ESIA

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

OF THE PROPOSED REHABILITATION AND CONSTRUCTION OF THE

PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

Across Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe and Borno States

BY

FEDERAL MINISTRY OF TRANSPORTATION, ABUJA

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ENVIRONMENTAL IMPACT ASSESSMENT

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List of Abbreviation and Acronyms

ADB	Asian Development Bank
AfDB	African Development Bank
Al	Aluminium
Ar	Argon
BOD	Biological Oxygen Demand
CBD	Convention on Biological Diversity
Cd	Cadmium
CEC	Cation Exchangeable Capacity
CFU	Colony Forming Unit
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
Cr	Chromium
CR	Critically Endangered
CSR	Corporate Social Responsibility
CSW	Commercial Sex Workers
Cu	Copper
DO	Dissolved Oxygen
EBRD	European Bank for Reconstruction and Development
e.g.	For example
EC	Electrical Conductivity
etc	et cetera
ESIA	Environmental Impact Assessment
EPFI	Equator Principles of Financial Institutions
Fe	Iron
FMEnv	Federal Ministry of Environment
FMoT	Federal Ministry of Transport
Hg	Mercury
HNO_3	Trioxonitrate (v) Acid
HUB	Hydrocarbon Utilizing Bacteria
HUF	Hydrocarbon Utilising Fungi
IFC	International Finance Corporation
ISQG	International Sediment Quality Guidelines
km^2	Kilometer square
M	Meter
ml	Milliliter
Mn	Manganese
NESREA	National Environmental Standards and Regulations Enforcement Agency
Ni	Nickel
NTU	Nephelometric Turbidity Unit
Pb	Lead
pH	Potential of Hydrogen

PSD	Particulate Size Distribution
PSU	Practical Salinity Unit
RAP	Resettlement Action Plan
TDS	Total Dissolve Solids
THB	Total Heterotrophic Bacteria
THC	Total hydrocarbon content
THF	Total Heterotrophic Fungi
THUB	Total Heterotrophic Utilizing Bacteria
TOC	Total Organic Carbon
TSS	Total Suspended Solids
V	Vanadium
Vu	Vulnerable
WCA	Waste Collection Areas
WHO	World Health Organization
Zn	Zinc

Units

%	Percentage
%	Percentage
μg	Microgram
μs/cm	Micro Siemens per centimetre
<	Less than
>	Greater than
≤	Lesser than or equal to
≥	Greater than or equal to
°C	Degree Celcius
°F	Degree Fahrenheit
0C	Degree centigrade
Kg	Kilogram
L	Litre
Mg	Miliigram
mg/kg	Milligram per kilogram
mg/l	Milligram per litres
mol/eq	Molar equivalent

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EXECUTIVE SUMMARY

E.S 1 Introduction

The existing Eastern Nigerian narrow-gauge railway traverses 12 States of the Nigeria, from Rivers in the south to Borno in the north. Two existing branch lines connect Kaduna and Jos from Kafanchan and Kuru respectively. One new branch line is proposed for Goniri through Damaturu to Gashua, all in Yobe State.

The Port Harcourt-Kafanchan section of the existing Eastern Nigeria Narrow-gauge Railway is one of the earliest railways built in Nigeria in the early 20th century. The Port Harcourt-Kafanchan section, Kafanchan-Kaduna connecting line, and Kafanchan-Kuru-Jos Railway were built at the same time in the early 1940s. The Kuru-Maiduguri Railway, completed in 1965, was the last railway built in the 20th century in Nigeria.

In 1984, the passenger traffic volume of the existing narrow-gauge railway reached the peak number of passengers dispatched over the years. Later, due to lack of maintenance, low transport capacity, as well as the rapid development of highway transport, highway transportation is significantly more competitive than railway, so passenger traffic volume of railway shrunk severely.

After the rehabilitation and reconstruction carried out in the later 1990s and 2010, the passenger traffic volume has rebounded. But the volume decreased again in 2016, serious damages to the bridges and subgrade have consequently caused the stoppage of operation.

Due to the need to improve the economic activities through the provision of modern intermodal transportation systems in Nigeria, the Federal government through Federal Ministry of Transportation is set to rehabilitate the existing Port Harcourt - Maiduguri narrow gauge Railway and its accessories, and construct new accessories to ease transportation of goods and personnel along the region.

This project Rehabilitation and construction necessitated the preparation of this ESIA Report with additional inputs that included stakeholders' engagement, baseline data update, inclusion and description of additional project components, their impacts, mitigation and management.

E.S 1.1 Project Location and Components

The Nigerian Eastern Railway Line takes off from Port Harcourt in Rivers State and terminates in Maiduguri, Borno State, with branches in Kaduna, Plateau and Yobe States, traversing sixty-five (65) Local Government Areas in twelve (12) States covering about 1,894 km. the project components include:

- Existing Nigerian Eastern Railway: Port Harcourt - Maiduguri narrow gauge, 1,443km, 265km of this has been rehabilitated;
- New Gashua Branch Line. Goniri - Gashua narrow gauge, 216km;
- Existing Kaduna Connecting Line: Kafanchan - Rigachikun, 200km;
- New Rigachikun Transshipment Station;
- Existing Jos Branch Line Railway: Kuru -Jos narrow gauge, 35km;

- New Asa Transshipment Station

E.S 1.2 Policy, Legal and Institutional Framework

Section 20 of the constitution of Nigeria (1999), makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria. And Section 12 establishes, though impliedly, that international treaties (including environmental treaties) ratified by the National Assembly should be implemented as law in Nigeria. Furthermore, 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.

National Environmental Policy

The policy specify guidelines for achieving sustainable development in fourteen vital sectors of the nation's economy, namely: Human Population; Land Use and Soil Conservation; Water Resources Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources; Agricultural Chemicals; Energy Production; Air Pollution; Noise in the Working Environment; Settlements; Recreational Spaces, Green Belts, Monuments, and Cultural Property.

It also contains Nigeria's commitment to ensure that the country's natural and built environment is safeguarded for the use of present and future generations. This commitment demands that efficient resource management and minimization of environmental impacts be the core requirements of all development activities.

National Land Policy

The legal basis for land acquisition and resettlement in Nigeria is the Land Use Act of 1978, modified in 1990. According to the act, all land in Nigeria is vested in the Governor of each State, to be held in trust for the use and common benefit of all people.

The administration of urban land is directly under the control and management of the Governor; whereas non – urban land is under the control and management of the Local Government Area. The Governor had the right to grant statutory rights of occupancy to land. Local Government has the right to grant customary rights of occupancy.

The Land Act gives government the right to acquire land by revoking statutory and customary rights to land for the overriding public interest. In doing so, the act specifies that the state or local government should pay compensation to the current holder or occupier with equal value. The act also requires the state or local government to provide alternative land for affected people who will lose farmlands and alternative residential plots for people who will lose their house.

The Environmental Impact Assessment (EIA) Act Cap E12 LFN, 2004

The EIA Act makes it mandatory for any person, authority, corporate body private or public, to conduct EIA prior to the commencement of any new major development or expansion that may likely have significant effect on the environment. The Act sets the EIA objectives and the procedures for consideration of EIA of certain public or private projects.

This project is a major development, which is expected to have some impacts on the environment. Hence, full compliance with the EIA Act is required. The EIA guidelines (procedural and sectoral) issued by the FMEnv drives from this Act and the project proponents shall conduct their activities in conformance with these guidelines.

Land Use Act of 1978

The Land Use Act (Cap 202, 1990), now Cap L5 Laws of the Federation of Nigeria 2004, is one of the key legislations that has direct relevance to this project. Relevant sections of these laws that may relate to this project with respect to land ownership and property rights, resettlement and compensation are summarized in this section. The Act vest every parcel of Land, in every State of the Federation, in the Executive Governor of the State.

He holds such parcels of land in trust for the people and government of the State. All land irrespective of the category belongs to the State while individuals only enjoy a right of occupancy as contained in the Certificate of Occupancy up to the limit of 99 years. The administration of the urban land is vested in the Governor, while rural land is vested in the Local Government Councils.

The Local Government Councils may grant customary rights of Occupancy for residential and other purposes, up to a limit of 500 hectares for agricultural purposes and 5,000 for grazing except with the consent of the Governor. The State is required to establish an administrative system for the revocation of the rights of occupancy, and payment of compensation for the affected parties. The holder or occupier of such revoked land is to be entitled to the value of the unexhausted development as at the date of revocation.

National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007

Administered by the Ministry of Environment, the National Environment Standards and Regulations Enforcement Agency (NESREA) Act of 2007, repealed the Federal Environmental Protection Agency (FEPA) Act. It is the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources. This project will comply with NESREA regulations, including conducting ESIA, environmental audit every three years after commissioning, obtain permit before disposing hazardous wastes, etc.

E.S 1.3 Other National Laws

Other National Laws Relevant to the project include the following;

- The Nigerian Urban and Regional Planning Act 1992
- Harmful Waste (Special Criminal Provisions) ACT CAP H1, LFN 2004; prohibits dumping of harmful wastes within Nigeria.
- The Management of Hazardous and Solid Waste Regulation, S.1I.15 of 1991 (No. 102, Vol. 78, August 1991)
- The Endangered Species Act, CAP E9, LFN 2004; protects endangered species.
- National Effluent Limitation Regulation S.I.8 of 1991 (No. 42, Vol. 78, August 1991)
- The Factories Act, 1987 (Factory Act cap 126, LFN, 1990); contain labour requirements, including occupational health, and similar matters.
- The Pollution Abatement Regulation, S.I.9 of 1991 (No. 42, Vol. 78, August,1991)
- Labour Act - CAP. L1 L.F.N. 2004; specify requirements relevant to labour issues, including wages, recruitment, discipline, employee welfare, employment of women and child labour.
- Nigeria National Forestry policy 2006: Guiding principles for the New National Forest Policy
- Wages Board and Industrial Council Act, 1974; established the National Wages Board and Area Minimum Wages Committee for States and for Joint Industrial Councils for particular industries, which determines minimum wages.
- Criminal Code Act CAP 77 LFN 1990
- Workers' Compensation Act, 1987; provisions for the payment of compensation to workmen for injuries suffered in the course of their employment and compulsory insurance covers employees of all categories
- National Environmental Regulations established by NESREA based on Section 34 of the NESREA Act, 2007. Those relevant to this project include Effluent Limitations, management of Solid and Hazardous Waste and Pollution Abatement in Industries Generating Wastes.
- FRSC Act CAP 141 LFN 2007
- National Inland Waterways Authority Act CAP N47 LFN 2004

E.S 1.4 State Regulations

The various state Ministries of Environment and Natural Resources (in Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe and Borno states) have the same responsibility for environmental protection within the states.

Its duties include protecting and developing the general environment of the State. Other duties as outline include:

- Monitor the Implementation of ESIA guidelines and procedures on all developmental proje ct in the State
- Monitor and regulate disposal of solid, gaseous, and liquid wastes from facilities
- Monitor air, water, land and soil in the State to determine pollution levels; and

- ❖ Establish penalties for persons obstructing personnel of the ministry in the performance of their duties.
- ❖ Routine liaison with the Federal Ministry of Environment in order to achieve the National Policy on environment;
- ❖ Co-operate with the Federal Ministry of Environment and other relevant National Directorates/Agencies in the promotion of environmental education of the citizenry;
- ❖ Responsible for monitoring compliance with waste management standards;
- ❖ Responsible for general environmental matters in the state including the negative effects of human activity and physical planning;

Monitoring of the implementation of the ESIA and the Environmental Audit Report guidelines and procedures on all development policies and project within the state.

E.S 1.5 The EIA Process in Nigeria

The Federal Ministry of Environment (FMEnv) developed procedural guideline as well as sectoral guideline for conducting EIA in Nigeria in accordance with the EIA Act. The following steps sequentially summarises the entire process.

- ➢ Project Initiation
- ➢ Prepare/submit Project proposal
- ➢ Screening
- ➢ Scoping process
- ➢ Site Verification/TOR approval
- ➢ Conducting the study and submit reports to the Ministry
- ➢ Review process, including public display and public hearing
- ➢ Approval of the project or otherwise
- ➢ Project commencement
- ➢ Impact mitigation monitoring
- ➢ EIA certification

E.S 1.6 EIA Terms of Reference

In line with the Nigeria's EIA procedural guidelines (FEPA, 1995), the Terms of Reference (ToR) for the EIA of the proposed project approved by the FMEnv's had the following objectives:

- Define the relevant framework of legal and administrative requirements for EIA of the proposed project;
- Outline the general scope of the EIA study including the overall data requirements on the proposed project and affected environment; and.
- Define the procedures and protocols for identification and assessment of associated and potential impacts and for selecting appropriate prevention, reduction, and control as well as enhancement measures for such impacts; and eventually developing an effective Environmental Management Plan (EMP) for the project.

E.S 2 Project Justification

The Proposed Rehabilitation and construction of the Port Harcourt – Maiduguri Narrow Gauge Railway Project is in line with the overall aim of the FGN to revitalize and reinvigorate the rail sector so as it can contribute more to the national economy.

Moreover, currently over 95 percent of the traffic leaving the area is transported by road to the detriment of the road network. It is thus expected that the resuscitating the rail sector, will increase freight and passenger capacity as well as release pressure on the dilapidated road network. The railway is also expected to reduce the travel times for both goods and passengers.

The broad aim of the rehabilitation and construction of the Port Harcourt – Maiduguri Narrow Gauge Railway Project is to enhance mobility, accessibility and transport along the South Eastern, linking the northcentral and north east regions.

- **Overview of Existing Facilities**

Insufficient width of subgrade shoulder caused by subgrade surface scouring or subsidence

Slope foot of riverside subgrade and subgrade located in bridge and culvert both side is scoured by flood

No drainage system, the foot of the cutting slope slides due to scouring, and part of the subgrade is water-logged for a long time

The shallow layer slides and collapses in high fill embankment section

The bridge has been completely damagedPartially scoured at pier and abutment foundation

All sleepers are steel. Most of the platform and the train stations are damaged, and there are debris and weeds, Encroachment, ballast is partially missing, the station tracks are seriously rusted and corroded, part of the tracks are missing

E.S 2.1 Analysis of Project Alternatives

Three options were considered - the do-nothing option which simply means avoiding most of the negative effects associated with the railway rehabilitation and missing all the positive benefits that would accrue such as increased capacity of the railway by ferrying more freight and passengers, improved operation and financial returns, ease access to markets, employment opportunities, improved agriculture through accessing farm inputs etc. This was therefore dismissed.

The second alternative to the project for consideration was the use of air transportation. This type of transport is more expensive and is out of reach of many Nigerians. while the third option was to upgrade of the road system through construction of super-highways. The current cost of maintaining the dilapidated Port Harcourt – Enugu – Makurdi – Jos – Maiduguri highway is very high. Further to this, the cost of upgrading the super-highway will be very high and uneconomical. The last option was to execute the proposed project now to bring its benefits to bear on the economy positively.

The first three options were therefore rejected in favour of the last.

E.S 2.2 Envisaged Sustainability

The sustainability of the project has been considered on three premises – technical, economic and environmental and social. Technically, the project shall be technically viable because, it is professionally designed and the technology employed is readily available and it shall depend on available construction materials. On the economic premise, the railway project has the potential to be economically sustainable because the proponent has obtained the necessary financial strength to execute the project. In addition, the proposed project will create jobs during construction and operation to people in the area. Environmental and social sustainability stem from the complete acceptance of the project by host communities, the careful identification and mitigation of project negative impacts.

E.S 3 Project Description

The Nigerian Eastern Railway Line takes off from Port Harcourt in Rivers State and terminates in Maiduguri, Borno State, with branches in Kaduna, Plateau and Yobe States, traversing sixty-five (65) Local Government Areas in thirteen (12) States covering about 1,894 km.

The proposed project has five phases of development; Design/Permitting, 1st phase Decommissioning, Construction, Operational phase and 2nd phase decommissioning.

The existing Port Harcourt-Maiduguri railway has been worn down by the years without repair, and most sections are not in operation. Sections that are in operation also have potential hazards. There are many small radius curves that limit the speed of the train.

The total length of the Port Harcourt-Maiduguri Railway is 1,443km. The length of the curves is 299.7 km, accounting for 20.8% of the total length of line. The length of curves with radius less than 600m is 233.5km, accounting for 16.2% of the total length of the line and 77.9% of the total length of the curves. The length of curves with radius less than 400m is 157.34km, accounting for 10.9% of the total length of line and 52.5% of the total length of the curves.

After rehabilitation and construction of Port Harcourt - Maiduguri Railway Project, the main technical standards as outlined below;

- **Nigerian Existing Eastern Railway**:
  Port Harcourt - Maiduguri narrow-gauge main railway, with a total length of about 1,443 km.
- Maximum design speed: 80km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 15‰～26.5‰ (retention of original value)
- Minimum curve radius: 400m, the existing radius is maintained in urban area and special difficult area.
- Traction type: Diesel
- Locomotive type: DF4D

- Tonnage rating: 800t
- Effective length of arrival-departure track: 375m～450m (retention of original value)
- Blocking type: Electric train staff

ii Kaduna Existing Connecting Line: Kafanchan - Rigachikun narrow-gauge railway with a total length of about 200 km.

- Maximum design speed: 60km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 12.5‰
- Minimum curve radius: 400m, the existing radius is maintained in urban area and special difficult area.
- Traction type: Diesel
- Locomotive type: DF4D
- Tonnage rating: 800t
- Effective length of arrival-departure track: 400m
- Blocking type: Electric train staff

iii Jos Existing Branch Line Railway: Kuru - Jos narrow-gauge railway with a total length of about 35 km.

- Maximum design speed: 60km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 23‰
- Minimum curve radius: 400m, the existing radius is maintained in urban area and special difficult area.
- Traction type: Diesel
- Locomotive type: DF4D
- Tonnage rating: 800t
- Effective length of arrival-departure track: 350m
- Blocking type: Electric train staff

iv Gashua New Branch Line Railway: Goniri - Gashua narrow-gauge railway with a total length of about 216 km

- Maximum design speed: 60km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 12‰
- Minimum curve radius: 300m

- Traction type: Diesel
- Locomotive type: DF4D
- Tonnage rating: 800t
- Effective length of arrival-departure track: 450m
- Blocking type: Electric train staff

E.S 3.1 Design Principle of the track Rehabilitation

265km long track of existing eastern narrow-gauge railway mainlines and all track of existing Jos branch line has been rehabilitated with good condition, therefore, for track of these sections, the rehabilitation work do not adopt. For other sections, the UIC 50 rail will be used on the main line with jointed track.

For subgrade section, the concrete sleeper and clip fastening will be used. For bridges, wood sleepers and complete fastenings will be used. 1,560 pieces of sleepers are laid per kilometer.

The whole line ballast bed will be regulated. 50% of ballast of the existing operation section will be considered to be reused. 30% of ballast of the existing out-of-service section will be considered to be reused. The thickness of the new ballast bed is 30cm; the top width of the ballast bed is 2.56m, and the gradient of side slope is 1:1.5.

E.S 3.2 Design Principle for route

The main line from Port Harcourt to Maiduguri adopts the following principles;

Minimum curve radius: 400m for main line, the existing radius is maintained in urban area and special difficult area.

Transition curve length: to match the radius of the curve.

Ruling gradient:18‰.

The length of grade section: The length of grade section should be designed as long as possible, and the minimum single grade section should not be less than 200m.

Vertical curve: When the algebraic difference between adjacent gradients is greater than 4‰, vertical curves should be setup. Circular curves will be adopted as vertical curves with radius of 5000m.

Algebraic difference between adjacent gradient: The connection between adjacent grade section should be designed as a small algebraic gradient difference, and not more than 20‰ under difficult conditions.

Setting of station site: Station should be placed on straight line, and can be located on the curves with radius not less than 600m under difficult condition.

Setting principle of level crossing and grade separation: There are few highways along this railway, and the traffic flow of the highways is small. After the railway is reconstructed, the level crossing with existing road will be maintained.

E.S 3.3 Design Principle for Subgrade

The principles of defects treatment are as follows:

I**n the section with insufficient shoulder width:** adopt dry-laid stone masonry stack (dry-laid stone masonry shoulder protection + M10 cement mortar plastering, ensuring the width no less than 40cm) to widen the shoulder or adopt ballast retaining wall for protection.

Subgrade with poor drainage conditions: drainage ditches shall be added in some embankment areas according to local condition; rectangular side ditch (or slab ditch) shall be setup in the cutting section or the existing side ditch shall be desilted, and overhead ditch shall be setup according to the terrain condition (in section with particularly serious slope scouring).

