silt (%)		23.18	13.91	11.82
Clay (%)		60.86	69.87	85.24
Texture		Loamy Silt	Loamy Silt	Loamy Silt
TPH, mg/kg	EPA 8015	16.568	12.660	10.973
PAH, mg/kg	EPA 8270	<0.01	<0.01	<0.01
BTEX,mg/kg	EPA 5021	<0.01	<0.01	<0.01
THC, mg/kg	EPA 8015	19.036	14.876	11.765
TOG, mg/kg	EPA 413.1	25.172	18.213	12.367
Nitrite, mg/kg	EPA 353.2	0.018	0.008	0.012
Sulphate, mg/kg	EPA 375.4	22.016	19.972	30.218
Phosphate, mg/kg	EPA 365.3	2.934	1.365	0.193
Chloride, mg/kg	EPA 325.3	14.90	20.90	22.90
Bicarbonate, mg/kg	EPA 310.2	<0.1	<0.1	<0.1
Ammonium, mg/kg	EPA 350.1	0.093	0.042	0.018
Total Nitrogen, mg/kg	EPA 351	4.943	1.536	0.257
Sodium, mg/kg	EPA 7000B	212.373	166.293	218.372
Potassium, mg/kg		351.011	450.538	560.125
Calcium, mg/kg		616.267	999.983	412.378
Magnesium, mg/kg		338.134	344.924	306.256
Manganese, mg/kg		1.903	0.822	0.319
Cobalt, mg/kg		<0.001	<0.001	<0.001
Barium, mg/kg		<0.001	<0.001	<0.001
Cadmium,mg/kg		<0.001	<0.001	<0.001
Chromium,mg/kg		<0.001	<0.001	<0.001
Copper, mg/kg		0.011	0.008	0.004
Iron, mg/kg		1530.267	1318.562	1224.617
Vanadium, mg/kg		<0.001	<0.001	<0.001
Lead, mg/kg		<0.001	<0.001	<0.001
Mercury, mg/kg		<0.001	<0.001	<0.001
Nickel, mg/kg		0.023	0.051	0.063
Zinc, mg/kg		0.726	0.418	0.908
Total Heterotrophic Bacteria, Cfu/g	SPREAD PLATE	3.0×10^5	3.0×10^5	3.0×10^5
Hydrocarbon Utilizing Bacteria, Cfu/g	VAPOUR PHASE	5.1×10^3	2.8×10^3	2.9×10^3
Total Heterotrophic Fungi, Cfu/g	SPREAD PLATE	2.8×10^4	3.0×10^4	2.6×10^4
Hydrocarbon Utilizing Fungi, Cfu/g	VAPOUR PHASE	3.4×10^3	2.7×10^3	2.6×10^3
Total Coliform, (MPN/100g)	SPREAD PLATE	64	23	39
Faecal Coliform, (MPN/100g)	SPREAD PLATE	15	7	9

For Ebic Integrated Services Limited

PREPARED BY;Ayatmmo,E.

EBIC INTEGRATED SERVICES LTD (EISL)

REVIEWED BY; Queeneth, A

APPROVED BY; JUDE, O

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Service Request: EISL/EHI/10/2024
Client: Environheroes International Limited
Project Title: CNG & Power Plant (Environmental Impact Assesment)
Sample Origin: Bayelsa State
Sample No/Type: 8 Soil

Date Sampled: 23/10/2024
Date Received: 30/10/2024
Date Of Analysis: 31/10/2024 - 11/11/2024
Date of Reporting: 13/11/2024