Subgrade closed to the river: according to the river flow speed, the scouring prevention and reinforcement measures shall be adopted, such as mortar rubble masonry slope protection, gabion, dumping fill of large stones, concrete or reinforced concrete retaining wall.

Slope collapse section: the full width filling in the ruined sections or section with larger collapse shall be reconstructed. Meanwhile the slope protection shall be reinforced. The grass planting or arch framework slope protection shall be mainly used for protection. The mortar rubble masonry protection on the whole slope shall be used in water immersible area, and the slope supporting seepage ditch shall be added if necessary.

E.S 3.4 Project support facilities

There are 104 existing stations in the main line. 43 stations will be closed and 61 stations will be rehabilitated and reconstructed in the short term. 30 stations will be closed and 74 stations will be rehabilitated and reconstructed in the medium and long term

E.S 3.4.1 Bridge and Culvert

Bridge structures are determined according to factors including the terrain and landform, hydrological characteristics, geological conditions, project cost, construction period. For common bridges, 24m or 32m post-tensioned simply-supported prestressed concrete T girders are generally adopted. The existing 157 railway bridges are billed for rehabilitation / reinforcement; and also, the 2,062 existing culverts. The new railway line includes in total 1 super-large bridge, 6 major and medium bridges, 2 frame bridges, 535 culverts, 2 highway-over-railway overpasses and 3 pedestrian overpasses.

E.S 3.4.2 Locomotive

The locomotive facilities shall be provided based on the existing track conditions, the traction type, the station distribution, the train operation organization characteristics, the goods flow direction, the natural conditions and living conditions along the line, and operation conditions and railway network planning of the adjacent lines. For locomotive allocation, new locomotives shall be purchased. Locomotive shall use the diesel narrow-gauge locomotives made in China.

E.S 3.4.3 Rescue Equipment

A 160t rescue crane and its auxiliary rescue equipment shall be provided at Kafanchan Diesel Locomotive and Rolling Stock Depot, Elelenwo Locomotive Turnaround Depot, Rigachikun Locomotive Turnaround Point, Gashua Locomotive Turnround Point and Maiduguri Locomotive Turnround Point. One freight train inspection yard and one side repair track is respectively provided at Elelenwo, Rigachikun, Jos, Gashua and Maiduguri to be responsible for the freight train inspection and casual repair.

This project will give priority to the use of existing fire protection facility. If the existing fire facility is not good for reuse purpose or the capacity of existing fire facility is insufficient, new fire facility will be added. All stations and sections shall be equipped with outdoor fire water supply system in accordance with the requirements of the code

E.S 3.4.4 Infrastructure maintenance facilities

The comprehensive maintenance principle shall be adopted for the fixed equipment of the railway. The main set-up principles are as:

Maintenance of this railway adopts the large maintenance machinery.
Comprehensive maintenance organization layout will be re-planned. The maintenance organizations shall be of 3 levels: comprehensive maintenance depot, comprehensive maintenance section and comprehensive maintenance point.

Three comprehensive maintenance depots shall be provided at the whole line. One comprehensive maintenance section shall be set about every 80-120km in accordance with station distribution and conditions of station and yard. Comprehensive maintenance point shall be set in the station without comprehensive maintenance depot or section.

One comprehensive maintenance depot shall be respectively provided at Enugu, Kanfanchan and Maiduguri, 3 in total. One comprehensive maintenance section shall be respectively provided at Elelenwo, Aba, Eha Amufu, Makurdi, Lafia, Gudi, Kuru, Tafawa Balewa, Alkalere, Gombe, Bajoga, Zonkwa, Kaduna Junction, Damaturu and Gashua, 15 in total. One comprehensive maintenance point shall be respectively provided for the rest stations without comprehensive maintenance depot or section, 62 in total.

E.S 3.4.5 Communication

Communication system shall be rehabilitated and reconstructed in line with the principles of using economic and practical products with proven technology that meet the digitization requirements. One $GYTA_{53}$ 24-core long-distance trunk optical cable is directly buried along one side of the railway. $GYTA_{53}$ optical cables and $HYAT_{53}$ local electrical cables shall be laid in stations and yards according to user's demand.

The communication system mainly includes data communication system, telephone switching system, radio communication system, power supply, lightning protection and grounding system.

E.S 3.4.6 Power supply scheme

The power source of substation shall be led from the local power grid. A diesel generator room shall be set up at the station as the backup power after the power failure of the transformer. The new substation or box-type substation shall be provided for locomotive turnround point, comprehensive maintenance work section, freight yard, etc

E.S 3.5 Water Supply System

The amount of surface water needed for the various construction activities over the project construction period, is estimated at 1,850,000 m^3. Water is sourced from the rivers traversed by the proposed railway alignment. Where surface water was not available or where quality was deemed inadequate, boreholes will be constructed. The Contractors will acquire the necessary water use permit required for water abstraction prior to any abstraction.

E.S 3.6 Waste Management

Wastes Generated shall be segregated and collected at the temporary waste collection areas (WCA), with separate storage segments for prime recyclables (scrap metals, tyres, plastic, wooden material), and separate segment for other hazardous waste including waste oils, oil filters, etc. The Contractors will subcontract a licensed and reputable waste management company for the collection, transport and disposal of waste produced across the four phases of the project (1st Phase Decommissioning, Construction, Operation and 2nd phase Decommissioning/Abandonment).

E.S 4 The Existing Environment

Environmental impact assessment procedure for the Rehabilitation of the Eastern railway line project involves the use of adequately planned and well-structured analysis to establish the existing environmental conditions of the proposed project location. This environmental status will provide the basis for identification of potential impacts of the project activities on the ecological system and the resource use of the area.

A one-season fieldwork was embarked upon for the biophysical, social and health studies. Responses by the natives are not limited to any particular season. The field data gathering exercise was performed between 9th through 21th November, 2020. The collected samples were analysed in certified laboratories in the Akwa Ibom State Ministry of Environment/Science and Technology laboratory in Uyo.

E.S 4.1 Air Quality

The principal potential source of air quality impact arising from the construction of the rail project will be fugitive dust. The potential dust sources associated with construction activities is likely to be generated from loading and unloading, top soil removal, travel over dirt roads and wind erosion. Projects will have potential cumulative construction dust impacts will be works due to railway and adjoining busy expressway. During the operational phase of the project, two major sources of air pollution may be identified in the neighborhood of the site. The first source is vehicular exhaust from the road traffic in and around the study area. The second source is emission from chimneys in the immediate area.

E.S 4.2 Noise Pollution

- Construction phase - the noise generated from construction activities and related powered mechanical equipment will have the potential to pose adverse noise impacts to the surrounding sensitive receivers.
- Operational phase - the future noise environment will be affected by road traffic noise, rail noise and fixed noise sources such as pumping station, rail station and ventilation systems.

E.S 4.3 Geology and Geomorphology

The geological setting of the study area falls Majorly within 5 sedimentary basins (Niger Delta Basin, Anambra Basin, Lower Benue basin, Upper Benue basin and Chad Basin) and a basement complex in Nigeria as outlined below

	Encountered Geologic Formations		Lateral Extent along the Railway route
1	Niger Delta Sedimentary Basin		Rivers, Imo and Umuahia.
2	Anambra Sedimentary Basin		Ozalla, Nara, Ndeaboh and Mgbowo axis, all in Enugu State.
3	Middle Benue Trough		Oturkpo, Taraku, Chongke, Ukpiam, Utomkon and Makurdi axis all in Benue State and part of Nasarawa State (Lafia axis).
4	North Central Nigerian Basement Complex		Gudi and Akwanga axis (Nassarawa State), Kaduna State, Jos and part of Bauchi State.
5	Upper Benue Trough	Gongila Sedimentary Basin	Watsira, Bagali, Badara and Cheledi axis all in Bauchi State and part of Gombe State (Tonde and Wurisato axis)
		Yola Sedimentary Basin	Part of Gombe State (Jerikom, Dukul, Tongo, Ashaka axis) and part of Yobe State (
6	Bornu Basin (Nigerian part of Chad Basin)		Maiduguri, and part of Yobe State (Damaturu, Mogono, Yelawa , Gashua axis)

The major landforms typical of this study area are the **River Deltas** encountered at the Port Harcourt end of the project, **residual hills** and dry valleys encountered within Enugu axis and **plateaus** as observed in the Jos axis of the study area with the highest altitude of above 4000ft above sea level. The three major geomorphic structures observed within the study area are the resultant effect of weathering, differential erosion accompanied with deposition of sediments and well defined extinct volcanic cones. Some visible geologic structure was encountered in the study area both within the Crystalline and Sedimentary Formations such as joints, mudcracks, unconformity, plane bedding, body fossils and quartz veins.

E.S 4.4 Hydrogeology

The study area falls within 7 drainage basins (Anambra Imo Basin, Chad Basin, Hadeja Jamare basin, Lower Benue basin, Niger Delta basin, Upper Niger basin and Upper Benue basin). Its drainage pattern is semi-dendritic which together with the low drainage density indicates an underlying homogeneous lithology and a moderately well drained subsurface condition. Sedimentary deposits dominate the study area and is evident from the local and Regional geological consideration. Sands (from medium to high) acts as excellent reservoir rock, the clayey intercalations, when present acts as aquitard or aquiclude, depending on the thickness, areal continuity and permeability of the layer. Within the crystalline Formation, Groundwater occurs in the soft overburden aquifer and fractured bedrock aquifer. Hand dug wells within the study area are shallow therefore they tap water only from soft overburden aquifer. It is only some boreholes that tap water from fractured bedrock aquifer because they are drilled with mechanized equipment. The thickness of soft overburden aquifer in the study area is between 10 m observed within jos axis and 30 m in Lafia.

E.S 4.5 Soil Quality

Soil resources of the study area were conducted. Soil samples were collected at thirty-five (35) stations. These include 28 sampling points and 7 control samples. The mean concentration value of pH (6.989), nitrate (10.192 mg/kg), phosphate (3.722 mg/kg), sulphate (3.261 mg/kg) and calcium (48.775 mg/kg) investigated for soil samples had concentrations within WHO/FMEnv permissible limit of 6-8, 50mg/kg, 5mg/kg, 500mg/kg, and 180 mg/kg respectively.

No WHO/FMEnv permissible limits is available for permeability with mean concentration value of 40.433%, porosity (44.392%), bulk density (1.417mg/kg), PSD of sand (73.167%), clay (19.417%) and silt (7.417%), moisture content (40.508%), magnesium (7.383 mg/kg), potassium (0.413 mg/kg) and sodium (1.737 mg/kg). THC concentration was below equipment detection limit in all the soil samples analysed.

Out of all the heavy metals analysed, vanadium, nickel and lead were below equipment detection limit of <0.001. The mean concentration value of iron (10.836 mg/kg), copper (0.991mg/kg), and zinc (5.558mg/kg) were all within WHO/FMEnv permissible limits of 45 mg/kg, 36mg/kg and 140mg/kg respectively.

E.S 4.6 Surface water

Sixteen (16) surface water (12 sampling stations and 4 controls) around the project were analysed for their physico-chemical properties. The mean concentration value of pH (6.354), temperature (34.6630C), conductivity (108.756 µS/cm), BOD (1.214 mg/l), COD (8.731 mg/l), sulphate (3.764 mg/l), nitrate (2.661 mg/l), and TDS (18.129 mg/l) were all within their respective WHO/FMEnv permissible limits. No WHO/FMEnv permissible limits is available for salinity with mean concentration value of 0.076 PSU, phosphate (0.468 mg/l) and TSS (16.31 mg/l).
THC and COD concentrations level of the analysed surface water samples were below equipment detection limit of <0.001.

Heavy metals analysed include copper, iron, lead, zinc, cadmium, and chromium. Among these, lead, cadmium and chromium were below equipment detection limit of 0.001mg/l. The mean concentration value recorded for copper (0.272 mg/l) and zinc (0.453 mg/l) were observed to be below WHO permissible limit of 1 mg/l and 3 mg/l respectively. However, iron with mean concentration value of 1.725 mg/l exceeded WHO/FMEnv permissible limit of 0.36mg/l. This could be attributed to waste water discharges from domestic sources and storm water.

E.S 4.7 Sediments

The sampling points was same as that of the surface water. Summary of the physico-chemical properties reviewed that the mean concentration value obtained for pH (7.208), electrical conductivity (299.106 µS/cm), TOC (25.963 %), Phosphate (5.566 mg/kg), nitrate (9.008 mg/kg), sulphate (0.825 mg/kg), sodium (5.541 mg/kg), potassium (9.053 mg/kg), calcium (21.67 mg/kg) and magnesium (2.509 mg/kg) all had their concentration level in the analysed sediment samples within FMEnv/ISQG permissible limit for aquatic lives.

The concentrations of lead, cadmium, vanadium and chromium in streambed sediment collected within the proposed project area were below their respective limit of detection. However, the mean concentration of manganese (4.002 mg/kg), zinc (3.061 mg/kg) and copper (0.934 mg/kg) in the sediment samples were all within WHO permissible limit of 7 mg/kg, 88 mg/kg and 25 mg/kg for aquatic lives respectively. Only iron with mean concentration value of 2.848 mg/kg do not have any stipulated guideline limits.

E.S 4.8 Groundwater

Groundwater samples were obtained from twenty (20) boreholes; which includes fifteen (15) sampling stations and five (5) control points in close proximity to the study area were analysed for physico-chemical properties. The mean concentration value of pH (6.152), temperature (30.87°C), turbidity (0.31 NTU), total hardness (21.49 mg/l), conductivity (17.35 µS/cm), DO (0.145 mg/l), sulphate (2.069mg/l), nitrate (0.208mg/l) and TDS (8.675mg/l) investigated for the ground water samples had concentrations within the WHO/FMEnv permissible limit of 6.5-9.0, 40^0C, 5.0 NTU, 250mg/l, 1000µS/cm, 5mg/l, 150mg/l, 250mg/l, 10mg/l, and 1000mg/l respectively. No WHO/FMEnv permissible limits existed for salinity with mean value of 0.009 ppt, phosphate (0.076 mg/l), and TSS (0.13 mg/l).

THC, BOD and COD concentrations level in the analysed groundwater samples were below equipment detection limit of <0.001.

The heavy metals investigated in the groundwater samples include copper, iron, lead, zinc, cadmium, and chromium. Lead, cadmium, and chromium concentration level in the analyzed samples were below equipment detection limit of <0.001. The mean concentration value of copper (0.006 mg/l), iron (0.284 mg/l) and zinc (0.284 mg/l) were within WHO permissible limits of 1 mg/l, 0.36 mg/l, and 3 mg/l respectively.

E.S 4.9 Microbiology

For surfacewater, Total coliform, faecal coliform, faecal streptococci and heterotrophic bacteria were detected in the samples. Isolation of *E. coli* provides conclusive evidence that the water was polluted by faecal matter within the period of sampling. Presence of heterotrophic bacteria in water poses no health risks to humans but a high heterotrophic plate count is an indicator for ideal conditions for the growth of bacteria. This can be a breeding ground for more pathogenic bacteria. Sediment microorganisms are crucial for the biodegradation of organic matter and the recycling of nutrients while these microorganisms are susceptible to toxic pollutants. The degradation of organic pollutants in aquatic ecosystems is mainly performed by bacteria.

For Groundwater, both total coliform and fecal coliform bacteria (*Escherichia coli*) were not detected in the samples. Viable cells of bacteria were detected, and are harmless to human beings but a high heterotrophic plate count is an indicator for ideal conditions for the growth of pathogenic bacteria.

E.S 4.10 Flora and Fauna

The flora and fauna wildlife resources of the study area were inventoried using the following parameters; species richness, species diversity indices, species abundance and IUCN 2016 version. In addition to these parameters, vegetation structure, alien and invasive species, indigenous species uses and growth habits were also used to evaluate the inventoried floristic species. While the flora species were studied using transects, quadrats and interviews, fauna species were censored using direct and indirect evidences.

A total of 48 species were censored yielding 1880 individuals (Abundance). About 55.6% were trees, 5% shrubs, 22.4% were herbs and about 17% were grasses/sedges. Some of the tree species censored in these habitats include; *Parkia oliveri*, *Daniellia oliveri*, *Afzelia Africana*, *Monotes kerstingii*, *Terminalia mollis*, *Burkea africana* and *Butyrospermum niloticum, Magnifera Indica, Citrus sinensis, Carica papaya, Anacardium occidentale, Psidium guajava, Azadirachta indica, Gmelina arborea, Butyrospermum parkii and Parkia bioglobosa*. The indigenous uses of each plant inventoried were assessed. Some of the indigenous uses include fuel wood, medicinal purposes, as fruits and seeds, as sundry products, as beverages and drinks, as fodder, as wattles, as nuts, as spice, as flavours and thickeners as chewing stick, as gum and adhesives, and some for prevention of soil erosion. Some species with numerous indigenous uses include *Acaacia melfera, and Azadirachta indica Acacia senegalensis*, *Khaya ivorensis*. The IUCN version of 2016 criteria were used to evaluate the conservation status of the species. The result indicated species threatened, vulnerable, endangered, least concern, dominate.

A total of 59 fauna resources were inventoried in the study. These fauna species were obtained via indirect and indirect evidences.

E.S. 4.11 Hydrobiology

Results on phytoplankton analysis revealed that a total number of 842 phytoplankton species representing 5 taxonomic groups were obtained within the study area during the survey. The family constituted 35% Baccillariophyceae, 20% Chlorophyceae , 19% Euglenophyceae, 18% Cyanophyceae and 8% Dinophyceae. Zooplankton analysis revealed that Cladocera were the family dominated the zooplankton population with 41% in all stations sampled. This was followed by Crustaceans with 26% .

Fishery

The fishing gears commonly used in fish exploitation was mainly traps, hooks and lines. Data on fisheries were collected primarily from the local fishermen in the various rivers in the course of the project survey. A total of 202 fish species in Nine (9) families are found in Imo river, River Benue and Gongola river. A total of 52 fish specimens were bought and studied. These specimens were identified to belong to the various families, and species. Examination of the fish samples collected showed some of the fishes had physical deformities. Ulceration and fin rots were prevalent possibly due to the activities of piscine predator. Examination of gut contents revealed traces of planktons and fish in the diet.

E.S 4.12 Socio-economics

The study was conducted in 50 representative communities in the twelve project-affected States (Rivers, Abia, Ebonyi, Enugu, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe, and Borno). In selecting the sampled communities, proximity to the railway line, the cultural and historical antecedents of the communities were all considered.

The project-affected local government consulted are presented in Table ES1.

Table ES1: The Project Affected States and LGAs

S/N	STATE	LGA
1	Rivers State	Port Harcourt
		Obio/Akpor
		Oyigbo
2	Abia State	Ukwa West
		Ugwnagbo
		Aba South
		Aba North
		Oboma Ngwa
		Isiala Ngwa North
		Isiala Ngwa South
		Umuahia North
		Umuahia South
		Bende
		Isikwato
3	Ebonyi	Ivo
		Ishielu
4	Enugu	Enugu South
		Nkanu East
		Nkanu West
		Aninri
		Enugu North
		Enugu East
		Isi Uzo
5	Benue	Ado
		Oturkpo
		Gwer East
		Markurdi

S/N	STATE	LGA
		Guma
12	Nasarawa	Keana
		Obi
		Lafia
		Nasarawa Eggon
		Akwanga
6	Kaduna	Sanga
		Jema's
		Kaura
		Zangonka
		Kachia
		Kajuru
		Chikun
		Kaduna South
		Kaduna North
7	Plateau	Riyom
		Jos South
		Jos North
		Barkin Ladi
		Mangu
8	Bauchi	Tafawa-Balewa
		Bauchi
		Alkaleri
		Kirfi
9	Gombe	Akko
		Kwami
		Yamaltu
		Funakaye
11	Yobe	Gulani
		Gujba
10	Borno	Kaga
		Kondoga

Source: PGM Fieldwork, 2020

Household Composition, Structure, and Size

The average household size in Nigeria according to National Demographic and Health Surveys (NDHS) 2018 is 4.7 persons. Urban households are slightly smaller than rural households (4.3 persons versus 5.0 persons). A majority of the households in Nigeria are headed by men (82%). The average household size is also bigger in the north than in the south. This assertion by the NDS 2018 is not different from what was obtained during the fieldwork as 4.8 and 6.0 persons were gotten for project-affected states in the south and project-affected states in the north respectively.

Results from the 2003 National Demographic and Health Surveys show that there more female household heads in the south than in the north. South-South states took the lead with 28.2%, and North-west has the least female household headship with 6.5%.

Fertility, Mortality and Life Expectancy

During Focused Group Discussions (FGDs) along in the communities along the RoW, groups interviewed indicated that factors that enhance fertility among them include general acceptance of the marriage institution, relatively early sexual activity and marriage, and polygamy. Fertility is best measured by the Total Fertility Rate (TFR) which is an indication of the total number of children a woman is estimated to have in her reproductive lifetime. The existence of precise estimates of the TFR values for each project-affected community could not be ascertained and no values were available. DHS of Nigeria reported fertility by state. By state, fertility ranges from 3.9 children per woman in Rivers to 7.2 children per woman in Bauchi State.

Life Expectancy estimates for project-affected States are the same as the national estimates. The World Health Organization (WHO) in its World Health Statistics 2017 estimated that life expectancy for men in Nigeria is 42 years and 47 years for women.

Literacy and Education

Overall, 36% of females and 27% of males in Nigeria have no education. Eighteen percent of females and 19% of males age 6 or older have attended some primary school; however, only 11% of both sexes have completed primary education. The median number of years of schooling is 3.6 for women and 5.4 for men. At the zonal level, the North West and North East have the highest percentages of both females (55% and 57%, respectively) and males (40% and 47%, respectively) with no education. Twenty-four percent of women in the highest wealth quintile have more than secondary education, while only 7% have no education. On the contrary, 75% of women in the lowest quintile have no education and less than 1% have more than secondary education.

In the South, male-child school dropout is minimal compare to the North and is blame on poverty, mercantilism, and blind curriculum. At interviews with primary and secondary school teachers in Yobe and Borno States, the school drop-out rate was said to be high and was estimated at between 10% and 15% per class, this was attributed to the activities of Boko haram insurgents in the area.

Migration Trend Pattern

Result shows that 55% and 80% of respondents were non-migrants in the southern states and the Northern States respectively. This trend was not entirely unexpected given the insecurity currently experience in most northern states. There were indications that some household members in the northern states of the project area had relocated over the years for various reasons. The most common reasons for relocation were insecurity especially in Yobe and Borno States, marriage, school, and work, and the most affected age groups were those between 10 and 44 years. Those who relocated went mostly to cities in Nigeria, like Sokoto, lokoja, Port Harcourt, Abuja, and Lagos.

Language, Marriage, and Family

Nigeria is pluralistic in ethnic composition, with a rich and diverse historical and cultural heritage. The official language, as in every state of the country, is English. However, Igbo in the south and Hausa in the north has gained wide acceptability as a medium of communication. The project-affected communities except those in the southeastern states are all multilingual as there many indigenous ethnic groups therein. The marriage institution is accepted and revered in all the communities. Marriages are contracted between adult males and adult females; there are no accounts of either same-sex or juvenile marriages. Monogamy and polygamy are practiced but local sources say that polygamy is on the decline.

Traditional Governance

The communities have distinct but similar traditional administrative structures. The structure comprises the traditional ruler assisted by chiefs and a Community Development Union (CDU) with the youth and women groups. The traditional heads are elected from eligible males. Eligibility is determined by age (minimum of 35 years) and standing/integrity. Additionally, in Bauchi, Gombe, Yobe, and Borno state the candidate must come from particular families considered royal families. Occupants hold office for life except where they are deposed by the community or the government. The traditional heads report to District heads who are appointed by the various state government. The Chiefs or the Mai Agwan as they are referred to in the Northern section of the project area are appointed by their respective community to oversee the affairs of the community and represent them in community matters. They also have the role of advising the District heads. The communities also have CDUs which are headed by a Chairman and assisted by a Secretary in the day to day running of the union. They are often referred to as community Chairman and Secretary. Membership of the CDU executive is by election among adult males from the compounds.

Roles of Women and Youth in Community Development

During the survey across the 12 project-affected states, it was noted that culturally women could not, lead the communities, head the key organs of traditional administration, seat or participate with the men in taking community decisions except on demand by the traditional leader when issues that will be deliberated is centered on them. This cultural inhibition is a clear indication of gender inequality in the communities. The youth, on the other hand, has become a strong force in the communities. The youth across the study area is recognized as a formidable and critical segment of the population of the society whose strength and dynamism are essential in the process of development engineering.

Gender-Based Violence

With the intensification of conflict driven by Boko Haram, the prevalence of GBV has escalated dramatically in northeast Nigeria. According to the Nigeria Humanitarian Response Plan, about 30% of women in the northeast reported experiencing GBV since 2013. Women and girls are targeted for abduction by Boko Haram and are often raped, forced into labour, marriage, or religious conversion, abused, exposed to sexually transmitted infections, and are often pregnant upon escaping captivity. FGD revealed cases of both domestic and sexual violence against women in the area, largely blamed on the customs of marriage in the study area which involves bride price and dowry usually paid on women, this belief promotes the values that give men proprietary rights over women and girls and encourage polygamy.

Belief Systems and Practices

Residents of Rivers, Abia, Ebonyi, Enugu, and Benue States are mostly Christians. There are various Christian denominations with worship places spread across the project-affected communities. On the other hand, residents of Bauchi, Gombe, Yobe, and Borno are mostly Moslems. Traditional worship practices are carried out by a few adherents as many have converted to the Christian faith and abandoned traditional religious practices. Results from FGDs in the surveyed communities show that the people still have a deity called various names and it is believed to be responsible for the protection and justice in the area in Rivers, Abia, Ebonyi, Enugu, Benue State, and part of Nasarawa States.

Festivals in all the 12 project-affected states can be in the context of a holiday, often marked by merriment and high-spirited cultural fulfillment as a successful celebration featuring elaborate theatrical presentation, honouring a member or marking a collective festive period of a given community, as title taking, marriage ceremony, fertility rites of passage, and forming cycles. These festivals and carnivals feature music, dances, fashion, and food, allowing visitors to join in and have a first-hand experience of their culture.

Conflict Management and Security

Gombe, Yobe, and Borno State segment of the railway line is part of the Northeastern region which has experienced several conflicts with violent outcomes and attacks by Boko Haram. Conflict-affected households in northeastern Nigeria continue to experience difficulty in meeting their essential food and non-food needs. Displacement has led to the abandonment of income-generating activities, cultivation, disrupted trade flows, and the closure of most markets in the conflict-affected areas. The crisis in North-eastern Nigeria is being driven primarily by insurgent attacks attributed to Boko Haram – an Islamic Extremist group that is vehemently against western influence in any form; including government, rule of law, healthcare, and education. Boko haram has been actively engaged in terrorist activities in Nigeria since 2009. In Rivers and Abia State also there was an issue of militancy in the state before the Federal Government granted amnesty to militants who would agree to lay down their arms, in October 2009. Amnesty notwithstanding, many youths in the area have become violence-prone and even social misfits.

The youth will be a group to watch and also dialogue within the course of the railway operation in all the 12 project-affected states. The active role of the community-based vigilantes in the provision of security for lives and properties is also observed in all the study areas. In Gombe, Yobe, and Borno they are called civilian JTF.

Settlement Pattern and Housing Conditions

All the communities have the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the settlements. Their nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups. The building of houses in clusters has since increased in Gombe, Yobe, and Borno as a way of checking invasion from the Boko Haram terrorists. Spacing between houses is not definite and could range from three or four meters to about ten meters. Across the study area, the materials used in constructing houses are mud (wattle and daub), thatch, corrugated iron sheets (zinc), and cement blocks. About 47% of the houses are poorly designed; they do not have toilets and bathrooms in-house. Bathrooms, where land is available, may be provided in a fenced area behind the house. The most common type of toilet (about 41% and 28%) in all the communities is the pit toilet and water system toilet respectively.

Livelihood Activities

Livelihood activities across the surveyed communities are similar. The identified activities are mainly primary production activities like farming, hunting, fishing, timber works, and tapping and production of palm wine and palm oil. Commerce and provision of services like trading, artisanship practices, and employment in the civil/public services were majorly identified in Rivers, Abia, Ebonyi, and Enugu. The largest proportion of household members in Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe, and Borno communities are engaged in farming and rearing livestock such as cattle, sheep, goats, donkeys, and horses at the commercial level. Artisanship practices inclusive of electrical repairs, boat building, tailoring, etc are significant in all the study area. Civil/public service employees in the communities are mostly Federal, State, and Local Government workers, teachers, and health workers. Others are inclusive of a few residents who are involved in contracting, especially in the various state capitals.

Household Income Levels and Expenditure Patterns

The average household member across the study area earns less than 1USD per day, it implies that a majority of household members in the study area live below the poverty line. The major items of expenditure in the households are food, health care, purchase of household items including utilities (kerosene, petrol, etc), transportation and clothing

Infrastructural Base

Public access to the project-affected communities is by dilapidated and poorly maintained tarred **roads** with most of the State and LGA headquarters having paved internal link streets. Additionally, telecommunication services from GSM service providers are received in most parts of the communities, although these services fluctuate in some of the communities.

Education facilities in the project-affected communities consist mainly of public primary, junior and senior secondary schools. The infrastructures in many of the schools are inadequate. The students' desks and chairs are broken and insufficient, classrooms are also insufficient, and some of their ceilings, windows, doors, and floors are broken. The schools do not have decent utilities like toilets and they also do not have equipped libraries and laboratories. The student to teacher ratio in the public primary schools is high, as much as 60:1. Teachers in the secondary schools are not enough to cover all the subject areas, and subjects like Mathematics, Physics, Introductory Technology, Agricultural Science, English Language, and Home Economics are often taught by teachers who did not study these core subjects in the universities.

There is generally a dearth of functional government orthodox **health facilities** in the entire study area. Perhaps the only one that can be considered functional and patronized by several residents are the General Hospitals located in most LGA headquarters. The basic problems of the hospitals are inadequate staffing, broken down and unmaintained equipment, and lack of drugs. The situation is such that most households generally do not have confidence in them and would rather 'consult' drug stores or take their members requiring medical attention to the various State capitals.

Public water and electrification are very much dysfunctional in the project-affected communities. Several water boreholes have been constructed in the communities but most of them are not working largely because of poor maintenance culture. Similarly, most of the communities have **electricity** facilities and are linked to the national grid. The power output is however so poor and erratic that a fair number of residents, especially those involved in various economic enterprises, also possess electricity generating sets to ameliorate the effect of poor power supply and power outages.

In terms of trading opportunities, all the surveyed communities can boast of small, functional but poorly infrastructures a makeshift marketing facility which deals with foodstuff basically from which the people may procure their essential needs except for Port Harcourt, Aba, Umuahia, Enugu, Markudi, Kaduna and other state capitals with large and function markets with modern market facilities.

Health Facilities and Services

The study area has both orthodox and non-orthodox health care providers and facilities. Most Local Government headquarters have a General Hospital which provides first aid, serves as an HIV/AIDS counseling center and treatment for minor ailments, as well as immunization services for children and women of childbearing age. The antigens they give include BCG, OPV, DPT, Measles, TT, YF, and HBV.

Apart from the orthodox facility, there are drug stores (chemists) located in some of the communities. There are also hawkers (individuals who carry drugs, especially malaria drugs, analgesics, antibiotics, and various creams and balms) hawking drugs from one settlement to another. The number and the quality of drugs being distributed could not determine during the study.

Water Sources

In Nigeria, 66% of households have access to an improved source of drinking water, 74% in urban areas, and 58% in rural areas. Urban and rural households rely on similar sources of drinking water. The three most common improved sources of drinking water in urban and rural households are tube wells or boreholes (41% in urban and 34% in rural households), protected dug wells or springs (13% in urban and 12% in rural households), and public taps/standpipes (7% in urban and 8% in rural households) (NDHS 2018). The sources of water used in households in the study area include water from the surrounding rivers and streams, rainwater, well, and water from public and private boreholes.

In the surveyed area in Rivers State, many households avoid the use of rainwater as a result of their belief that rainwater is being polluted by gaseous emissions from flares from oil and gas activities in and around their communities. For this reason, also, the use of rainwater is mostly limited to the washing of clothes and other things and not for cooking.

Waste Management Practices

Waste disposal practices in the 12 project-affected communities are quite similar. Refuse and sewage is mostly disposed of in the surrounding farmlands, rivers, and streams. Generally, three methods of refuse disposal are practiced in the rural area of the project area and they are; dumping of refuse in the river, bush, and burning while the state capitals like Port Harcourt, Umuahia, Enugu, Markudi, Jos, Bauchi, and Gombe uses the services of the state own waste management agency. Similarly, two methods of sewage disposal practiced are used and they are; pier system toilets and water closet toilets. About 60% of households in the study communities dump their refuse in the rivers, while 72% use the pit toilets.

E.S 5 Stakeholders Engagement

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the Port Harcourt-Maiduguri railway project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also to notify the stakeholders of the nature, scale, and timing of the proposed project, thereby eliminating any fears or apprehension.

- **Public Consultation process**

The consultation team has sought to ensure that all identified stakeholders, including the project impacted communities, are aware of the proposed project and the ESIA process through extensive community consultation. The stakeholder engagement strategy was designed to attain meaningful participation and involvement that enabled stakeholders and the community to actively contribute to the development of new ideas and options as the project is planned and developed.

- **levels of Consultation**

Two levels of consultations, as are generally recognized in the ESIA process, were held. These are institutional and Project affected communities (PACs) involvement. The public forum with project-affected communities, NGOs, and CBOs, youth groups, women organizations, religious organizations, and traditional bodies held between 16-23 November 2020 in the project-affected communities with the various village heads and traditional rulers in attendance and also with major institutional stakeholders on 10th, 12th, 13th, 16th, and 19th November 2020 in Enugu, Umuahia, Port Harcourt, Damaturu, and Jos respectively.

- **Identification of Stakeholders**

The proponent's policy makes it mandatory to consult with stakeholders and relevant authorities in all activities. The key stakeholders identified and consulted for the proposed construction of the Port Harcourt-Maiduguri Railway project at Port Harcourt, Umuahia, Enugu, Jos, and Damaturu are:

i. Federal Ministry of Environment
ii. Federal Ministry of Transportation
iii. Federal Ministry of Works and Housing
iv. Nigeria Railway Corporation
v. National Environmental Standards and Regulations Enforcement Agency (NESREA)
vi. Federal Roads Safety Corps
vii. National Inland Waterways Authority
viii. Nigeria Security and Civil Defence Corps (NSCDC)
ix. Department of State Security (DSS)
x. Nigeria Police
xi. Rivers, Abia, Enugu, Nasarawa, Kaduna, and Yobe
    a. State Ministry of Environment
    b. State Ministry of Works
    c. State Ministry of Lands
    d. State Ministry of Urban and Physical Planning
    e. State Ministry of Women Affairs
    f. State Ministry of Local Government and Chieftaincy Affairs
    g. Waste Management Agencies
xii. The 65 affected LGCs
xiii. Elders, youth, and women groups of affected communities (grouped into 50 clusters)
xiv. Association of Environmental Impact Assessment of Nigeria (AEIAN)
xv. Institute of Natural Resources and Environmental Management (INRES), University of Port Harcourt
xvi. National Union of Railway Workers
xvii. Road Transport Employer Association of Nigeria
xviii. Nigeria Society of Engineers

- **Public Disclosure**

As part of the formal regulatory and consultation process, when the draft ESIA report is submitted to FMEnv. FMEnv makes a public notice of the opportunity for information and comment on the draft ESIA report for the project. This notification is typically done through a newspaper and radio announcement.

The notification will provide:

- a brief description of the project;
- a list of venues where the ESIA report is on display and available for viewing;
- duration of the display period; and
- contact information for comments.

The FMEnv generally requires a twenty-one (21) working day display period. Display venues will be decided by FMEnv but could be expected to include:

- FMEnv offices in Abuja;
- FMEnv Lagos office
- Rivers, Abia, Ebonyi, Enugu, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment; and
- Project Affected Local Government headquarters

Communities' Concerns

- **Environmental damage:** Most communities fear that the construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.
- **Social problems:** Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.
- **Health problems:** Increase in the occurrence of STDs and HIV/AIDs.
- **Payment of compensation:** Involuntary displacement and loss of property

- **Community Expectations**

Expectations of the communities consist mainly of human capital development and the development of infrastructural facilities.

E.S 6 Impacts and Mitigation Measures

The summary of impact analysis as described in the environmental impact assessment report is presented here. The impact analysis considers the various phases of the project:

- pre-construction phase
- 1^{st} phase Decommissioning
- construction phases
- operation phase, and
- 2^{nd} phase decommissioning phase

This analysis is based on a cause/effect matrix between project-related impact sources and valued environmental and social components. Impacts are defined by their intensity (low, medium, major), their extent (regional, local, limited) and their duration (long, medium, short). The method used to identify, analyze and mitigate environmental and social impacts, or to improve positive impacts, places the project in a sustainable development perspective. The mitigation of anticipated negative impacts and the enhancement of positive impacts allow its environmental and social acceptability by stakeholders.

Anticipated Socio-Economic Benefits

- The potential socio-economic benefits that will arise due to the commencement of the project includes
- Increased earning to local labourers from vegetation clearing and site preparation
- Provision of social amenities like portable water supply, electricity, and asphalt road
- Direct employment to qualified Nigerians and local inhabitants
- Increased revenue to state and through payment of electrical bills
- Increased foreign and local investments in the area and in the country, leading to wealth creation, employment generation, infrastructural development, and economic empowerment
- Availability of land for alternative use, after project decommissioning

Potential Negative Impacts

- Environmental issues identified may involve negative impacts includes;
- Depletion of ecosystem resources and potential soil and water pollution
- More burden on local infrastructures
- Emissions to air (in particular dust); discharge of effluent/waste water to the aquatic environment and potential water pollution
- Occupational health and safety
- Public health issues involving waste management and community health.

E.S 6.1 Mitigation Measures

Mitigation impact hierarchy has been applied for the identified significant (adverse and beneficial) impacts, by considering prevention/avoidance, reduction, and control of adverse impacts in that order and enhancement for the beneficial impacts. Measures proposed are as follows with the Proponent, being the responsible implementing entity during construction and operation phase;

Mitigation Measures During Pre-construction and Construction Phases

- Develop and implement stakeholder engagement plan for each phase of the project.
- Engage actively and activate the grievance resolution mechanism.
- Undertake revegetation planting agro-forestry trees that increase availability of fodder or fruit trees, to maximize livelihood benefits for local population.
- Carefully select the landing area of falling trees to minimize damages to crops.
- Secure equipment and demarcate any excavation work areas.

- Maintain equipment and machinery in good running condition, including brakes, mufflers and silencers, and catalysers.
- Manage all associated constructional risks through the use of competent professionals/engineers or isolating the source of risk or use of acceptable administrative measures in the workplace
- ensure all personnel wear appropriate personnel protective equipment (PPE).
- construct drainages to control runoffs
- maintain all vehicles and internal combustion engines at optimal working conditions.
- Require the Contractor to adopt policies and procedures that comply with national legislation and address all aspects of labor standards relevant to the project.
- Supply drinking water and maintain its quality and ensure sanitation at the construction sites.
- Develop and Implement an H&S management plan to protect every worker involved in construction activities, even temporary workers.
- Prepare and implement an HIV/AIDS prevention program.
- ensure that contractors do not unduly exploit the local workers through salary cuts and payment delay
- ensure all incidents are reported and documented and corrective actions taken
- Screen health of potential employees as part of the recruitment process.
- Ensure construction workers are discouraged from engaging in the exploitation of natural resources such as hunting and collection of forest products such as wood
- Carryout daily safety briefings before commencement of work each day.
- Maintain construction camps in a clean and healthy condition as prescribed by international worker health standards.
- Communicate with communities effectively and involve their representatives.
- Employ non-skilled and semi-skilled labour, where available and provide training in relevant skills needed by the project to enable community members participate.
- Encourage the recruitment of female workers.
- Apply the Physical Cultural Resources Management Plan, waste management plan, vegetation management plan, etc.