LABORATORY TEST RESULTS

FIELD ID	TEST METHOD / SAMPLE ID	SS1 TOP	SS1 BOTTOM	SS2 TOP	SS2 BOTTOM	SS3 TOP	SS3 BOTTOM	SS4 TOP	SS4 BOTTOM
	LAB ID	EISL/5722	EISL/5723	EISL/5724	EISL/5725	EISL/5726	EISL/5727	EISL/5728	EISL/5729
pH	EPA 9045D	6.11	6.31	7.09	6.32	5.82	8.32	7.11	7.09
Moisture content (%)	ASTM 2216 D	6.51	3.54	2,89	5.12	4.99	6.31	4.37	6.54
TOC (%)	EPA 9060A	7.68	4.78	5.21	6.32	8.57	6.43	10.34	7.39
Color	Musell Chart	Dark Reddish Gray 10R 3/4	Dull Brown7.5R 6/3	Light Red 2.5YR 7/6	Yellowish Red 5YR 4/6	Light reddish brown 5YR 6/4	Yellowish red 5YR 4/6	Light reddish brown 2.5YR 7/4	Yellowish red 5YR 4/6
Porosity,%	ASTM D4404	19.69	21.75	5.65	2.58	12.54	18.53	24.81	17.86
Permeability, cm/h	ASTM 2434 D	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Bulk Density, g/cm_3	ASTM 1895	12.4	14.0	16.2	15.8	17.4	17.8	18.2	18.6
Sand (%)	ASTM 7928 D	71.00	75.52	91.36	79.16	19.38	56.57	23.20	85.68
Silt (%)		27.00	21.40	6.53	18.85	70.82	25.12	68.98	12.36
Clay (%)		2.00	3.10	2.12	1.99	9.8	18.31	7.82	1.96
Texture		Sand Loam	Loamy Sand	Sand	Loamy Sand	Silt Loam	Sandy Loam	Silt Loam	Loamy Sand
TPH, mg/kg	EPA 8015	13.597	10.876	14.952	8.949	18.112	11.919	15.403	17.984
PAH, mg/kg	EPA 8270	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX, mg/kg	EPA 5021	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THC, mg/kg	EPA 8015	77.452	51.234	62.345	44.876	61.548	63.334	74.345	83.382
TOG, mg/kg	EPA 413.1	96.663	67.678	76.018	53.087	77.345	76.346	87.739	93.748
Nitrite, mg/kg	EPA 353.2	0.094	0.047	0.016	0.024	0.183	0.047	0.023	0.028
Sulphate, mg/kg	EPA 375.4	0.254	0.126	0.157	0.144	0.104	0.264	0.341	0.206
Phosphate, mg/kg	EPA 365.3	0.209	0.123	0.244	0.350	0.222	0.432	0.514	0.448
Chloride, mg/kg	EPA 325.3	2.99	4.99	2.99	1.99	4.99	1.99	3.99	1.99
Bicarbonate, mg/kg	EPA 310.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium, mg/kg	EPA 350.1	1.763	1.432	2.089	1.433	2.543	1.313	3.981	1.415
Total Nitrogen, mg/kg	EPA 351	0.173	0.231	0.343	0.512	0.534	0.196	0.632	0.724
Sodium, mg/kg	EPA 7000B	156.580	379.814	388.234	490.131	425.485	292.420	240.620	218.620
Potassium, mg/kg		170.019	146.389	294.828	318.136	262.522	418.171	378.235	277.849
Calcium, mg/kg		668.875	586.289	681.011	559.969	700.348	579.889	403.432	514.331
Magnesium, mg/kg		147.053	191.573	107.456	129.442	190.013	124.793	121.573	130.053
Manganese, mg/kg		18.365	12.953	30.524	16.376	14.245	27.312	21.634	18.345
Cobalt, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, mg/kg		1.702	0.483	0.415	1.401	1.779	1.234	2.783	1.995
Iron, mg/kg		1359.082	1208.043	1624.881	1419.547	1559.291	1432.725	1513.657	1330.948
Vanadium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, mg/kg		0.023	0.074	<0.001	0.052	0.074	<0.001	0.052	0.071
Mercury, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, mg/kg		<0.001	0.324	0.0145	<0.001	1.028	<0.001	<0.001	<0.001
Zinc, mg/kg		0.016	0.042	0.038	0.054	0.049	0.098	0.076	0.052
Total Heterotrophic Bacteria, Cfu/g	SPREAD PLATE	5.2×10^6	7.4×10^5	6.2×10^6	5.3×10^6	8.9×10^6	4.7×10^6	7.3×10^6	4.2×10^6
Hydrocarbon Utilizing Bacteria, Cfu/g	VAPOUR PHASE	4.0×10^3	2.9×10^3	2.5×10^3	3.0×10^3	2.6×10^3	2.7×10^3	3.1×10^3	4.0×10^3
Total Heterotrophic Fungi, Cfu/g	SPREAD PLATE	3.9×10^4	4.4×10^4	6.1×10^4	2.5×10^4	3.9×10^4	4.0×10^4	4.2×10^3	2.3×10^4
Hydrocarbon Utilizing Fungi, Cfu/g	VAPOUR PHASE	4.2×10^3	2.9×10^3	2.5×10^3	4.2×10^3	3.0×10^3	4.3×10^3	2.5×10^3	2.6×10^3
Total Coliform, (MPN/100g)	SPREAD PLATE	39	64	28	21	23	7	9	21
Faecal Coliform, (MPN/100g)	SPREAD PLATE	28	15	11	9	11	0	4	7