Mitigation Measures During Operations Phase

- Provide all internal combustion equipment with properly functioning silencers or mufflers.
- ensure all personnel wear appropriate personnel protective equipment (PPE)
- ensure only competent and well-trained personnel are used for the job
- employ the best available Waste technology in its operations
- Prepare and implement an Emergency Response Plan.
- Contain any spills and clean up spills as soon as possible.
- ensure an inventory of waste is developed and maintained
- enforce the use of safe fuel handling procedures
- maintain all equipment at optimal working conditions

- Dispose of organic material properly and in line with waste management regulation and in collaboration with local communities.
- ensure all equipment are periodically maintained and records kept
- Adopting procurement practices that favour skilled and semiskilled indigenes of the area
- provide dedicated fire fighting personnel and equipment
- Undertake monitoring of natural resources exploitation and implement a sensitization program in order to educate and increase local communities' awareness on natural resources protection.
- Ensure The use of trained personnel in handling electrical wires
- Assume its corporate responsibilities by assisting the host communities in their developmental drive, such as provision of infrastructures and social amenities where possible
- Implement training programs to build local capacity.
- Ensure all personnel are medically fit before mobilization to base camp
- Also subject all workers to periodic medical test
- ensure that process wastewater is treated before discharging to nearby water bodies
- encourage mutual existence between the workers and the communities by appointing community liaison officers (CLO).
- Communicate with communities effectively and involve their leaders.
- Prompt payment of all bills and fees to the appropriate government authorities
- ensuring that tax deductions from employees get to the appropriate government agencies

Mitigation Measures During 1st and 2nd phase Decommissioning

- Sell reusable parts to locals at greatly reduced prices
- Ensure decommissioning in the daytime to limit night time noise impact to locals
- Ensure all machines are well serviced and in optimal working conditions
- Consult with relevant stakeholders (FMEnv, Host communities etc.) to decide on the best option for landuse after abandonment.
- Ensure re-vegetation is affected with local species
- Clear all concrete rubble or debris

CHAPTER 1

INTRODUCTION

1.1 Background Information

The Existing Eastern Nigerian narrow-gauge railway traverses 12 states of the Eastern Nigeria from south to north. The line goes towards the north from existing Port Harcourt New station to Maiduguri. Two existing branch lines connect Kaduna and Jos respectively.

The Port Harcourt-Kafanchan section of the existing Eastern Narrow-gauge Railway is one of the earliest railways built in Nigeria in the early 20th century. The Port Harcourt-Kafanchan section, Kafanchan-Kaduna connecting line, and Kafanchan-Kuru-Jos Railway were built at the same time in the early 1940s. The Kuru-Maiduguri Railway, completed in 1965, was the last railway built in the 20th century in Nigeria.

In 1984, the passenger traffic volume of the existing narrow-gauge railway reached the peak number of passengers dispatched over the years. Later, due to lack of maintenance, low transport capacity, as well as the rapid development of highway transport, highway transportation is significantly more competitive than railway, so passenger traffic volume of railway shrunk severely.

After the rehabilitation and reconstruction carried out in the later 1990s and 2010, the passenger traffic volume has rebounded. But the volume decreased again in 2016, serious damages to the bridges and subgrade have consequently caused the stoppage of operation.

Due to the need to improve the economic activities through the provision of modern intermodal transportation systems in Nigeria, the Federal government through Federal Ministry of Transportation is set to rehabilitate the existing Port Harcourt - Maiduguri narrow gauge Railway and its accessories, and construct new accessories to ease transportation of goods and personnel along the region.

This project Rehabilitation and construction necessitated the preparation of this ESIA Report with additional inputs that included stakeholders' engagement, baseline data update, inclusion and description of additional project components, their impacts, mitigation and management.

1.1.1 Project Components

- Existing Nigerian Eastern Railway: Port Harcourt - Maiduguri narrow gauge, 1,443km. 265km of this have been rehabilitated;
- New Gashua Branch Line. Goniri - Gashua narrow gauge, 216km;
- Existing Kaduna Connecting Line: Kafanchan - Rigachikun, 200km;
- New Rigachikun Transshipment Station;
- Existing Jos Branch Line Railway: Kuru -Jos narrow gauge, 35km; and
- New Asa Transshipment Station

1.2 The Proponent

The proponent, Federal Ministry of Transportation (FMoT) is a cabinet Ministry of the Government of the Federation. Currently, it has various operations departments among which are the Rail Transport Services Department which oversees the Nigerian Railway Corporation (NRC), the operators of the railway systems in Nigeria. Others include the Marine Services Department oversees NIMASA, NPA, NIWA (Marine and River transport systems). A Cabinet Minister heads the Ministry, supported by a Minister of State. The Permanent Secretary follows, as the chief accounting officer while the Departments are headed by Directors.

The Ministry is responsible to build a world-class transportation system which will provide a safe, secure, efficient, affordable and also inter-modal transport system that is self-sustaining to the socio-economic growth across the country. Nigerian Railway Corporation (NRC) is one of the parastatals of FMoT established by Nigerian Railway Corporation act 1955 and Re-Enactment Act 2008 with the sole mandate of providing effective rail transportation with affordable, reliable, widely linked network and customer-oriented services.

1.2.1 The Proponent's Intent

FMoT carries out a function of environmental stewardship by recognizing the importance of comprehensive Environmental Planning and Management. The success of any rail project is committed to the necessary study to understand the environmental system of the project area, to address areas where significant negative environmental impacts (natural, physical, and social) may occur, with a view to addressing them, adequately. In pursuance of this, FMoT through her environmental consultant, is conducting this Environmental Impact Assessment (ESIA) of the project.

This ESIA is in line with the Federal Ministry of Environment's (FMEnv's) Environmental Impact Assessment Procedural/Sectorial Guidelines for infrastructure projects as well as other international environmental standards.

1.3 Project Location

The Nigerian Eastern Railway Line takes off from Port Harcourt in Rivers State and terminates in Maiduguri, Borno State, with branches in Kaduna, Plateau and Yobe States, traversing sixty five (65) Local Government Areas in twelve (12) States covering about 1894km (Table 1.1 and Figure 1.1).

Table 1.1: Table showing the project Affected LGAs.

SN	STATE	LGA	Number
1	Rivers State	Port Harcourt, Obio/Akpor, and Oyigbo	3
2	Abia State	Ukwa West, Ugwunagbo, Aba South, Aba North, Oboma Ngwa, Isiala Ngwa North, Isiala Ngwa South, Umuahia North, Umuahia South, Bende and Isikwato.	11
3	Ebonyi	Ivo and Ishielu	2
4	Enugu	Aninri, Nkanu East, Nkanu West, Enugu South, Enugu North, Enugu East, Isi Uzo	7
5	Benue	Ado, Oturkpo, Gwer East, Makurdi, Guma.	5
6	Nasarawa	Keana, Obi, Lafia, Nasarawa Egon, Akwanga.	5
7	Kaduna	Sanga, Jema'a, Kaura, Zangon Kataf, Kachia, Kajuru, Chikun, Kaduna South, Kaduna North	10
8	Plateau	Riyom, Jos South, Jos North, Barkin Ladi, Mangu.	5
9	Bauchi	Tafawa Balewa, Bauchi, Alkaleri, Kirfi	4
10	Gombe	Akko, Kwami, Yamaltu, Funakaye	4
11	Yobe	Gulani, Gujba, Damaturu, Tarimuwa, Busari, Bade	6
12	Borno	Kaga, Kondoga, MMC	3
			65

Source: PGM Fieldwork, 2020

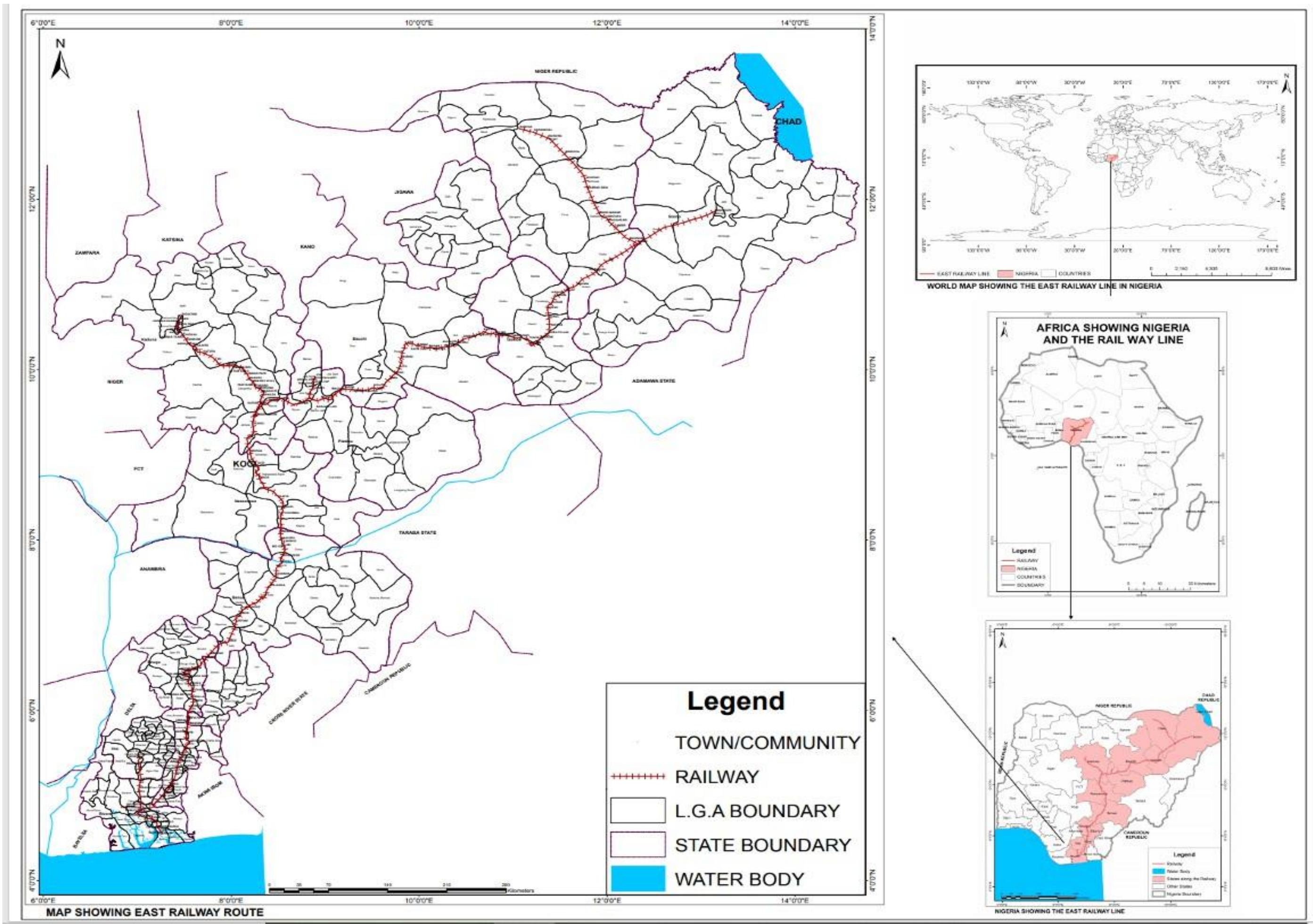


Fig. 1.1: Map showing the project affected area

1.4 Scope of the Study

This ESIA covers an area of 1km (500m on either side of the rail line) as the spatial boundary and also 2,044.1km railway line and its associated rail stations for all environmental attributes along the railway corridor and its ancillary facilities. as stipulated by FMEnv guidelines.

This ESIA report covers the 1st phase decommissioning, construction, operations and decommissioning/Abandonment phases of the project, as described in Chapter 3.

The ESIA is aimed at meeting the requirements of the Nigerian regulatory authorities; and international institutions such as the IFC, AfDB, ADB and EPFI and other major lending institutions that may be involved with the project at any time in its lifespan.

This ESIA has considered the following:

- International Finance Corporation's Performance Standards on Environmental and Social Sustainability (January 1, 2012);
- International Finance Corporation, Access to Information Policy January 1, 2012;
- International Finance Corporation's Environmental, Health, and Safety, General Guidelines, April 30, 2007:
- IFC Environmental, Health, and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions And Ambient Air Quality (April 30, 2007)
- IFC Environmental, Health, and Safety Guidelines for Linear projects such as rail and road: construction section: (April 30 2007);
- FD (06. 2012);
- European /(EU) Emission Standards, EU Laws including EU Directives (November 16, 2012), and Directive 2008/50/EC on ambient air quality and cleaner air for Europe;
- International Organization for Standardization (ISO) 14000 Standards;
- ILO Labour Standards (Core Labour Standards and Basic Terms and Conditions of Employment for all Workers, including subcontractors) and
- OHSAS 18001 for Occupational Health and Safety.
- The European Investment Bank Environmental and Social Practices Handbook (2010);
- The European Bank for Reconstruction and Development Environment and Social Policies of May 2014
- African Development Bank Integrated Environmental and Social Impact Assessment Guidelines, October 2003;

- African Development Bank Group's Policy on the Environment ('Environmental Safeguards Policy'), September 2013
- African Development Bank Involuntary Resettlement/livelihood restoration Policy, November 2003; and
- Environmental Review Procedures for Private Sector Operations of the African Development Bank May 2000.
- The Equator Principles of Financial Institutions (EPFI) of June 2013

1.5 World Bank's Environmental and social Safeguard Policies

The World Bank's 2018 environmental and social safeguard policies are a cornerstone of its support to sustainable poverty reduction. The objective of these policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for bank and borrower staff in the identification, preparation, and implementation of programs and projects. These Policies include:

ESSP 1 - Environment Assessment
ESSP 2 - Labour and Working Conditions
ESSP 3 – Resource Efficiency and Pollution Prevention and Management
ESSP 4 - Community Health and Safety
ESSP 5 - Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement
ESSP 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources
ESSP 7 - Indigenous People and People in Sub-Saharan Africa
ESSP 8 - Cultural Heritage
ESSP 9 - Financial Intermediaries
ESSP 10 - Stakeholders Engagement and Information Disclosure

This ESIA has reviewed these policies because they are relevant to the Project as shown in the following sub sections:

ESSP 1 - Assessment and Management of Environmental and Social Risks and Impacts is the overarching standard that provides the procedural basis for an integrated environmental and social assessment of investment projects in a risk-driven, outcome-based, and proportionate manner. It establishes the need to characterize how disadvantaged and vulnerable groups may be affected by projects and how impacts may be addressed. It introduces the concept of ecosystem services and measures to manage risks and impacts related to them. It builds on the existing OP/BP 4.01, Environmental Assessment, and, together with ESS10, applies to all investment projects. It broadens the scope of assessment by adding explicit requirements covering social risks and impacts. It provides clearer project definitions for borrowers and introduces a clear and actionable risk management system.

Under this policy, projects are categorized as category A, B, or C according to type, scale, location and anticipated severity of environmental impacts. The category indicates the scope and detail required for the ESIA. These categories are presented in Table 1.2.

Table 1.2: Categorization of ESIA

Category	Requirements
A	A full (comprehensive) ESIA is normally required as the project may have significant adverse impacts that may be sensitive, irreversible, and diverse. These are mainly new construction projects.
B	More limited environmental analysis is appropriate, as the project may have specific environmental impacts and mitigation measures can be more easily designed. Projects under this category entail maintenance, or rehabilitation rather than new construction
C	Environmental analysis is normally unnecessary. Projects focus on education, family planning, health, and human resources development

Source: IFC 2012

ESSP 2: Labour and Working Conditions is the World Bank's first proposal to introduce a set of operational policy requirements for labour and working conditions in investment projects. The standard prohibits child and forced labour and supports freedom of association and collective bargaining. Considering the nature of different types of projects, workers, and suppliers, it includes proportional requirements for community labour projects, the provision of a grievance mechanism for project workers, and requirements relating to occupational health and safety.

ESSP 3: Resource Efficiency and Pollution Prevention and Management incorporate key provisions of OP/BP 4.09, Pest Management, and address the efficient management of energy, water, raw materials, and other resources. It also requires borrowers to characterize and estimate emissions of air pollutants, including project-related greenhouse gas emissions. This project has triggered this policy which has been addressed in the project description (chapter 3), physical and biological components of chapter 4 and the ESMP in Chapter 7. It was further amplified with the consideration of the GHG and climate change.

ESSP 4: Community Health and Safety focuses on projects' risks to and impacts on communities. It incorporates key provisions of OP/BP 4.37, Safety of Dams, and addresses the design and safety aspects of infrastructure, equipment, services, traffic, and hazardous materials. It includes requirements for the deployment of security personnel. Characterization of the project waste streams; traffic studies and the development of high levels traffic and waste management plans satisfies this provision.

ESSP 5: Land Acquisition. Restrictions on land use and involuntary resettlement maintains key provisions of OP/BP 4.12, Involuntary Resettlement, including the principles of compensation at replacement cost and assistance in restoring or improving livelihoods. It gives explicit recognition to the importance of exploring ways for affected people to share in the benefits of the project.

Regarding resettlement, the Bank guidelines prescribe measures to minimize the negative impacts and ensure that the displaced community benefits from the project. Therefore, the Policy requires that displaced person should be:

- Compensated for their losses at full replacement cost prior to the actual move;
- Assisted with the move and supported during the transition period in the resettlement site;
- Assisted in their effort to improve their former living standards, income earning capacity, and production levels, or at least restore them
- Integrated socially and economically in to host communities so that adverse impacts on host communities are minimized. The best way of archiving this integration is for resettlement to be planned through consultation involving affected people and future hosts and affected people

In addition, land, housing, infrastructure, and other compensation should be provided to the adversely affected population, indigenous groups, ethnic minorities, and pastoralists who may have customary right to the land and other resources taken for the project. The absence of legal title to land by such groups should not be a barrier to compensation.

This policy has been triggered since in some areas of the route, physical and economic displacement to allow construction works.

ESSP 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources incorporates key provisions OP/BP 4.04, Natural Habitats, and OP/BP 4.36, Forests, requiring borrowers to assess and take measures to mitigate the impacts of the project on biodiversity, including loss of habitat, degradation, and the introduction of invasive alien species. It also establishes principles to govern the sustainable use of living natural resources, such as forests and fisheries.

The policy affirms commitment to the evaluation of the indigenous ecosystem services present in any project area, development of a robust ESMP.

ESSP 7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities maintains key provisions of OP/BP 4.10, Indigenous Peoples, while recognizing that some shareholders may use different terms to describe Indigenous Peoples. It requires Free, Prior, and Informed Consent in specified circumstances. For ESS7, consent refers to the collective support of affected Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities. This policy does not apply to the project.

ESSP 8: Cultural Heritage reaffirms the objectives of OP/BP 4.11, Physical Cultural Resources, requiring projects to use chance finds procedures and other approaches to protect cultural heritage, and providing for consultation with affected communities. It broadens the definition and treatment of cultural heritage to include both tangible and, in specified circumstances, intangible cultural heritage.

This policy addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be in urban or rural settings, and may be above or below ground, or under water. Their cultural interest may be at the local, provincial, or national level, or within the international community.

Cultural resources are important as sources of valuable historical and scientific information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices. The loss of such resources is irreversible, but fortunately, it is often avoidable.

ESSP 9: Financial Intermediaries requires financial intermediaries (FIs) to put in place an environmental and social management system with associated procedures. ESS9 reflects existing FI requirements under OP 4.01 and OP 4.03, as well as IFC's approach to FI operations.

ESSP 10: Stakeholder Engagement and Information Disclosure consolidates and improves provisions related to borrower engagement with stakeholders, including meaningful consultation, access to information, and grievance redress. It provides for ongoing dialogue between the borrower and stakeholders, including project-affected parties, throughout the life of a project, and lays out requirements for information disclosure and grievance redress. A continuous Stakeholder Engagement Plan has been developed for this project.

1.6 Legal and Administrative Framework for Environmental Protection/ESIA

Environmental Protection has become a more central topic of discussion worldwide and an imperative for sustainable development. Since the 1972 Stockholm Declaration on the Human Environment, there has indeed been a phenomenal growth in national environmental laws and related administrative machinery worldwide. Nigeria is not left behind in this regard as the Federal Government of Nigeria, in 1988, promulgated the Federal Environmental Protection Agency Act 58 of 1988, Federal Environmental Protection Agency (Amendment) Act No 59 of 1992, Environmental Impact Assessment Act No 86 of 2004 among others, and established the Federal Environmental Protection Agency (FEPA), now Federal Ministry of Environment (FMEnv) to administer them. In compliance with the provisions of the Federal Environmental Act, States Environmental Edicts were also formulated with the establishment of the State Environmental Protection Agencies (SEPAs), (some now subsumed into State Ministries of environment) for their administration. Similarly, related ministries and several quasi-governmental institutions exercise control over environmental issues in areas where each has direct mandate.

The legal and regulatory framework, within which the ESIA for the proponent is executed, is entrenched in the broader framework of the international, national, state edicts, LGA Bye-Laws, sectoral and FMoT/ NRC's in-house policy applicable to the Environment in Nigeria.

These include:

A. all applicable International Agreements and Conventions to which Nigeria is a signatory;

B. the regulations, standards, codes, and recommended practices of the Federal Ministry of Environment;

C the regulations, standards, codes and recommended practices of the National Environmental Standards and Regulatory Enforcement Agency (NESREA)

D. the regulations, standards, codes, and recommended practices of various State Ministries of Environment, and affected Local Governments Environmental Departments.