For Ebic Integrated Services Limited

EBIC INTEGRATED SERVICES LTD (EISL) RC 1229377 Date

PREPARED BY; Ayatmmo,E **REVIEWED BY; Queeneth, A** **APPROVED BY; JUDE, O**

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Service Request: EISL/EHI/10/2024
Client:Environheroes International Limited
Project Title: CNG & Power Plant (Environmental Impact Assesment)
Sample Origin: Bayelsa State
Sample No/Type: 8 Soil

Date Sampled: 23/10/2024
Date Received: 30/10/2024
Date Of Analysis: 31/10/2024 - 11/11/2024
Date of Reporting: 13/11/2024

LABORATORY TEST RESULTS

FIELD ID	TEST METHOD / SAMPLE ID	SS5 TOP	SS5 BOTTOM	SS6 TOP	SS6 BOTTOM	SS7 TOP	SS7 BOTTOM	SS8 TOP	SS8 BOTTOM
	LAB ID	EISL/5730	EISL/5731	EISL/5732	EISL/5733	EISL/5734	EISL/5735	EISL/5736	EISL/5737
pH	EPA 9045D	6.98	8.02	6.32	5.14	6.09	6.31	6.74	8.92
Moisture content (%)	ASTM 2216 D	4.51	5.68	6.32	5.82	4.45	5.63	3.87	5.62
TOC (%)	EPA 9060A	4.21	8.31	6.76	7.95	6.14	7.21	6.17	4.25
Color	Mussel Chart	Reddish brown 5YR 4/3	Strong brown 7.5YR 4/6	Reddish brown 5YR 4/4	Dull Brown7.5R 6/3	Dull Brown7.5R 6/3	Dark Reddish Gray 10R 3/4	Strong brown 7.5YR 4/6	Reddish brown 5YR 4/4
Porosity,%	ASTM D4404	15.80	21.9	19.23	20.85	19.90	17.46	15.75	19.44
Permeability, cm/h	ASTM 2434 D	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	High
Bulk Density, g/cm_3	ASTM 1895	14.4	14.8	11.5	19.1	14.8	17.9	15.5	110.2
Sand (%)	ASTM 7928 D	78.54	75.42	80.53	62.64	59,09	19.47	40.44	56.45
Silt (%)		16.50	11.82	12.29	28.43	28.22	70.28	20.61	33.87
Clay (%)		4.96	12.76	7.18	8.93	15.69	10.25	19.83	9.68
Texture		Loamy Sand	Sandy Loam	Loamy Sand	Sandy Loam	Sandy Loam	Silt Loam	Loam	Sandy Loam
TPH, mg/kg	EPA 8015	11.022	14.241	15.488	9.925	11.754	18.315	18.296	13.063
PAH, mg/kg	EPA 8270	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX, mg/kg	EPA 5021	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THC, mg/kg	EPA 8015	83.889	93.456	84.381	62.330	103.546	96.281	82.343	64.339
TOG, mg/kg	EPA 413.1	95.817	121.583	91.066	78.263	163.641	117.217	99.459	73.129
Nitrite, mg/kg	EPA 353.2	0.021	0.079	0.042	0.069	0.029	0.014	0.09	0.082
Sulphate, mg/kg	EPA 375.4	0.317	0.299	0.342	0.562	0.871	0.302	0.543	0.654
Phosphate, mg/kg	EPA 365.3	0.817	0.431	0.326	0.428	0.178	0.407	0.306	0.222
Chloride, mg/kg	EPA 325.3	1.99	2.99	4.99	2.99	8.99	1.99	3.99	4.99
Bicarbonate, mg/kg	EPA 310.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium, mg/kg	EPA 350.1	1.133	5.433	1.426	2.360	1.430	1.588	4.293	1.989
Total Nitrogen, mg/kg	EPA 351	0.263	0.485	0.438	0.186	0.34	0.285	0.439	0.432
Sodium, mg/kg	EPA 7000B	245.400	149.500	163.780	117.380	167.320	123.600	192.967	150.300
Potassium, mg/kg		174.214	121.046	132.432	156.928	122.708	250.771	123.349	176.588
Calcium, mg/kg		498.206	539.668	337.149	491.776	404.749	462.874	564.888	631.399
Magnesium, mg/kg		189.871	100.728	111.325	183.856	109.319	150.274	174.145	195.235
Manganese, mg/kg		24.368	41.723	24.167	18.365	22.618	29.437	18.291	18.356
Cobalt, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, mg/kg		1.544	1.192	2.446	1.110	1.544	1.143	0.231	0.229
Iron, mg/kg		1112.269	1123.676	1112.56	1123.354	1116.715	1230.853	1139.652	1118.458
Vanadium, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, mg/kg		0.009	0.078	0.098	0.034	0.017	0.096	0.017	1.098
Mercury, mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, mg/kg		0.345	0.125	<0.001	0.202	0.088	0.582	<0.001	<0.001
Zinc, mg/kg		0.043	0.057	0.031	0.053	0.049	0.029	0.033	0.021
Total Heterotrophic Bacteria, Cfu/g	SPREAD PLATE	2.9 x 10^6	4.7 x 10^6	3.9 x 10^6	5.3 x 10^6	8.3 x 10^5	7.0 x 10^5	6.9 x 10^5	3.6 x 10^6
Hydrocarbon Utilizing Bacteria, Cfu/g	VAPOUR PHASE	3.8 x 10^3	2.7 x 10^3	2.5 x10^3	2.7 x 10^3	2.4 x 10^3	3.0 x 10^3	2.9 x 10^3	2.5 x 10^3
Total Heterotrophic Fungi, Cfu/g	SPREAD PLATE	2.9 x 10^4	3.1 x 10^4	1.0 x 10^4	3.8 x 10^4	2.5 x 10^4	2.9 x 10^4	3.8 x 10^4	4.1 x 10^4
Hydrocarbon Utilizing Fungi, Cfu/g	VAPOUR PHASE	2.5 x 10^4	4.2x 10^3	2. 9 x 10^3	2.5 x 10^3	4.2x 10^3	7.0 x 10^3	3.1 x 10^3	4.8 x 10^3
Total Coliform, (MPN/100g)	SPREAD PLATE	23	11	15	20	11	14	7	20
Faecal Coliform, (MPN/100g)	SPREAD PLATE	9	4	7	11	7	7	0	7

For Ebic Integrated Services Limited

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Service Request: EISL/EHI/10/2024
Client: Environheroes International Limited
Project Title: CNG & Power Plant (Environmental Impact Assesment)
Sample Origin: Bayelsa State
Sample No/Type: 8 Soil

Date Sampled: 23/10/2024
Date Received: 30/10/2024
Date Of Analysis: 31/10/2024 - 11/11/2024
Date of Reporting: 13/11/2024