Existing statues on environmental protection in Nigeria contain specific provisions designed to prohibit or control environmental pollution/degradation and to prescribe sanctions or damages to be enforced against persons or corporate entities who contravene these provisions. The principal body responsible for environmental protection matters and saddled with enforcing existing statutes and regulations in Nigeria is the Federal Ministry of Environment (FMEnv).

This section provides a preliminary identification of the Nigerian administrative framework and describes the relevant Nigerian legislation, international treaties and industry standards and guidelines that the project will follow. Specifically, this section provides a summary of:

- Nigerian administrative and legislative organization;
- National environmental and social legislation deemed applicable to the Project;
- International conventions to which Nigeria is a signatory;
- International standards and guidelines to which the Project will also align; and
- The Federal Ministry of Transportation internal standards and guidelines with which the project will also be consistent.

This shall be discussed under the following sub sections

- Federal (FMEnv and NESREA)
- State Ministries of Environment
- Relevant Local Government Legislature
- International Lenders AfDB, ADB, IFC, EBRD and EPFI,

1.7 Legal Laws and Regulations

1.7.1 Federal Ministry of Environment

The Federal Environmental Protection Agency (FEPA) [presently subsumed into the Federal Ministry of Environment (FMEnv) was established in 1988 by Act No 58 of 1988 and subsequently amended through Act 59 of 2004. The body is charged with the overall responsibility of environmental matters in Nigeria. It has developed instruments of intervention to halt environmental degradation in form of policies, standards, guidelines, regulations and programmes. With the initiation of these instruments, enforcement by FMEnv has become the most effective tool to bring industries into compliance through compliance promotions. The relevant policies, guidelines and regulations enforced by FMEnv that are relevant to the Project include:

- National Policy on the Environment (1989);
- Federal Environmental Protection Agency (Amendment) Act No 59 of 1992)
- Environmental Impact Assessment Act (Act No 86 of 2004); and

- National Guidelines and Standards for Environmental Pollution Control in Nigeria (1991).

National Policy on Environment

The National Policy on Environment, 1989 (revised 1999 and 2016), provides for "a viable national mechanism for co-operation, co-ordination and regular consultation, as well as harmonious management of policy formulation and implementation process which requires the establishment of effective institutions and linkages within and among the various tiers of government- federal, state and local governments".

Environmental Impact Assessment Procedural Guidelines by Act 58 of 1988, the Federal government created the Federal Environmental Agency (FEPA). Act No 58 of 1988 was amended by FEPA (Amendment) Act No. 59 of 2004. This legislation vests in FEPA overall responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigerian's natural resources in general and environmental technology, including initiation of policy related to environmental research and technology, among other functions.

National Guidelines and Standards for Environmental Pollution Control in Nigeria

In line with the strategic thrust of the National Policy on Environment, the National Guidelines and Standards for Environmental Pollution Control in Nigeria was published in March 1991 to serve as a basic instrument for monitoring and controlling industrial and urban pollution. The main thrusts of these guidelines are:

- effluent limitations;
- water quality or industrial water uses at point of intake;
- noise exposure limitations;
- industrial emission limitations;
- management of solid and hazardous wastes.

Pollution Abatement in Industries, Industries Generating Wastes Regulation

The pollution abatement regulation, 9 of 1991 (No. 42, Vol. 78, August, 1991), imposes restrictions on the release of toxic substances and stipulate 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 FMEnv; requirement of permit by industries for the storage and transportation of harmful toxic waste; the generator's liability; strategies for waste reduction; permissible limits of discharge into public drains; protection of workers and safety requirements; for environmental audit (or environmental impact assessment for new industries) and penalty for contravention.

Management of Hazardous and Solid Wastes Regulation

The management of hazardous and solid waste regulation, 15 of 1991 (No. 102, Vol. 78, August 1991), define the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators etc. It also describes the hazardous substances tracking program with a comprehensive list of acutely hazardous chemical products and dangerous waste constituents. It also states the requirements and procedures for inspection, enforcement, and penalty.

(1) Environmental Impact Assessment Act

The ESIA Act CAP E12 LFN 2004 makes ESIA mandatory for all new major public and private projects in Nigeria. The ESIA Act sets out to:

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

In September 1995, FEPA now FMEnv published ESIA Sectorial and Procedural guidelines for projects in Nigeria. The guidelines are intended to assist in the proper and detailed execution of ESIA studies of new projects in consonance with ESIA Act No. 86 of 2004. The FMEnv ESIA process is shown in Figure 1.2.

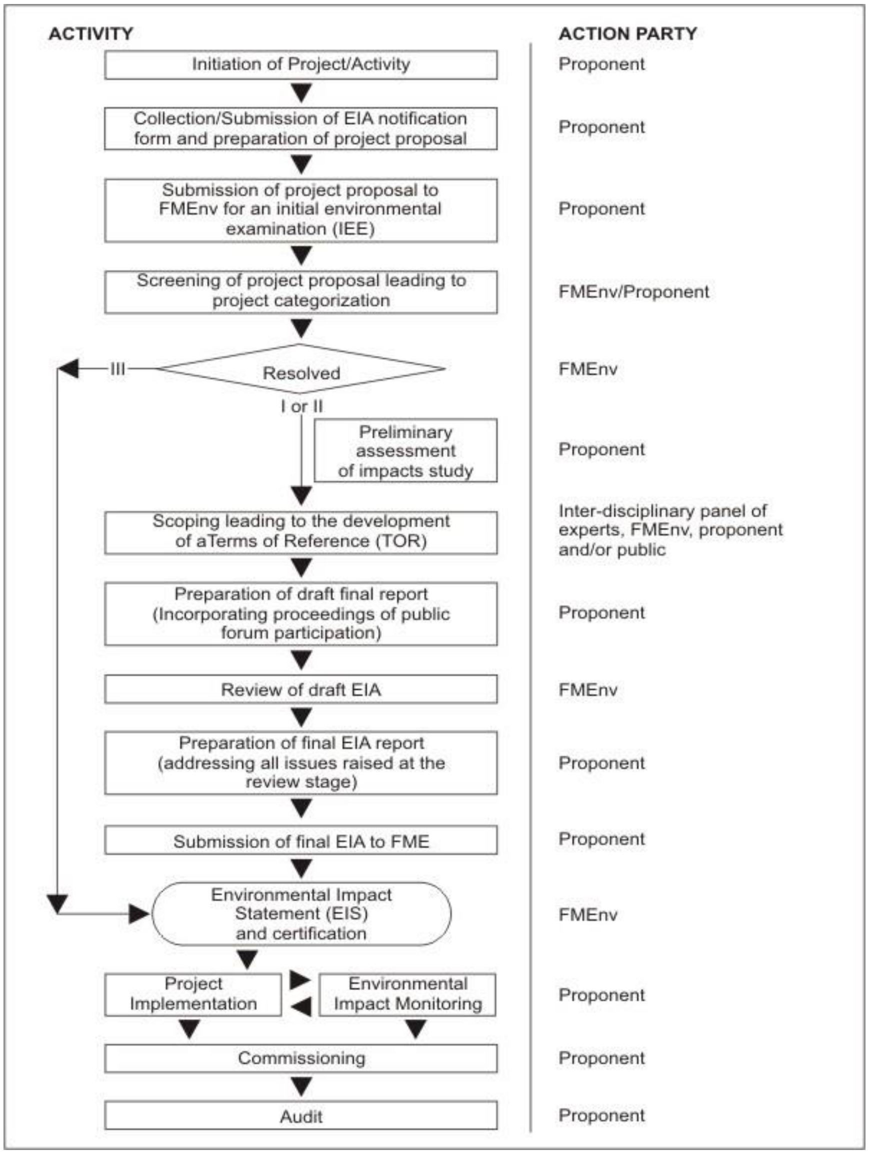


Figure 1.2: The Federal Ministry of Environment's ESIA Process (Source: FMEnv)

1.7.2 Nigeria National Forestry policy 2006: Guiding principles for the New National Forest Policy

The following general principles guide the New National Forest Policy. These principles are based on the government reform agenda, of poverty reduction and good governance. Specifically, the principles are based on the need to:

• address the factors affecting the decline of the forest resources.

• streamline the contribution of forests to economic development and growth particularly the National Economic Empowerment and Development Strategy (NEEDS) whose four key Strategies are – reorienting values, reducing poverty, creating wealth and generating employment.

• mobilize the community and civil society in forestry development.

• to promote partnerships with the private sector, the Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs).

• address transparency and in the tendering administration for forest concessions and to encourage long term concessions.

• accommodate the international forest policy initiatives, the implementation of the Intergovernmental Panel on Forests (IPF) and on Intergovernmental Forum on Forests (IFF) proposals for action for a sustainable forest management.

• mainstreaming forestry activities into the Millennium Development Goals

The National Objectives of the policy are:

- Livelihoods and Poverty Reduction;
- Food Security, Biodiversity Conservation and Environmental Services;
- Partnership in Governance;
- National Forestry Legislation;
- International Obligation;
- Forestry Valuation; and
- Forest Sector Investment.

1.7.3 National Environmental Standards and Regulations Enforcement Agency (NESREA)

This is an agency under the Federal Ministry of Environment. It was established by Act 25 of 2007. The agency is charged with enforcing regulatory standards relating to environment. NESREA has developed the following twenty-four environmental regulations which have been published in the Federal Republic Official Gazette and are now in force. Table 1.3 lists the key regulations that are expected to be applicable to this Project.

Table 1.3: NESREA Environmental Protection Regulations Relevant to Project

Regulation	Description
National Environmental (Wetlands, River Banks and Lake Shores) Regulations (No 29 of 2009 Section 1 No 26)	Provides for the conservation and managed use of wetlands and their resources in Nigeria. It ensures the sustainable use of wetlands for ecological and tourism purposes and protect wetland habitats for associated species of fauna and flora.
National Environmental (Watershed, Mountainous, Hilly and Catchments	Make provisions for the protection of water catchment areas.

Regulation	Description
Areas) Regulations (No 27 of 2009 Section 1 No 27)	
National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28)	The purpose of this Regulation is to provide the legal framework for the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution.
National Environmental (Permitting and Licensing System) Regulations, 2009. S. I. No. 29	. The provisions of this Regulation enable consistent application of environmental laws, regulations and standards in all sectors of the economy and geographical region.
National Environmental (Access to Generic Resources and Benefit Sharing) Regulations, 2009. S. I. No. 30	The overall purpose of this Regulation is to regulate the access to and use of generic resources to ensure the regeneration and sustainability of threatened species.
National Environmental (Ozone Layer Protection) Regulation, 2009. S. I. No. 32.	This provision seeks to prohibit the import, manufacture, sale and the use of ozone-depleting substances.
National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35	The main objective of the provisions of this Regulation is to ensure tranquilitytranquillity of the human environment or surrounding and their psychological well-being by regulating noise levels.
National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12	The overall objective of these Regulations is to check all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.
National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, 2010. S. I. No. 15.	The principal thrust of these Regulations is to prevent and minimize the destruction of ecosystem through fire outbreak and burning of any material that may affect the health of the ecosystem through the emission of hazardous air pollutants.
National Environmental (Protection of Endangered Species in International Trade) Regulations, 2010. S. I. No. 16	The major objective of this Regulation is to protect species of endangered wildlife from extinction through the prohibition of trade, importation, etc.
National Environmental (Coastal and Marine Area Protection) Regulations, 2010. S. I. No 18.	This Regulation provides for the regulatory framework for the application of preventive, precautionary and anticipatory approaches to avoid degradation of the coastal and marine environment
National Environmental (Construction Sector) Regulations, 2010. S. I. No. 19.	The purpose of these Regulations is to prevent and minimize pollution from Construction, Decommissioning and Demolition Activities to the Nigerian Environment.

Regulation	Description
National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20	The purpose of these regulations is to restore, preserve and improve the quality of air. The standards contained herein provide for the protection of the air from pollutants from vehicular emission.
National Environmental (Non-Metallic Minerals Manufacturing Industries Sector) Regulations, 2010. S. I. No. 21	The principal thrust of this Regulation is to prevent and minimize pollution from all operations and ancillary activities of the Non-metallic Minerals manufacturing sector.
National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22	The purpose of this Regulation is to restore, enhance and preserve the physical, chemical, and biological integrity of the nation's surface waters, and to maintain existing water uses.

Source: www.nesrea.com

1.7.4 The Nigerian Urban and Regional Planning Act LFN 2004

Act 88 of 1992 established 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.

1.7.5 Harmful Wastes (Special Criminal Provision etc) Act No 42

Activities relating to the purchase, sale, importation, transit, transportation, deposit and storage of harmful wastes are prohibited and declared unlawful under the Act. From the commencement of this Act, any person who, without lawful authority: (a) carries, deposits, dumps or causes to be carried, deposited or dumped, or is in possession for the purpose of carrying, depositing or dumping, any harmful waste on any land or in any territorial waters or contiguous zone or Exclusive Economic Zone of Nigeria or its inland waterways; or (b) transports or causes to be transported or is in possession for purpose of transporting any harmful waste; or (c) imports or causes to be imported or negotiates for the purpose of importing any harmful waste; or (d) sells, offers for sale, buys or otherwise deals in any harmful waste, shall be guilty of a crime under this Act. Remaining provisions deal with prosecution, crimes by body corporate and penalties.

1.8 Other Nigerian Guidelines and Standards

A summary of the key applicable guidelines and standards are presented below.

1.8.1 National Effluent Limitation Regulation

The National Effluent Limitation Regulation, S.I.8 of 1991 (No. 42, Vol. 78, August 1991) makes it mandatory for industries such as waste generating facilities to install anti-pollution and pollution abatement equipment on site. The Regulation is specific for each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the environment. Appropriate penalties for contravention are also prescribed.

1.8.2 Pollution Abatement in Industries Generating Wastes Regulations

The Pollution Abatement Regulation, S.I.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 FMEnv; requirement of permit by industries for the storage and transportation of harmful or toxic waste; the generator's liability; strategies for waste reduction; permissible limits of discharge into public drains; protection of workers and safety requirements; environmental audit (or ESIA for new industries) and penalty for contravention.

1.8.3 Management of Hazardous and Solid Wastes Regulations

The Management of Hazardous and Solid Waste Regulation, S.I.15 of 1991 (No. 102, Vol. 78, August 1991) defines the requirements for ground water protection, surface impoundment, land treatment, waste piles, landfills, and incinerators. It describes the hazardous substances tracking program with a comprehensive list of acutely hazardous chemical products and dangerous waste constituent. It also states the requirements and procedure for inspection, enforcement, and penalty.

1.8.4 Nigerian Standard for Drinking Water Quality (Industrial Standard NIS554:2007)

This standard is intended to ensure the safety of drinking water supplies and protection of public health, and to encourage the improvement of management of all drinking water systems in the country. The standard parameters and maximum allowable limits for drinking water in Nigeria. It also includes normative references/laws guiding drinking water quality, definition of terminologies, institutional roles and responsibilities, monitoring, data management and compliance criteria.

1.8.5 Nigeria's Cultural Policy (1996)

The national cultural policy is generally regarded as an instrument of promotion of national identity and Nigerian unity, as well as of communication and cooperation among different Nigerian and/or African cultures.

1.8.6 FRSC Act CAP 141 (LFN)

In February 1988, the Federal Government created the Federal Road Safety Commission through Act No. 45 of the 1988 as amended by Act 35 of 1992 referred to in the statute books as the FRSC Act cap 141 Laws of the Federation of Nigeria (LFN). Passed by the National Assembly as Federal Road Safety Commission (Establishment) Act 2007.

1.8.7 British Design Manual for Roads and Bridges as adopted by Nigeria

British standards for roads and bridges construction as adopted by Nigeria covers

- Design Manual for rail and Bridges (DMRB)
- Manual of Contract Documents for Rail Works (MCHW)
- Interim Advice Notes (IANs)
- Routine and Winter Service Code (RWSC)
- Network Maintenance Manual (NMM)
- Technology Management and Maintenance Manual (TMMM)

1.8.8 Endangered Species Act 2016

Section 1 (prohibition of hunting of or trading in wild animals) of the Endangered Species Act ii of 1985 (amended in 1990) prohibits the hunting, capture and trade of endangered species such as otter, shrew, giant/tree/long-tailed pangolin, colobus monkeys, chimpanzee, gorilla, African palm squirrel, lion, leopard, cheetah, hyenas, immature elephant, giraffe, whales, dolphins, porpoises, crocodiles, etc. the endangered species Act, Cap E9, LFN 2016 focuses on the protection and management of Nigeria's wildlife and some of their species in danger as a result of overexploitation .

- ❖ Section 1: prohibits, except under a valid license, the hunting, capture or trade in animal species, either presently or likely being in danger of extinction.
- ❖ Section 5 define the liability of any offender under this act
- ❖ Section 7 provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this act.
- ❖ The Act also stipulates pertinent permits, certificates, and the processes for trading of the identified endangered species as well as prescribes penalties for contraventions.

1.8.9 Criminal Code Act CAP 77 LFN 1990

The Nigerian Criminal Code makes it an offence punishable with up to 6months imprisonment for any person who:

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

1.8.10 National Social Legislation

In the consideration of Nigerian social legislation, the following issues may be some of the important social aspects of the Project:

- ❖ resettlement and displacement;
- ❖ community health and safety;
- ❖ labour, working conditions and employment;
- ❖ cultural properties;
- ❖ economic activities; and
- ❖ access to fishing.

1.8.11 Labour Act CAP LI LFN 2004

The Labour Act CAP LI LFN 2004is the primary law protecting the employment rights of individual workers. The act covers protection of: wages; contracts; employment terms and conditions; and recruitment. It also classifies workers and special worker types. Union membership is governed by the Trade Union

Amendment Act (1995). 1999 constitution includes stipulation of "equal pay for equal work without discrimination on account of sex, or any other ground whatsoever".

While Nigeria has ratified all eight core International Labour Organization Conventions and enacted laws to enforce the provisions, there are indications of restrictions on the trade union rights of workers in Nigeria, discrimination, child labour and forced labour.

1.9 State Regulations

The various state Ministries of Environment and Natural Resources (in Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe and Borno states) have the same responsibility for environmental protection within the states.

Its duties include protecting and developing the general environment of the State. Other duties as outline include:

- Monitor the Implementation of ESIA guidelines and procedures on all developmental proje ct in the State
- Monitor and regulate disposal of solid, gaseous, and liquid wastes from facilities
- Monitor air, water, land and soil in the State to determine pollution levels; and
- Establish penalties for persons obstructing personnel of the ministry in the performance of their duties.
- Routine liaison with the Federal Ministry of Environment in order to achieve the National Policy on environment;
- Co-operate with the federal ministry of Environment and other relevant National Directorates/Agencies in the promotion of environmental education of the citizenry;
- Responsible for monitoring compliance with waste management standards;
- Responsible for general environmental matters in the state including the negative effects of human activity and physical planning;
- Monitoring of the implementation of the ESIA and the Environmental Audit Report guidelines and procedures on all development policies and project within the state.

1.10 Local Government Legal Requirements

The proposed project cuts across 65 LGAs in Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe and Borno states. The local governments have environmental departments. This department is saddled with the domestication, monitoring and enforcement of all relevant environmental laws and policies enacted by the state government in their domains.

1.11 International Guidelines and Conventions

In addition to the national laws/regulations, Nigeria is signatory to several international conventions and treaties supporting the use of ESIA as the key tool for achieving pollution control, sustainable environmental development and preservation of habitats of global significance. Some of the more pertinent of these are: World Heritage Convention, United Nations Guiding Principles on the Human Environment, The Rio Declaration on Environment and Development, Convention to Regulate International Trade in Endangered Species, Convention on Conservation of Migratory species of Wild Animals, United Nations Convention on Biological Diversity etc.

1.11.1 World Heritage Convention

The World Heritage Convention (1978), which seeks to set aside areas of cultural and natural heritage, the latter defined as areas with outstanding universal value from the aesthetic, scientific and conservation points of view.

1.11.2 United Nations Guiding Principles on the Human Environment

The United Nations (UN) published the concept of Guiding Principles on the Human Environment in 1972. Ten of these Guiding Principles were defined as formal declarations that express the basis on which an environmental policy can be built and which provide a foundation for action. The principles relevant to the railway project are summarized below.

Principle Two

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

Principle Three

The capacity of the earth to produce vital renewable resources must be maintained and wherever practicable, restored or improved.

Principle Six

The discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted in order to ensure that serious or irreversible damage is not inflicted upon the ecosystems. The just struggle of the peoples of all countries against pollution should be supported.