LABORATORY TEST RESULTS

FIELD ID	TEST METHOD	SAMPLE ID	SS9 TOP	SS9 BOTTOM	SS10 TOP	SS10 BOTTOM	SS11 TOP	SS11 BOTTOM	SS12 TOP	SS12 BOTTOM
		LAB ID	EISL/5738	EISL/5739	EISL/5740	EISL/5741	EISL/5742	EISL/5743	EISL/5744	EISL/5745
pH	EPA 9045D		7.52	6.83	6.64	7.42	5.99	6.32	6.99	8.31
Moisture content (%)	ASTM 2216 D		3.34	5.74	4.55	5.77	3.28	4.62	5.32	3.91
TOC (%)	EPA 9060A		6.32	4.54	8.43	5.87	1.98	2.56	3.47	5.46
Color	Mussel Chart		Dull Brown7.5R 6/3	Light red 2.5YR 6/8	Dark Reddish Gray 10R 3/4	Dark Reddish Gray 10R 3/4	Dark Reddish Gray 10R 3/4	Dull Brown7.5R 6/3	Light reddish brown 2.5YR 7/4	Dull Brown7.5R 6/3
Porosity,%	ASTM D4404		2.75	18.75	13.63	2.75	15.38	9.63	17.88	21.63
Permeability, cm/h	ASTM 2434 D		Low	Low	Low	Low	Low	Moderate	Moderate	Moderate
Bulk Density, g/cm_3	ASTM 1895		19.2	11.9	18.7	12.3	10.8	17,6	14.9	10.6
Sand (%)	ASTM 7928 D		50.44	37.55	18.96	28.73	28.82	46.95	34.58	48.2
Silt (%)			43.72	54.92	70.22	63.05	54.12	28.88	27.26	27.84
Clay (%)			5.84	7.53	10.82	8.22	12.27	22.33	38.02	21.64
Texture			Sandy Loam	Silt Loam	Silt Loam	Silt Loam	Silt Loam	Loam	Clay Loam	Clay Loam
TPH, mg/kg	EPA 8015		16.171	10.874	12.858	9.148	11.913	8.074	18.679	10.469
PAH, mg/kg	EPA 8270		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX, mg/kg	EPA 5021		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THC, mg/kg	EPA 8015		75.343	63.719	83.653	76.234	84.431	77.421	102.436	112.473
TOG, mg/kg	EPA 413.1		83.864	76.543	95.264	86.523	126.66	98.984	117.944	140.423
Nitrite, mg/kg	EPA 353.2		0.052	0.018	0.015	0.029	0.014	0.057	0.031	0.053
Sulphate, mg/kg	EPA 375.4		0.128	0.942	0.743	0.823	0.309	0.431	0.921	0.095
Phosphate, mg/kg	EPA 365.3		0.672	0.896	1.146	0.928	0.665	0.921	1.481	0.379
Chloride, mg/kg	EPA 325.3		0.99	7.99	4.99	2.99	4.99	5.99	9.99	2.99
Bicarbonate, mg/kg	EPA 310.2		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium, mg/kg	EPA 350.1		3.415	1.709	1.369	2.985	3.983	5.092	4.123	2.957
Total Nitrogen, mg/kg	EPA 351		0.648	0.784	0.217	0.432	0.328	0.472	0.289	0.329
Sodium, mg/kg	EPA 7000B		290.180	395.02	438.38	599.495	266.58	385.700	403.220	365.460
Potassium, mg/kg			431.379	240.37	328.614	311.285	408.525	473.395	570.362	1136.408
Calcium, mg/kg			337.994	217.685	332.938	235.874	266.733	220.732	238.628	242.473
Magnesium, mg/kg			176.871	120.585	171.753	134.603	125.989	140.792	115.092	151.845
Manganese, mg/kg			26.372	12.492	16.429	17.034	24.267	28.351	30.514	49.263
Cobalt, mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, mg/kg			0.227	0.232	0.223	0.240	0.249	0.225	0.218	0.230
Iron, mg/kg			1116.932	1150.759	1185.782	1196.809	1114.372	1182.884	1142.342	1187.842
Vanadium, mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, mg/kg			<0.001	0.674	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc, mg/kg			0.011	0.178	0.25	0.153	0.154	0.024	0.022	0.013
Total Heterotrophic Bacteria, Cfu/g	SPREAD PLATE		8.2×10^5	6.7×10^5	5.1×10^6	4.9×10^6	3.0×10^6	7.8×10^5	6.9×10^5	7.0×10^4
Hydrocarbon Utilizing Bacteria, Cfu/g	VAPOUR PHASE		5.4×10^3	4.0×10^3	7.0×10^3	3.1×10^3	5.8×10^3	5.2×10^3	3.5×10^3	3.2×10^3
Total Heterotrophic Fungi, Cfu/g	SPREAD PLATE		2.7×10^4	3.9×10^4	5.0×10^4	2.2×10^4	1.9×10^4	3.5×10^4	2.0×10^4	2.3×10^4
Hydrocarbon Utilizing Fungi, Cfu/g	VAPOUR PHASE		6.2×10^3	3.5×10^3	3.2×10^3	4.9×10^3	2.5×10^3	4.2×10^3	2.9×10^3	2.7×10^3
Total Coliform, (MPN/100g)	SPREAD PLATE		14	15	23	20	7	9	15	21
Faecal Coliform, (MPN/100g)	SPREAD PLATE		4	9	11	15	3	3	7	11

For Ebic Integrated Services Limited

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Service Request: EISL/EHI/10/2024
Client:Environheroes International Limited
Project Title: CNG & Power Plant (Environmental Impact Assesment)
Sample Origin: Bayelsa State
Sample No/Type: 10 Soil

Date Sampled: 23/10/2024
Date Received: 30/10/2024
Date Of Analysis: 31/10/2024 - 11/11/2024
Date of Reporting: 13/11/2024

LABORATORY TEST RESULTS

FIELD ID	TEST METHOD / SAMPLE ID	SS13 TOP	SS13 BOTTOM	SS14 TOP	SS14 BOTTOM	SS15 TOP	SS15 BOTTOM	SS16 TOP	SS16 BOTTOM	SS CONTRL TOP	SS CONTRL BOTTOM
	LAB ID	EISL/5746	EISL/5747	EISL/5748	EISL/5749	EISL/5750	EISL/5751	EISL/5752	EISL/5753	EISL/5754	EISL/5755
pH	EPA 9045D	5.73	5.39	6.33	5.72	7.31	6.44	5.95	7.84	6.38	7.15
Moisture content (%)	ASTM 2216 D	3.79	5.32	3.28	7.33	4,81	2.88	5.98	3.61	4.83	5.39
TOC (%)	EPA 9060A	4.78	2.85	6.83	9.21	6.35	6.21	7.31	4.44	2.91	4.05
Color	Mussel Chart	Reddish brown 5YR 4/3	Yellowish Red 5YR 4/6	Light reddish brown 5YR 6/4	Reddish brown 5YR 4/3	Light reddish brown 2.5YR 7/4	Yellowish red 5YR 4/6	Dull Brown7.5R 6/3	Dull Brown7.5R 6/3	Dark Reddish Gray 10R 3/4	Strong brown 7.5YR 4/6
Porosity,%	ASTM D4404	14.00	17.13	14.12	2.90	2.30	2.12	3.72	11.38	1.38	4.89
Permeability, cm/h	ASTM 2434 D	Moderate	Moderate	Moderate	Low	High	Low	Low	Moderate	Low	Moderate
Bulk Density, g/cm_3	ASTM 1895	17.5	12.4	16.9	10.4	17.1	19.6	13,9	17.8	16,3	11.8
Sand (%)	ASTM 7928 D	57.84	50.4	24.1	66.19	58.5	28.66	29.48	43.48	64.55	38.78
Silt (%)		14.35	28.29	69.36	27.31	16.72	40.81	52.72	33.65	22.26	39.91
Clay (%)		24.29	18.85	4.55	10.75	20.16	22.11	12.92	22.87	13.19	21.87
Texture		Sandy Clay Loam	Loam	Silt Loam	Sandy Loam	Sandy Clay Loam	Loam	Silt Loam	Loam	Sandy Loam	Loam
TPH,mg/kg	EPA 8015	10.319	8.276	14.558	11.364	16.220	11.852	22.865	18.320	11.920	8.510
PAH,mg/kg	EPA 8270	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX,mg/kg	EPA 5021	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THC,mg/kg	EPA 8015	53.781	103.655	112.563	82.454	93.541	53.431	92.665	71.423	92.435	82.1423
TOG,mg/kg	EPA 413.1	60.219	133.54	140.42	95.854	121.522	61.011	115.319	88.417	110.657	97.309
Nitrite,mg/kg	EPA 353.2	0.049	0.029	0.033	0.021	0.011	0.178	0.25	0.153	0.154	0.024