1.11.3 The Rio Declaration on Environment and Development

The UN Conference on Environment and Development met at Rio de Janeiro in June 1992, at which time it reaffirmed the 1972 declaration on the Human Environment and sought to build upon it. This was done with the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among states, key sectors of societies and people. It was also to aid work towards international agreements, which respect the interests of all, protect the integrity of the global environmental developmental system and recognize the integral and interdependent nature of the earth. The UN convention thus added additional principle to the originals, the more relevant being -

Principle Ten

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

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

Principle Thirteen

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

Principle Seventeen

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

Other applicable or potentially applicable international conventions and treaties to which Nigeria is a signatory, but for which enabling legislation may not be in place in all cases, include:

1.11.4 Convention to Regulate International Trade in Endangered Species

This convention was signed into law in 1973 during the Washington summit but came into force in 1975 and restricts the trade of fauna and flora species termed as endangered organisms. It establishes list of endangered species for which international commercial trade is prohibited or via permit system, regulated to combat illegal trade and over exploitation.

1.11.5 Convention on Conservation of Migratory species of Wild Animals

This convention also known as the Bonn Convention of 1979 was put into force in 1983. It obligates parties to protect endangered migratory species and to try to conclude international conservation agreements for vulnerable species that are not yet endangered. It also encourages member states to conserve and restore habitat areas for migratory species.

1.11.6 United Nations Convention on Biological Diversity

This convention was signed into law during the Rio Earth Summit in 1992. The convention places general obligations on countries to conserve sustainable use and equitably share the plants and animals of the earth.

In addition, Nigeria has adopted the World Bank Operational Directive 4.01 'Environmental Assessment' (1991), which classifies projects according to the nature and extent of their environmental impacts and supports the use of ESIA as the key tool for achieving sustainable development.

Other international conventions relevant to this project is shown in Table 1.4.

Table 1.4. Summary of Other Relevant International Conventions

International Conventions	
▪ Stockholm convention on persistent organic pollutants (PAPs, 22nd may 2001 ▪ Convention on Biodiversity (Rio convention) 1997 ▪ Framework Convention of United Nations on Climate Change (1997) ▪ 1995 Convention of Biological Diversity ▪ Convention Concerning the protection of the World Cultural and national Heritage Sites (World Heritage Convention) ▪ United Nations Framework Convention on Climate Change (1992). ▪ 1992 Agenda 21 of the Rio conference for sustainable development ▪ 1992 United Nations Framework on Biological Diversity ▪ 1991 Bamako Convention on the ban of the import into Africa and the Control of Trans-boundary movement and Management of Hazardous wastes within Africa ▪ 1990 Convention on Oil Pollution Preparedness, Response, and Co-operation ▪ Vienna Convention and Ozone Layer Protection (1990)	▪ Montreal Protocol for Substances Depleting the Ozone Layer (1990) ▪ 1989 Basel Convention on the Control of Trans-Boundary Movements of hazardous Wastes and their disposal. ▪ 1987 Montreal Protocol on substances that deplete the Ozone Layer ▪ Convention on the Control of Trans-boundary movement of Hazardous Substance ▪ (1987) ▪ 1985 Vienna Convention for the Protection of Ozone Layer ▪ 1985 Endangered species Contro1 of International Trade and Traffic] Act ▪ 1984 Conservation for cooperation in the protection and development of the marine and coastal environment of the west and central Africa region ▪ 1982 Convention on Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Regions ▪ 1979 Convention on conservation of Migratory Species of Wild Animals ▪ 1968 African Convention on the Conservation of Nature and Natural Resources

International Conventions	
▪ 1973 International Convention on Trade in Endangered Species of Wild Fauna and Flora ▪ Convention to Combat Desertification ▪ 1972 Convention Concerning the Protection of World Cultural and Natural Heritage ▪ 1973 Convention on International Trade in Endangered Species (CITES) ▪ 1969 Convention on Civil Liability for Oil Pollution Damage ▪ 1969 Convention on the Migratory Species of Wild Animals (Bonn Convention)	▪ Convention on Wetlands of International Importance especially as waterfowl habitat (Ramsar) ▪ 1962 Convention on African migratory locust ▪ 1958 Convention on the Continental Shelf ▪ 1958 Convention on the Territorial 'Sea and Contiguous zone ▪ 1954 Convention on Prevention of Pollution of the Sea and land by Oil

1.11.7 International Union for Conservation of Nature and Natural Resources (IUCN) Guideline

The guidelines present practical measures that aimed at the conservation of mangroves and enhancing the protection of marine ecosystem. This section also discusses the major natural processes in the mangrove ecosystems that should be protected by environmental management measures. These processes are linked to a number of important functions, which will be maintained if the processes are protected from adverse disruption. This section also discusses the importance of mangroves to local facilities.

A section on Environmental Management and Planning discusses the policy and principles for environmental management in mangrove areas. It includes discussions on Environmental Profile, Environmental Impact Assessment (ESIA), Environmental Management, Environmental Monitoring, and Environmental Audit. It is recommended that a preliminary ESIA be prepared before the commencement of any activity on the project site and it is to build on the findings of the environmental profile and examine sensitive issues in detail.

The concluding section of the guidelines deals with Environmental Management of field operations in mangrove areas. In this section, practical methods and directions for Environmental Management are given for each field operational activity.

1.12 International Framework

With respect to Applicable International Environmental and Occupational Safety and Health Laws and Regulations, this report has also taken into consideration the IFC "Environmental, Health, and Safety Guidelines, IFC "Environmental, Health, and Safety Guidelines, IFC "Environmental, Health, and Safety Guidelines, General EHS Guidelines (January 1 2012), OPIC-Environmental and Social Policy Statement (ESPS), October 15, 2010; OPIC- Environmental Handbook (February 2004), International Finance

Corporation's Performance Standards on Environmental and Social Sustainability (January 1, 2012); International Finance Corporation, Access to Information Policy, January 1, 2012; IFC Environmental, Health, and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions And Ambient Air Quality (January 1 2012): FD (06. 2012) and European / (EU) Emission Standards, EU Laws and EU Directives (November 16, 2012); International Organization for Standardization (ISO) 14000 Standards; ILO Labour Standards (Core Labour Standards and Basic Terms and Conditions of Employment for all Workers, including subcontractors) and OHSAS 18001 for Occupational Health and Safety and the "Pollution Prevention and Abatement Handbook" by the World Bank Group- effective July 1998.

Within these handbooks, different guidelines are mentioned for assessing industrial facilities with respect to their environmental compliance. In the present case, the guidelines for new rail projects are applicable for the Social and Environmental Impact Assessment.

1.12.1 The Equator Principles

Development financiers play a major role in the development and enforcement of international sustainable development standards through the conditioning of their loans. This is often through the Equator Principles (EP), the first version of which was launched in June 2003. The Equator Principles provide a framework for financial institutions seeking to manage environmental and social risks, and to promote best practice in this context. Major signatories are private banks which provide project financing in developing countries. The signatories require borrowers to demonstrate that they have substantially met these principles or will do so in the development and management process. These undertakings are aligned with the IFC/World Bank policies, safeguards, performance standards and guidelines. The third version, Equator Principles III, was launched and became effective from 4 June 2013.

They apply to all transactions from 1 January 2014, may be applied to transactions signed between 4 June and 31 December 2013, however mandates signed before 4 June 2013 are not required to use EP III.EP III reflects new requirements related to managing impacts on climate, human rights considerations in due diligences and strengthening of reporting and transparency. Integrated reporting is required to strengthen the company's system for mitigating and managing environmental and social impacts arising from mining operations. The EPs have now been adopted by 79 financial institutions (Equator Principles website, 7 June 2013).

The Principles require observance of the International Finance Corporation (IFC) Performance Standards and the World Bank Group Environmental, Health and Safety (EHS) Guidelines when developing projects in non-high-income OECD countries.

1.12.2 Asian Development Bank Environment, Health and Safety Guidelines

The following relevant Asian Development Bank guidelines and policies are relevant to the project:

- Integrated Environmental and Social Impact Assessment Guidelines, October 2003.
- Asian Development Bank Group's Policy on the Environment ('Environmental Safeguards Policy'), February 2013.

- Involuntary Resettlement Policy, November 2003.
- Environmental Review Procedures for Private Sector Operations of the Asian Development Bank May 2000.
- Environmental and Social Assessment Procedures for Asian Development Bank's Public Sector Operations, June 2001.

1.12.3 Other benchmarks, guidelines, and Reference Material EU reference Documents and Directives

Integrated Pollution Prevention and Control (IPPC) Reference Document on the General Principles of Monitoring (July 2003).

The reference document titled "The General Principles of Monitoring" reflects an information exchange carried out under Article 16(2) of Council Directive 96/61/EC. It provides information to guide IPPC permit writers and operators of IPPC installations in meeting their obligations under the Directive about monitoring requirements of industrial emissions at source.

- **Environmental Noise Directive (2002/49/EC)**

The European Parliament and Council adopted Directive 2002/49/EC relating to the assessment and management of environmental noise on 25 June 2002, also called as the "END", following a proposal by the Commission adopted in Year 2000 (1).

The END aims to "define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to the exposure to environmental noise". For that purpose, several actions are to be progressively implemented. It furthermore aims at providing a basis for developing EU measures to reduce noise emitted by major sources, in particular road, rail and infrastructure, aircraft, outdoor and industrial equipment and mobile machinery.

- **Directive 2001/80/EC (Large Combustion Engine Directive)**

The overall aim of the LCP Directive is to reduce emissions of acidifying pollutants, particles, and ozone precursors. Control of emissions from large combustion vehicles plays an important role in the Union's efforts to combat acidification, eutrophication, and ground-level ozone as part of the overall strategy to reduce air pollution.

- **EU – Ambient Air Quality and Cleaner Air Directive (2008/50/EC)**

The ambient air quality directive revises European legislation relating to ambient air quality with the aim of reducing pollution to levels which minimize the harmful effects on human health and on the environment.

1.13 Environmental Policy Handbook (2005)

This Handbook explains a brief outline of EU environmental policy history, analysis and presents some 60 EU environmental laws and nature protection legislation, most of which have been adopted in the last 11 years, establishing links between the different pieces of legislation. Against the current decline in environmental policy and the trend towards its subordination to jobs and economic growth, the handbook encourages an informed and intelligent use of existing legislative networks and calls for resistance to attempts to water it down.

Handbook for Implementation of EU Environmental Legislation

The sole objective of the Handbook for Implementation of EU Environmental Legislation (December 2008) among other issues, is to provide a planning framework and systematic guidance on the approaches and specific activities required to ensure the effective and legally compliant implementation of EC environmental legislation. It targets candidate countries, potential candidate countries, as well as existing Member States. The Handbook outline:

- ❖ Separate fiches containing information and guidance about each legal act presented in the EC's guidance document;
- ❖ Ample examples of implementation efforts in existing Member States, highlighting institutional, policy and legislative framework;
- ❖ An introduction to each environmental sector setting out a framework for planning the implementation of the legislation contained within that environmental sector.

1.14 ILO Guidelines on Occupational Safety and Health Management Systems

The International Labour Organization (ILO) published ILO-OSH 2001, also referred to as "Guidelines on Occupational Safety and Health Management Systems" In 2001, to assist organizations with introducing OSH management systems. In other to achieve via a constant process of policy, organization, planning and implementation, evaluation, and action for improvement, supported by constant auditing to determine the success of OSH actions, these guidelines encourage continual improvement in employee health and safety.

The ILO recognizes that national legislation is essential, but sometimes insufficient on its own to address the challenges faced by industry, and therefore elected to ensure free and open distribution of administrative tools in the form of occupational health and safety management system guidance for everyone. The ILO management system was created to assist employers to keep pace with rapidly shifting and competitive industrial environments. This open access forum is intended to provide the tools for industry to create safe and healthy working environments and foster positive safety cultures within the organizations.

1.14.1 OHSAS 1800

As an international occupational health and safety management system specification, OHSAS 18000 comprises two parts, OHSAS 18001 and 18002 and embraces several other publications. In the global world, OHSAS 18000 is the recognized assessment specification for occupational health and safety management systems. This recognized specification for occupational health and safety management system (OHSAS 18000) operates based on policy, planning, implementation and operation, management review, checking and corrective action and continual improvement.

1.14.2 ISO 14001

ISO 14001 mandate is to outline criteria for an environmental management system. Rather than stating requirements for environmental performance, it maps out a framework that an organization or company follow in order to successfully set up an effective environmental management system to be used by any organization that wants to improve resource efficiency, reduce waste and drive down costs. ISO 14001 gives company management and employees as well as external stakeholders' assurance that environmental impact is being measured and improved. ISO 14001 can also be integrated with other management functions and assists companies in meeting their environmental and economic goals.

As with other ISO 14000 standards, ISO 14001 is voluntary, with its main aim to assist companies in continually improving their environmental performance, whilst complying with any applicable legislation. Organizations are responsible for setting their own targets and performance measures, with the standard serving to assist them in meeting objectives and goals and the subsequent monitoring and measurement of these.

ISO 9001 Quality Management Systems and ISO 14001 Environmental Management System can work in tandem with OHSAS 18001/18002 to complement each other and form a better overall system. Each component of the system is specific, auditable, and accredit able by a third party after review.

1.14.3 ISO 26000

ISO launched the development of an International Standard in 2005, providing guidelines for Social Responsibility. It was adopted in November 2010. ISO 26000 in contrast with most ISO standards does not aim at certification. ISO 26000 objective is to "provide harmonized, globally relevant guidance based on international consensus among expert representatives of the main stakeholder groups and so encourage the implementation of social responsibility worldwide.

The guidance in ISO 26000 draws on best practice developed by existing public and private sector initiatives and is intended to be useful to organizations large and small in both these sectors". ISO 26000 defines social responsibility as the "responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behaviour that contributes to sustainable development, including health and the welfare of society; takes into account the expectations of stakeholders, is in compliance with applicable law and consistent with international norms of behaviour and is integrated throughout the organization and practiced in its relationships"

ISO 26000 deals with a wide range of issues and has identified seven "core subjects": organizational governance; human rights; labour practices; the environment; fair operating practices; consumer issues; and community involvement and development.

Although it is not meant to be neither a standard-setting document nor a certification standard. However, nothing in this literature prevents countries from adopting national standards based on ISO 26000 that could become certifiable.

1.15 IFC Good Practice Note Addressing Grievances from Project-Affected Communities

Understanding community concerns and complaints and addressing them will benefit Companies across sectors and through all stages of project development. This Good Practice Note gives guidance on basic principles and steps-by-step processes that organizations should consider when creating and implementing grievance mechanisms. Together, these principles and steps constitute a baseline set of considerations and good strategies for designing and implementing procedures appropriate to the project scale and impact.

1.16 Objectives of the ESIA

The objectives of the ESIA are as follows:

- Establish the existing biological, physical, social and economic conditions of the project area.
- Characterize the environment thereby identifying the resultant hazards (including social) associated with the railway line and infrastructures.
- Make recommendations to eliminate / mitigate / control the magnitude and significance of identified potential and associated adverse impacts of the project.
- Develop a cost effective ESMP that recommends plans and procedures to manage the consequences and recover from exceptional events throughout the lifecycles of the project.
- Ensure proper consultations with the communities bordering the railway line and infrastructures in the line with the Federal Ministry of Environment guidelines and other international standards.
- Obtain project ESIA certification and other associated environmental approvals and permits.

1.17 Organization of the Study

Reconnaissance survey was conducted and sampling locations were identified on the basis of the following:

- Existing topography;
- Location of villages/towns/sensitive areas;
- Location of water bodies
- Accessibility, power availability and security of monitoring equipment;
- Pockets of domestic pollution within the study area; and
- Areas which represent baseline conditions.

1.18 Study Limitations

This ESIA is based on data and information obtained from project impacted communities at the time of the study. Any future changes to the project description, as presented in chapter 3, upon which this report is based or additional relevant information revealed as project design, equipment and service procurement proceed may affect the analysis, assessment and conclusions contained in this report. Should such changes occur, they shall be the subject of further study to verify that the conclusions of this ESIA do not change and to determine whether any additional mitigation, management or monitoring measures are warranted.

1.19 Report Structure

The ESIA Report is presented in eight chapters.

- Chapter one is an introduction containing relevant background information and the legal and administrative framework for ESIA in Nigeria among other information;
- The second chapter presents the project justification, the need/value and its envisaged sustainability as well as the project development and site/route options considered;
- Chapter three contains detailed description of the proposed project including its location, overall layout, basis for design, type and specifications of equipment/facilities to be installed and operation/maintenance of the proposed project;
- The fourth chapter describes the baseline biophysical and socio-economic status of the study area respectively.
- Chapter five discusses the Information on consultation with stakeholders;
- Chapter six presents the identified potential and associated environmental impacts of the proposed project and the various mitigation measures proffered against the identified significant impacts;
- Chapter seven provides a cost-effective environmental management plan that would be adopted throughout the project's lifecycle. It also enumerates the environmental monitoring programme, the waste management programme and the project's decommissioning/abandonment plan.
- Chapter eight concludes the report and requests approval for project implementation.

Other sections of the report include (not in any chronological order) the table of content, the list of references, list of ESIA preparers, list of abbreviations and acronyms, acknowledgement page, the executive summary and various appendices.

CHAPTER 2

PROJECT JUSTIFICATION

2.1 Need for the Project

The Proposed Rehabilitation and construction of the Port Harcourt – Maiduguri Narrow Gauge Railway Project is in line with the overall aim of the FGN to revitalize and reinvigorate the rail sector so as it can contribute more to the national economy.

Moreover, currently over 95 percent of the traffic leaving the area is transported by road to the detriment of the road network. It is thus expected that the resuscitating the rail sector, will increase freight and passenger capacity as well as release pressure on the dilapidated road network. The railway is also expected to reduce the travel times for both goods and passengers.

The broad aim of the rehabilitation and construction of the Port Harcourt – Maiduguri Narrow Gauge Railway Project is to enhance mobility, accessibility and transport along the South Eastern, linking the northcentral and north east regions.

The project is also aimed at providing and improving access to the existing Railway Station and providing intermodal transport system which will lead to decongestion of Port Harcourt -Enugu highway, Enugu – Makurdi highway and Makurdi – Jos Highway, ultimately.

2.2 Need for the Project

The benefits of this project for the people of the project catchment area are numerous. These include:

- Improved and more reliable transport system.
- Enhances productivity and efficiency in both public and private organizations
- It helps to develop and promote small, medium, and large-scale enterprises thereby creating direct and indirect employment opportunities.
- It helps to improve the security of lives and properties.
- General contribution to climate change through overall reduction of the use of trucks, cars and buses on the highways.
- General improvement of the standard of living for the populace.

2.3 Overview of Existing facilities

- Insufficient width of subgrade shoulder caused by subgrade surface scouring or subsidence.

Plate 2.1: insufficient of shoulder width

- Slope foot of riverside subgrade and subgrade located in bridge and culvert both side is scoured by flood

Plate 2.2: Subgrade destroyed and collapsed by flood

- No drainage system, the foot of the cutting slope slides due to scouring, and part of the subgrade is water-logged for a long time.

Plate 2.3: Collapsed at cutting

- The shallow layer slides and collapses in high fill embankment section.

Plate 2.4: Slides and collapses in transition section between bridge and embankment

- The bridge has been completely damagedPartially scoured at pier and abutment foundation

Plate 2.5: Serious damages on bridge and culvert structures

- Stations

All sleepers are steel. Most of the platform is damaged, and there are debris and weeds, Encroachment, ballast is partially missing, the station tracks are seriously rusted and corroded, part of the tracks are missing.

Plate 2.6: Port Harcourt station

Plate 2.7: Aba station

Plate 2.8: Enugu station

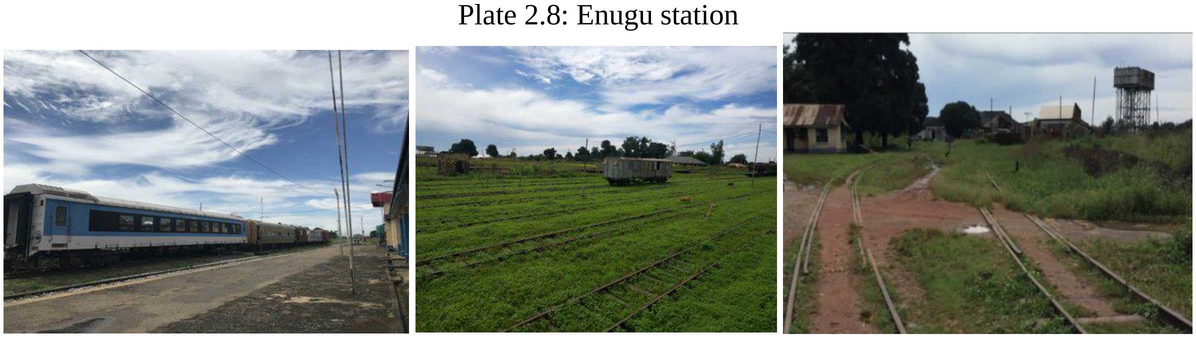


Plate 2.9: Kafanchan station

Plate 2.10: Kuru station

Plate 2.11: Bauchi station

Plate 2.12: Gombe station

Plate 2.13: Makurdi station

2.3 Value of the Project

This will beneficial to indigenous Nigerian engineers and contractors during this infrastructure development project. FMoT employees will also have the opportunity to increase and update their knowledge with best available technologies in railway and system operations.

The Engineering, Procurement, and Construction (EPC) portion of the total project costs for successive unit is expected to achieve cost reduction from savings to be derived from design, purchase of equipment, mobilization, constructions, sequencing and starting. We assume a saving of about 10% from the phasing of the project components.

- ***Operating and Maintenance Cost Estimates***

The basis for the operating and maintenance cost estimate is based on a 3-shift crew, with each shift working average of 8 hours. The technical disciplines of personnel per shift was also considered. The material maintenance cost relates to maintenance of the stations and railway lines and all ancillary facilities including periodic and statutory inspection and maintenance of the railway.

Total Pre-Estimated Amount and Index, See in the table 2.1.

Table 2.1 Total pre-estimated amount and index table

Description	Mainline length (km)	Total pre-estimated amount (USD $ million)	Comprehensive technical and economic index (USD $ million/km)
Port Harcourt-Aba	63	94.85	1.51
Aba-Kafanchan	674	937.24	1.39
Kafanchan-Kuru	66	83.3	1.26
Kuru-Maiduguri	640	651.41	1.02
Kafanchan-Rigachikun	200	92.31	0.46
Kuru-Jos	35	13.17	0.38
Goniri-Gashua	216	416.74	1.93
Rigachikun transshipment station		24.24	
Asa transshipment station		16.83	
Total	18941894	2330.09	1.14

Source: CCECC, 2020

In addition to the above investment, in order to ensure the operation and maintenance after the completion of this railway line, it is suggested to increase the following investment in the table 2.2 in the future:

Table 2.2 Extra-contract investments for operation and maintenance
Unit: USD $ million.

Item Description	Locomotive equipment	Rolling stock equipment	Station machinery and equipment	Track maintenance equipment	Procurement cost of locomotive and rolling stock	Large track maintenance machinery	Total estimated amount
Port Harcourt-Aba	9.59	3.27	0.3	0.24	457.04	25.16	495.61
Aba-Kafanchan	37.37		2.6	23.43			63.4
Kafanchan-Kuru			0.13	2.44			2.56
Kuru-Maiduguri	2.67	1.04	1.48	15.33			20.53
Kafanchan-Rigachikun			0.43	4.95			5.38
Kuru-Jos		0.25	0.24	0.16			0.65
Goniri-Gashua	2.67	0.25	0.36	4.88			8.17
Rigachikun transshipment station	2.67	0.31	3.26	0.08			6.33
Asa transshipment station	1.26		1.59	0.08	59.48		62.41
Total estimated amount	56.23	5.12	10.39	51.59	516.52	25.16	665.04

Source: CCECC, 2020

At the same time, additional investment USD$62.04 million in construction the new standard gauge connecting line about a length of 8km from Rigachikun to Rinji section will be required for transshipment between standard and narrow-gauge tracks.

2.4 Envisaged sustainability

Some factors are important to consider, in reaching project sustainability. They are related to practical aspects related to economic profitability, technical resources, and all, with an efficient management. With the growth in intermodal transportation demand that has occurred over the last decades, adequate and reliable railway system important to economic development.

2.4.1 Technical Sustainability

The project is fairly technically viable because it is maintaining the old railway technology both for the construction and operations phases. Also, it shall depend on available construction materials.

2.4.2 Economic Sustainability

The railway project has the potential to be economically sustainable because the proponent has obtained the necessary financial strength to execute the project. Also, there is high demand of the railway and the Return on Investment (ROI) is long term but surely steady, to ensure effective pay back of the loan in line with loan agreement.

2.4.3 Environmental Sustainability

This has been ensured, ab initio, by carefully selecting the railway alignment to avoid sensitive ecosystems along the railway alignment and to avoid built-up areas. In addition, practical mitigation measures have been proffered for the identified environmental impacts of the railway project and FMoT is fully committed to complying with the relevant applicable national environmental laws, applicable international conventions and world bank environmental safeguard policies.

Furthermore, FMoT is also committed to implementing the ESMP developed to further guarantee the environmental sustainability. FMoT has full department that handles environmental matters. The HSE department is headed by a General Manager who reports directly to the CEO of NRC. Significant number of ESIAs have been conducted in the past by FMoT/NRC. Hence, they have the technical skills needed to manage the mitigations that are determined for the identified impacts of this project.

2.4.4 Social Sustainability

The project has secured its first social license – the host communities' acceptance of the proposed project their eagerness to see it succeed, although with demands for the standard gauge technology. The railway project shall create job opportunities for unemployed indigenes and Nigerians.

The implementation also of the FMoT CSR to the host communities as contained in the MoU shall further heighten social sustainability.

FMoT is committed to comply with applicable national social laws, relevant international conventions and world bank social safeguard policies. Furthermore, FMoT has a Social Specialist, but will require training on World Bank involuntary resettlement policy as well as the new environmental and social management framework.

2.5 Consideration of Project Alternatives

Consideration of Project alternatives is crucial in ensuring that the developer and decision-makers have a wider base from which they can choose the most appropriate option. However, the railway which was built in 1955, thus it was not possible to asses all alternatives in detail.

Due to the above reasons, the alternatives discussed below are general ones and it is not possible to conduct initial (preliminary) environmental and social assessments due to a lack of an alternatives option.

2.5.1 No Project Option

The No-Project Option entails retaining the current status quo. Adopting this option would mean avoiding most of the negative effects associated with the railway rehabilitation and missing all the positive benefits that would accrue such as increased capacity of the railway by ferrying more freight and passengers, improved operation and financial returns, ease access to markets, employment opportunities, improved agriculture through accessing farm inputs etc. This was therefore dismissed.

2.5.2 Use of Air Transport

Another alternative to the project for consideration was the use of air transportation. This type of transport is more expensive and is out of reach of many Nigerians. It is also not practicable to transport most industrial goods through this means of transport. It would also be more hazardous to transport dangerous chemicals by air and transport of goods using this option would result in higher transport costs. This option is therefore rejected.

2.5.3 Upgrading the Existing Narrow Gauge Railway to Standard Gauge

As much as this option is more desirable, the cost of its execution would necessitate the delay of the proposed project, given the lean government earnings.

Therefore, this option is reserved for the future, in favour of the rehabilitation of the railway line.

2.5.4 Rehabilitation and Construction of the Port Harcourt-Maiduguri Narrow Gauge Railway and its accessories

Rehabilitation and Construction of the Port Harcourt-Maiduguri Narrow Gauge Railway and its accessories has the potential to reduce congestion of the dilapidated highway and reduce accidents.

CHAPTER 3

PROJECT DESCRIPTION

3.1 Introduction

This chapter describes the Port Harcourt-Maiduguri Railway Project, related project activities and ancillary facilities. The FMoT provided the information presented here, in response to information requests.

3.2 Project Phases

The proposed project has Four phases of development:

- Design and Permitting;
- Pre-construction;
- Construction; and
- Operational Phases

The fifth phase is the decommissioning, at the end of the project's lifespan, partly or wholly.

These five phases are within the scope of this ESIA and are interdependent as the commencement of the second and third phases wholly depends on the successful completion of the preceding one.

3.3 Design Parameters

The existing Port Harcourt-Maiduguri railway has been worn down by the years without repair, and most sections are not in operation. Sections that are in operation also have potential hazards. There are many small radius curves that limit the speed of the train.

The total length of the Port Harcourt-Maiduguri Railway is 1,443km.

The length of the curves is 299.7 km, accounting for 20.8% of the total length of line. The length of curves with radius less than 600m is 233.5km, accounting for 16.2% of the total length of the line and 77.9% of the total length of the curves. The length of curves with radius less than 400m is 157.34km, accounting for 10.9% of the total length of line and 52.5% of the total length of the curves.

Table 3.1 Route Technical Features of main line

Items			Unit	Quantity	Percentage of the whole line (%)
Line length			Km	1443.8	100
Straight line length			Km	1144.1	79.2
Curve	Curve length		Km	299.7	20.8
	in which	R≥600m	Km	66.2	4.6

Items			Unit	Quantity	Percentage of the whole line (%)
		400m≤R＜600m	Km	76.16	5.3
		＜400m	Km	157.34	10.9

Source: CCECC, 2020

3.3.1 Design Principle for Track

3.3.1.1 Principle of Existing Railway Rehabilitation

265km long track of existing eastern narrow-gauge railway mainlines and all track of existing Jos branch line has been rehabilitated with good condition. Therefore, for track of these sections, the rehabilitation work was not adopted.

For other sections:

- **Rail:** The UIC 50 rail will be used on the main line, with jointed track.
- **Sleeper and fastening:** For subgrade section, the concrete sleeper and clip fastening will be used. For bridges, wood sleepers and complete fastenings will be used. The sleeper is laid 1560 as per pieces per kilometer.

Kaduna connecting line will use 30% rail and steel sleepers removed from the main line, with new complete fastenings.

- **Ballast bed:** The whole line ballast bed will be regulated. 50% of ballast of the existing operation section will be considered to be reused. 30% of ballast of the existing out-of-service section will be considered to be reused.

3.3.1.2 Design Principle of Narrow Gauge Railway

- **Rail:**

The BS60R rail removed from the main line will be used on Gashua new line,: new UIC50 rail is adopted with jointed track.

- **Sleeper and fastening:**

Gashua new line: for subgrade section, use steel sleepers removed from the main line, with new complete fastenings. For bridges, use wood sleepers removed from the main line. And complete fastenings will be used. The sleeper is laid 1560 as per pieces per kilometer.

- **Ballast bed**

The thickness of the new ballast bed is 30cm; the top width of the ballast bed is 2.56m, and the gradient of side slope is 1:1.5.

3.3.2 Design Principle for Route

The main line from Port Harcourt to Maiduguri adopts the following principles:

- **Minimum curve radius:** 400m for main line, the existing radius is maintained in urban area and special difficult area.
- **Transition curve length:** to match the radius of the curve.
- **Ruling gradient**:18‰.
- **The length of grade section:** The length of grade section should be designed as long as possible, and the minimum single grade section should not be less than 200m.
- **Vertical curve:** When the algebraic difference between adjacent gradients is greater than 4‰, vertical curves should be setup. Circular curves will be adopted as vertical curves with radius of 5000m.
- **Algebraic difference between adjacent gradient:** The connection between adjacent grade section should be designed as a small algebraic gradient difference, and not more than 20‰ under difficult conditions.
- **Setting of station site:** Station should be placed on straight line, and can be located on the curves with radius not less than 600m under difficult condition.
- **Setting principle of level crossing and grade separation:** There are few highways along this railway, and the traffic flow of the highways is small. After the railway is reconstructed, the level crossing with existing road will be maintained.

The main technical standards of the existing railway is shown in Table 3.2

Table 3.2: Main technical standards of existing railway

Line type	**Eastern Railway Line**			**Connecting Line**	**Jos branch line**
	Port Harcourt～Kafanchan	**Kafanchan～Kuru**	**Kuru～Maiduguri**	**Kafanchan～Kaduna**	**Kuru～Jos**
Year	Existing	Existing	Existing	Existing	Existing
Maximum design speed(km/h)	60	60	60	60	60
Track gauge(mm)	1067	1067	1067	1067	1067
Number of main tracks	Single-line	Single-line	Single-line	Single-line, with double-line in some areas	Single-line
Ruling Gradient (‰)	18	26.5	15	12.5	23
Minimum curve radius(m)	171	29(Special 218)	290 (Special 218)	175	290
Traction Type	Diesel	Diesel	Diesel	Diesel	Diesel
Locomotive type	17(MX615 type) and 18 series	17(MX615 type) and 18 series	17(MX615 type) and 18 series	17(MX615 type) and 18 series	17(MX615 type) and 18 series
Tonnage rating (t)	500(800)	500(800)	500(800)	500(800)	300(500)
Effective length of arrival-departure track:(m)	400	375	450	400	350
Blocking type	Electric train staff				

Source: CCECC, 2020

3.3.3 Design Principle for Subgrade

The Eastern Railway in Nigeria was built in the early time, and most subgrade is low filling and shallow excavation with few bridges and culverts.

Owing to the large annual rainfall and lack of normal maintenance in the survey area, the subgrade settlement, slope scouring and side ditch siltation are serious. The main subgrade defects at the site are as follows:

- insufficient width of shoulder caused by subgrade settlement or shallow slope slide,
- serious toe erosion caused by little subgrade slope protection near bridge and culvert,
- collapse of cutting slope and local water ponding caused by failure of drainage system,
- shallow slide of slope due to few slope surface protections for high embankment subgrade, etc.

The principles of defects treatment are as follows:

(1) **In the section with insufficient shoulder width:** adopt dry-laid stone masonry stack (dry-laid stone masonry shoulder protection + M10 cement mortar plastering, ensuring the width no less than 40cm) to widen the shoulder or adopt ballast retaining wall for protection.

(2) **Subgrade with poor drainage conditions**: drainage ditches shall be added in some embankment areas according to local condition; rectangular side ditch (or slab ditch) shall be setup in the cutting section or the existing side ditch shall be desilted, and overhead ditch shall be setup according to the terrain condition (in section with particularly serious slope scouring).

(3) **Subgrade closed to the river:** according to the river flow speed, the scouring prevention and reinforcement measures shall be adopted, such as mortar rubble masonry slope protection, gabion, dumping fill of large stones, concrete or reinforced concrete retaining wall.

(4) **Slope collapse section**: the full width filling in the ruined sections or section with larger collapse shall be reconstructed. Meanwhile the slope protection shall be reinforced. The grass planting or arch framework slope protection shall be mainly used for protection. The mortar rubble masonry protection on the whole slope shall be used in water immersible area, and the slope supporting seepage ditch shall be added if necessary.

3.3.4 Design Principle of New Branch Line and Reconstruction of Small Radius

3.3.4.1 Width and Shape of Subgrade Surface

The subgrade surface width of embankment and cutting at straight line of reconstruction section and new branch line is 4.3m. The shape of the subgrade surface of the new railway branch line is designed as a triangular crown, and 4% herringbone drainage slope is setup from the center to both sides. When the curve is widened, the subgrade surface shall remain triangular. Typical cross section of subgrade is shown in Fig. 3.1 and Fig. 3.2.

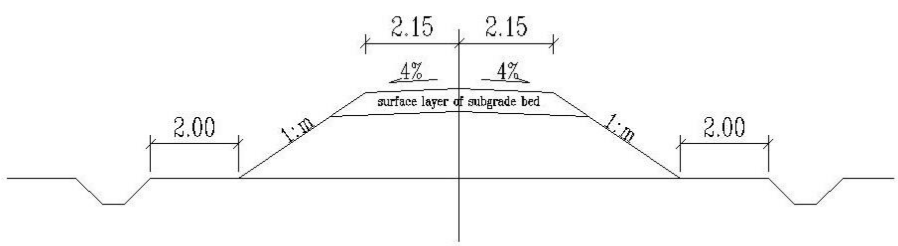


Figure 3.1: Typical cross section of general embankment

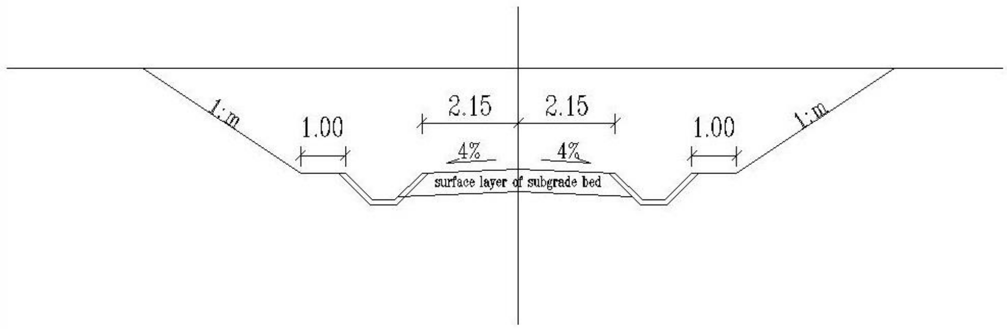


Figure 3.2: Typical cross section of general cutting

3.3.4.2 Subgrade Bed Structure and Fill Materials

Subgrade bed is mainly composed of surface layer of 50cm thick. The Group A and B fillers are adopted for surface layer, the particle size of which is not greater than 100mm. The filler below subgrade bed shall adopt qualified material (Group C or above) according to GTR requirement, which is generally A, B and C fillers.

3.3.4.3 Subgrade Slope Form and Protection

- Embankment slope protection works

The protection design shall be done for all embankment slope, and the protection measures shall be determined by the embankment height.

① When the slope height H < 8m, the slope is protected by grass seeding between drainage chutes.

② When the slope height H ≥ 8m, 2m wide bench shall be set at 8m below the subgrade formation, and the upper and lower slopes of the bench shall be protected by herringbone framework with water intercepting edge.

- Cutting slope protection works

Different protection measures should be used for cutting slope according to slope height and stratum conditions.

Soil and completely weathered slope and strongly weathered soft rock slope:

① When the slope height 0＜H＜4m, the slope is protected by grass seeding.

② When the slope height 4≤H＜8m, and the stratum is completely and strongly weathered soft rock, the slope shall be protected by the “irregular style” revetment or grass seeding protection. Other slopes shall be protected by grass seeding protection.

③ When the slope height H≥8m, the slope shall be protected by herringbone framework with water intercepting edge.

3.3.4.4 Deep Cutting

For deep cutting, the slope is generally protected by retaining wall, and the slope above retaining structure could be protected by water interception framework or others according to slope rate.

3.3.4.5 Soft Soil Subgrade

For soft soil subgrade, the stability and settlement check and calculation shall be done. When the safety factor of stability or settlement after construction couldn't meet the requirements of the codes, design measures, like excavation and replacement, reinforced cushion or composite foundation or others, shall be adopted. When the soft soil thickness is smaller than 3m, excavation and replacement shall be done and hard block stone shall be adopted below groundwater level.

3.4 Project Infrastructure

After rehabilitation and construction of Port Harcourt - Maiduguri Railway Project, the main technical standards as outlined in table 3.3 involve:

v **Nigerian Existing Eastern Railway**: Port Harcourt - Maiduguri narrow-gauge main railway, with a total length of about 1443 km.

- Maximum design speed: 80km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 15‰～26.5‰ (retention of original value)
- Minimum curve radius: 400m, the existing radius is maintained in urban area and special difficult area.
- Traction type: Diesel
- Locomotive type: DF4D
- Tonnage rating: 800t
- Effective length of arrival-departure track: 375m～450m (retention of original value)
- Blocking type: Electric train staff

vi **Kaduna Existing Connecting Line:** Kafanchan - Rigachikun narrow-gauge railway with a total length of about 200 km.

- Maximum design speed: 60km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 12.5‰
- Minimum curve radius: 400m, the existing radius is maintained in urban area and special difficult area.
- Traction type: Diesel

- Locomotive type: DF4D
- Tonnage rating: 800t
- Effective length of arrival-departure track: 400m
- Blocking type: Electric train staff

vii **Jos Existing Branch Line Railway**: Kuru **-** Jos narrow-gauge railway with a total length of about 35 km.