Sulphate,mg/kg	EPA 375.4	0.753	0.951	0.437	0.309	0.276	0.302	0.543	0.843	0.309	0.343
Phosphate,mg/kg	EPA 365.3	0.287	0.358	1.747	2.523	3.607	2.844	4.366	3.119	3.058	2.729
Chloride,mg/kg	EPA 325.3	3.99	6.99	1.99	3.99	1.99	2.99	4.99	9.99	0.99	1.99
Bicarbonate,mg/kg	EPA 310.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium,mg/kg	EPA 350.1	4.092	6.582	2.224	1.934	1.982	2.821	1.515	1.656	1.873	3.163
Total Nitrogen,mg/kg	EPA 351	0.523	0.843	0.312	0.489	0.319	0.182	0.143	0.643	0.216	0.742
Sodium,mg/kg	EPA 7000B	182.600	176.020	125.460	295.020	294.400	234.025	245.400	299.786	161.011	115.319
Potassium,mg/kg		116.155	149.209	104.302	134.555	127.094	195.399	141.332	155.602	124.174	94.926
Calcium,mg/kg		585.362	655.576	967.836	805.999	332.993	408.657	482.216	1471.262	386.429	243.678
Magnesium,mg/kg		143.274	188.156	157.313	191.183	149.222	194.559	178.313	182.816	132.741	87.172
Manganese,mg/kg		20.745	33.078	46.924	18.356	30.634	14.267	12.367	18.489	18.246	32.648
Cobalt,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper,mg/kg		0.102	0.094	0.047	0.016	0.024	0.183	0.047	0.016	0.042	0.022
Iron,mg/kg		1936.963	1140.092	1867.962	1173.963	1211.052	1997.649	1017.374	1208.935	1231.058	1067.853
Vanadium,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.521	0.379	0.087
Mercury,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel,mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc,mg/kg		0.196	0.022	0.018	0.209	0.312	0.298	0.219	0.307	0.276	0.287
Total Heterotrophic Bacteria,Cfu/g	SPREAD PLATE	3.9×10^6	8.0×10^5	4.3×10^6	6.0×10^5	7.4×10^5	3.5×10^6	4.6×10^6	4.1×10^6	2.9×10^6	5.1×10^5
Hydrocarbon Utilizing Bacteria,Cfu/g	VAPOUR PHASE	4.9×10^3	4.0×10^3	4.3×10^3	3.9×10^3	3.0×10^3	2.6×10^3	3.9×10^3	3.4×10^3	2.8×10^3	4.2×10^3
Total Heterotrophic Fungi,Cfu/g	SPREAD PLATE	4.5×10^4	3.2×10^4	5.9×10^4	3.5×10^4	4.1×10^4	3.3×10^4	6.0×10^4	3.7×10^4	4.2×10^4	27×10^4
Hydrocarbon Utilizing Fungi,Cfu/g	VAPOUR PHASE	4.2×10^3	2.9×10^3	2.5×10^3	4.2×10^3	2.6 x 103	2.5×10^3	2.9×10^3	3.0×10^3	2.6×10^3	2.8×10^3
Total Coliform,(MPN/100g)	SPREAD PLATE	11	23	15	20	9	14	20	15	9	15
Faecal Coliform,(MPN/100g)	SPREAD PLATE	7	9	3	9	4	3	11	7	0	3

For Ebic Integrated Services Limited

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