- Maximum design speed: 60km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 23‰
- Minimum curve radius: 400m, the existing radius is maintained in urban area and special difficult area.
- Traction type: Diesel
- Locomotive type: DF4D
- Tonnage rating: 800t
- Effective length of arrival-departure track: 350m
- Blocking type: Electric train staff

viii **Gashua New Branch Line Railway**: Goniri **-** Gashua narrow-gauge railway with a total length of about 216 km

- Maximum design speed: 60km/h
- Track gauge: 1067mm
- Number of main tracks: Single-line
- Maximum Gradient: 12‰
- Minimum curve radius: 300m
- Traction type: Diesel
- Locomotive type: DF4D
- Tonnage rating: 800t
- Effective length of arrival-departure track: 450m
- Blocking type: Electric train staff

Table 3.3: Main technical standards of existing east railway main lines and branch line (after rehabilitation and reconstruction)

Line type	Main Line			Kaduna link line	Jos branch line	Gashua(new)
	Port Harcourt～Kafanchan	Kafanchan～Kuru	Kuru～Maiduguri	Kafanchan～Kaduna	Kuru～Jos	Goniri～Gashua
Year	Existing	Existing	Existing	Existing	Existing	New

<table>
<tr><th rowspan="2">Line type</th><th colspan="3">Main Line</th><th>Kaduna link line</th><th>Jos branch line</th><th>Gashua(new)</th></tr>
<tr><th>Port Harcourt ～Kafanchan</th><th>Kafanchan～ Kuru</th><th>Kuru～ Maiduguri</th><th>Kafanchan～ Kaduna</th><th>Kuru～Jos</th><th>Goniri～ Gashua</th></tr>
<tr><td>Maximum design speed(km/h)</td><td>80</td><td>80</td><td>80</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td>Track gauge(mm)</td><td>1067</td><td>1067</td><td>1067</td><td>1067</td><td>1067</td><td>1067</td></tr>
<tr><td>Number of main tracks</td><td>Single-line</td><td>Single-line</td><td>Single-line</td><td>Single-line</td><td>Single-line</td><td>Single-line</td></tr>
<tr><td>Ruling Gradient (‰)</td><td>18</td><td>26.5</td><td>15</td><td>12.5</td><td>23</td><td>12</td></tr>
<tr><td rowspan="2">Minimum curve radius(m)</td><td>400</td><td>400</td><td>400</td><td>400</td><td>400</td><td rowspan="2">300</td></tr>
<tr><td colspan="5">The existing radius is maintained in urban area and special difficult area</td></tr>
<tr><td>Traction type</td><td>Diesel</td><td>Diesel</td><td>Diesel</td><td>Diesel</td><td>Diesel</td><td>Diesel</td></tr>
<tr><td>Locomotive type</td><td>DF4D</td><td>DF4D</td><td>DF4D</td><td>DF4D</td><td>DF4D</td><td>DF4D</td></tr>
<tr><td>Tonnage rating (t)</td><td>800</td><td>800</td><td>800</td><td>800</td><td>800</td><td>800</td></tr>
<tr><td>Effective length of arrival-departure track:(m)</td><td>400</td><td>375</td><td>450</td><td>400</td><td>350</td><td>450</td></tr>
</table>

Source: CCECC, 2020

3.5 Project Support Facilities

The main line Elelenwo-Maiduguri section of Nigeria Eastern Railway has an operation length of around 1,427 km. According to the demand of traffic volume and carrying capacity in block section, the port Harcourt-Maiduguri section has 60 stations in short term, including 2 district stations, 20 intermediate stations and 38 Passing loops; 13 Passing loops will be added in the middle and long term.

The maximum distance between stations is 42 km (Gabai-Buni), the minimum 10 km (Umugo-Aba), and the average 24.19 km. In the middle and long term, the maximum distance between stations is 40 km (Buni-Goniri and Borgozo-Duwari), the minimum 5 km (Uzuakoli-Nkpa), and the average 19.82 km. See in the table 3.4.

Table 3.4: List of Stations Provided for Elelenwo-Maiduguri Section of Main Line

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
1	Elelenwo	AK16+000	11	In operation	In operation	District station/Junction station	Passenger and freight trains
2	River	AK27+000	8	Out of operation	In operation	Passing loop	
3	Ubuzor	AK35+000	10	In operation	In operation	Passing loop	
4	Ogwe	AK45+000	8	Out of operation	In operation	Passing loop	(Junction station will be reserved)
5	Umugo	AK53+000	7	In operation	In operation	Passing loop	
6	Aba Town Halt	AK60+000	3	Out of operation	Out of operation	Passing loop	
7	Aba	AK63+000	8	In operation	In operation	Intermediate station	Passenger and freight trains
8	M'Boko Halt	AK71+000	8	Out of operation	In operation	Passing loop	
9	Omoba	AK79+000	6	Out of operation	Out of operation	Passing loop	
10	Umueze	AK85+000	8	In operation	In operation	Passing loop	
11	N'Bawsi	AK93+000	15	Out of operation	In operation	Passing loop	
12	Old Umuahia	AK108+000	5	Out of operation	Out of operation	Passing loop	

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
13	Umuahia-Ibeku	AK113+000	8	In operation	In operation	Intermediate station	Passenger and freight trains
14	Ameke-Ibeku	AK121+000	11	Out of operation	Out of operation	Passing loop	
15	Uzuakoli	AK132+000	5	Out of operation	In operation	Passing loop	
16	Nkpa	AK137+000	9	In operation	In operation	Intermediate station	Passenger trains
17	Ovim-Amaba	AK146+000	7	Out of operation	In operation	Passing loop	
18	Otampa	AK153+000	10	Out of operation	Out of operation	Passing loop	
19	Ozara	AK163+000	8	In operation	In operation	Passing loop	
20	Afikpo Road	AK171+000	4	Out of operation	Out of operation	Passing loop	
21	Ishiago	AK175+000	10	Out of operation	In operation	Passing loop	
22	N'Deaboh	AK185+000	5	Out of operation	Out of operation	Passing loop	
23	Eziator Quarry	AK190+000	6	In operation	In operation	Passing loop	
24	Uduma Achara	AK196+000		Out of	Out of	Passing loop	

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
			8	operation	operation		
25	Nomeh	AK204+000	8	In operation	In operation	Passing loop	
26	Ugbawka	AK212+000	10	Out of operation	Out of operation	Passing loop	
27	Agbani	AK222+000	13	In operation	In operation	Intermediate station	Passenger trains
28	Ayo	AK235+000	8	Out of operation	Out of operation	Passing loop	
29	Enugu	AK243+000	3	In operation	In operation	Intermediate station	Passenger and freight trains
30	Obwetti	AK246+000	4	Out of operation	Out of operation	Passing loop	
31	Iva Valley	AK250+000	20	Out of operation	In operation	Passing loop	
32	Ogbaho	AK270+000	15	In operation	In operation	Passing loop	
33	Nkalagu	AK285+000	5	Out of operation	Out of operation	Passing loop	
34	Eha Amufu	AK290+000	14	In operation	In operation	Intermediate station	Passenger trains
35	Igbede	AK304+000	16	In operation	In operation	Passing loop	

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
36	Igunmale	AK320+000	18	In operation	In operation	Passing loop	
37	Utonkon	AK338+000	21	In operation	In operation	Passing loop	
38	Otobi	AK359+000	16	In operation	In operation	Passing loop	
39	Oturkpo	AK375+000	16	In operation	In operation	Intermediate station	Passenger trains
40	Taraku	AK391+000	18	In operation	In operation	Passing loop	
41	Kinga	AK409+000	17	In operation	In operation	Passing loop	
42	Moi-Igbo	AK426+000	18	In operation	In operation	Passing loop	
43	Agana	AK444+000	13	In operation	In operation	Passing loop	
44	Adeke	AK457+000	6	In operation	In operation	Passing loop	
45	Makurdi	AK463+000	7	In operation	In operation	Intermediate station	Passenger and freight trains
46	Dawudu	AK470+000	16	Out of operation	In operation	Passing loop	
47	Achakpa	AK486+000		In	In	Passing loop	

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
			14	operation	operation		
48	Madaiki	AK500+000	15	Out of operation	In operation	Passing loop	
49	Udei	AK515+000	13	In operation	In operation	Passing loop	
50	Kaderko	AK528+000	22	In operation	In operation	Passing loop	
51	Agyaragu	AK550+000	15	In operation	In operation	Passing loop	
52	Lafia	AK565+000	9	In operation	In operation	Intermediate station	Passenger and freight trains
53	Awuma	AK574+000	12	Out of operation	Out of operation	Passing loop	
54	Barakin Abdullahi	AK586+000	19	In operation	In operation	Passing loop	
55	Mada	AK605+000	8	Out of operation	In operation	Passing loop	
56	Langa Langa	AK613+000	19	In operation	In operation	Passing loop	
57	Gudi	AK632+000	21	In operation	In operation	Intermediate station	Passenger trains
58	Moroa River	AK653+000	21	In operation	In operation	Passing loop	

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
59	Wasa	AK674+000		In operation	In operation	Passing loop	
60	Kogum River	AK685+000	11	Out of operation	Out of operation	Passing loop	
61	Jagindi	AK697+000	12	In operation	In operation	Intermediate station	Passenger trains
62	Gerti	AK714+000	17	In operation	In operation	Passing loop	
63	Kaningkon	AK730+000	16	Out of operation	Out of operation	Passing loop	
64	Kafanchan	AK737+000	7	In operation	In operation	Intermediate station/Junction station	Passenger trains
65	Kagoro	AK748+000	11	Out of operation	Out of operation	Passing loop	
66	Manchok	AK764+000	16	In operation	In operation	Intermediate station	Passenger trains
67	Kwakwi	AK784+000	20	Out of operation	Out of operation	Passing loop	
68	Hoss	AK793+000	9	Out of operation	Out of operation	Passing loop	
69	Kuru	AK803+000	10	In operation	In operation	Intermediate station/Junction station	Passenger trains
70	Heipang	AK813+000	10	Out of	Out of	Passing loop	

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
				operation	operation		
			8				
71	Forom	AK821+000		Out of operation	Out of operation	Passing loop	
			17				
72	Bakin Kogi	AK838+000		In operation	In operation	Passing loop	
			15				
73	Maijuju	AK853+000		Out of operation	Out of operation	Passing loop	
			24				
74	Zongo	AK877+000		In operation	In operation	Passing loop	
			24				
75	Tafawa Balewa	AK901+000		In operation	In operation	Intermediate station	Passenger trains
			19				
76	Bununu	AK920+000		Out of operation	Out of operation	Passing loop	
			20				
77	Liman Katagum	AK940+000		In operation	In operation	Passing loop	
			24				
78	Dandango	AK964+000		Out of operation	Out of operation	Passing loop	
			11				
79	Bauchi	AK975+000		In operation	In operation	Intermediate station	Passenger and freight trains
			6				
80	Inkil	AK981+000		Out of operation	Out of operation	Passing loop	
			21				
81	Bishi	AK1002+000		Out of operation	Out of operation	Passing loop	
			8				

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
82	Dindimaj	AK1010+000		In operation	In operation	Passing loop	
83	Alkalere	AK1030+000	20	In operation	In operation	Intermediate station	Passenger trains
84	Bundu Faruku	AK1057+000	27	In operation	In operation	Passing loop	
85	Zongoma	AK1088+000	31	In operation	In operation	Passing loop	
86	Bomala	AK1112+000	24	In operation	In operation	Passing loop	
87	Gombe	AK1141+000	29	In operation	In operation	Intermediate station	Passenger and freight trains
88	Daba Fulani	AK1168+000	27	In operation	In operation	Passing loop	
89	Tongo	AK1200+000	32	In operation	In operation	Passing loop	
90	Bajoga	AK1220+000	20	In operation	In operation	Intermediate station	Passenger trains
91	N'Jibuluwa	AK1242+000	22	Out of operation	Out of operation	Passing loop	
92	Gabai	AK1258+000	16	In operation	In operation	Passing loop	
93	Kukuwa	AK1278+000	20	Out of	In	Passing loop	

S/N	Station	Kilometerage from P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
				operation	operation		
			22				
94	Buni/Jiri	AK1300+000		In operation	In operation	Passing loop	
			23				
95	Ambiya	AK1323+000		Out of operation	Out of operation	Passing loop	
			17				
96	Goniri	AK1340+000		In operation	In operation	Intermediate station/Junction station	Passenger trains
			18				
97	Didiri	AK1358+000		Out of operation	In operation	Passing loop	
			23				
98	Borgozo	AK1381+000		In operation	In operation	Passing loop	
			19				
99	Bula Bulin	AK1400+000		Out of operation	Out of operation	Passing loop	
			21				
100	Duwari	AK1421+000		In operation	In operation	Passing loop	
			22				
101	Maiduguri	AK1443+000		In operation	In operation	District station	Passenger and freight trains
Total			1,427	101	101		
Of which, in operation				60	73		

Source: CCECC, 2020

- The Port Harcourt New-Elelenwo (excluded) branch line section of main line has an operation length of 16 km. It has 1 station in the short, middle and long term, with the maximum distance between stations of 16 km (Port Harcourt New-Elelenwo). See in the table 3.5.

Table 3.5: List of Stations Provided for Port Harcourt New-Elelenwo (Excluded) Branch Line Section of Main Line

SN	Station	Kilometerage From P.H.	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
1	Port Harcourt New	AK0+000		In operation	In operation	Intermediate station	Passenger and freight trains
			2				
2	Port Harcourt Wharf	AK2+000		Out of operation	Out of operation	Passing loop	
			3				
3	Diobu Halt	AK5+000		Out of operation	Out of operation	Passing loop	
			11				
4	Elelenwo	AK16+000		In operation	In operation	District station	Passenger and freight trains (excluded)
Total			16	3	3		
Of which, in operation				1	1		

Source: CCECC, 2020

- **Kafanchan (excluded) - Rigachikun connecting line:** The Kafanchan (excluded) - Rigachikun connecting line has an operation length of 200 km. It has 6 stations in the short, middle and long term, including 3 intermediate stations and 3 Passing loops, with the maximum distance between stations of 50 km (Zonkwa-Kurmin Biri), the minimum of 21 km (Kankomi-Rigachikun), and the average of 33.33 km in short, middle and long term. See in the table 3.6.

Table 3.6: List of Stations Provided for Kafanchan (Excluded) - Rigachikun Connecting Line

S/N	Station	Kilometerage From Kafanchan	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
1	Kafanchan	LAK0+000		In operation	In operation	Intermediate station /Junction station	Passenger trains (excluded)
			10				
2	Jemaa	LAK10+000		Out of operation	Out of operation	Passing loop	
			20				

S/N	Station	Kilometerage From Kafanchan	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
3	Zonkwa	LAK30+000	18	In operation	In operation	Intermediate station	Passenger trains
4	Kamuru	LAK48+000	11	Out of operation	Out of operation	Passing loop	
5	Duchin Bako	LAK59+000	21	Out of operation	Out of operation	Passing loop	
6	Kurmin Biri	LAK80+000	25	In operation	In operation	Passing loop	
7	Iri	LAK105+000	20	Out of operation	Out of operation	Passing loop	
8	Kutura	LAK125+000	15	In operation	In operation	Passing loop	
9	Kajuru	LAK140+000	14	Out of operation	Out of operation	Passing loop	
10	Kankomi	LAK154+000	9	In operation	In operation	Passing loop	
11	Dokaje	LAK163+000	7	Out of operation	Out of operation	Passing loop	
12	Tsaunin Kura	LAK170+000	9	Out of operation	Out of operation	Passing loop	
13	Kaduna Junction	LAK179+000	6	In operation	In operation	Intermediate station	Passenger and freight trains

S/N	Station	Kilometerage From Kafanchan	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
14	Kaduna North	LAK185+000	15	Out of operation	Out of operation	Passing loop	
15	Rigachikun	LAK200+000		In operation	In operation	Intermediate station /Junction station/Transshipment station	Passenger and freight trains
Total			200	14	14		
Of which, in operation				6	6		

Source: CCECC,2020

- **Kuru (excluded) -Jos branch line:** The Kuru (excluded)-Jos branch line has an operation length of 35 km. It has 2 intermediate stations in the short, middle and long term, with the maximum distance between stations of 19 km (Kuru-Bukuru), the minimum of 16 km (Bukuru-Jos), and the average of 17.5 km. See in the table 3.7.

Table 3.7 List of Stations Provided for Kuru (Excluded) -Jos Branch Line

S/N	Station	Kilometerage from Kuru	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
1	Kuru	ZAK0+000	13	In operation	In operation	Intermediate station /Junction station	Passenger trains (excluded)
2	Vom	ZAK13+000	6	Out of operation	Out of operation	Passing loop	
3	Bukuru	ZAK19+000	16	In operation	In operation	Intermediate station	Passenger trains
4	Jos	ZAK35+000		In operation	In operation	Intermediate station	Passenger and freight trains
Total			35	3	3		
Of which, in operation				2	2		

Source: CCECC, 2020

- **New branch line of Goniri (excluded)-Gashua section**: The new Goniri (excluded) -Gashua branch line has an operation length of 216 km. It has 4 stations in the short, middle and long term, including 2 intermediate stations and 2 Passing loops, with the maximum distance between stations of 64km (Lantewa-Baiomari), the minimum of 41km (Baiomari-Gashua), and the average of 54km. See in the table 3.8.

Table 3.8: List of Stations Provided for New Goniri (Excluded) -Gashua Branch Line

S/N	Station	Kilometerage from Goniri	Distance between stations (km)	Status of station		Type	Remarks
				2030	2040/2050		
1	Goniri	XAK0+000	50	In operation	In operation	Intermediate station /Junction station	Passenger trains (excluded)
2	Damaturu	XAK50+000	61	In operation	In operation	Intermediate station	Passenger trains
3	Lantewa	XAK111+000	64	In operation	In operation	Passing loop	
4	Baiomari	XAK175+000	41	In operation	In operation	Passing loop	
5	Gashua	XAK216+000		In operation	In operation	Intermediate station	Passenger and freight trains
Total				4	4		

Source: CCECC, 2020

- **Proposed new standard-gauge connecting line of Rigachikun (excluded)-Rinji (excluded) section:** The new standard-gauge Rigachikun (excluded) -Rinji (excluded) connecting line has an operation length of 7.6 km. This connecting line and Rinji station is not included in the scope of the investment of this project. See in the table 3.9.

Table 3.9 List of Stations Provided for Rigachikun (Excluded)-Rinji (Excluded) Connecting Line

S/N	Station	Kilometerage from Rigachikun	Distance between stations (km)	2030	2040/2050	Type	Remarks
1	Rigachikun	LBK0+000	7.6	In operation	In operation	Intermediate station /Junction station/Transshipment station	Passenger and freight trains (excluded)
2	Rinji	LBK7+600		In	In	Intermediate station	(excluded)

				operation	operation	/Junction station	
Total				0	0		

Source: CCECC, 2020

3.6 Bridge and Culvert

3.6.1 Main Technical Standards

- Design flood frequency:

New bridges and culverts: bridges and culverts are all designed as per 1/100.
Existing bridges and culverts: the original design standards shall be maintained.

- Design live load:

Existing railway bridges and culverts: the original design live load shall be maintained.
New railway bridges and culverts: the existing railway bridges and culverts live load for design shall be followed.

- Basic structure gauge

The original design standards shall be maintained.

- Grade separation clearance

New bridges and culverts: Railway bridges across roads and highways shall be designed according to relevant standards and the requirements of local departments. 0.1~0.2m margin should be reserved when conditions permit. The horizontal clearance beneath bridges across classified highways shall not be less than the width of existing highways, and shall meet the requirements of relevant departments. The vertical clearance shall not be less than 5.0m. The rural roads should be designed according to the following table 3.13.

Table 3.13 Clearance of traffic culverts

Function of traffic culverts	Clear height (m)	Clear width (m)
Pedestrian and livestock passage	3.0	3.0
Tractor road and animal-drawn carts passage	3.5	4.0
Car passage (single lane)	4.5	5.0

Source: CCECC, 2020

- Existing bridges and culverts: the original design standards shall be maintained.

- Navigation clearance

The clearance beneath the bridges should meet the requirements of relevant authorities.

- Seismic fortification standard

As the seismic peak ground acceleration is between 0 and 0.02g, it is unnecessary to have seismic design.

3.6.2 Principle of Bridge and Culvert

3.6.2.1 Principles of Utilization, Reinforcement and Reconstruction of Existing Bridges and Culverts

For the defects on railway bridge superstructure, anti-rust painting, repair welding, maintenance and anti-corrosion painting shall be adopted on the steel girder. For the defects of substructure, the local damaged parts of piers and abutments and the conical slope of abutment shall be repaired. Measures such as rock filled gabion shall be taken to protect serious scouring place of the bridge piers; and the bridge with serious siltation shall be dredged.

For the defects such as the collapse of the culvert wing walls, the exposure of the vertical apron, and cracks of some culvert structures, the repair of the culvert inlet and outlet and the culvert structure shall be carried out. In addition, the length of the pavement at the inlet and outlet shall be lengthened; the cracked culvert shall be repaired. The silt shall be dredged in time. The scour protection measures of the culverts shall be reinforced.

3.6.2.2 Structural Type, Opening and Foundation Type of New Bridge and Culvert

(1) Bridge span arrangement

Bridge structures are determined according to factors including the terrain and landform, hydrological characteristics, geological conditions, project cost, construction period. For common bridges, 24m or 32m post-tensioned simply-supported prestressed concrete T girders are generally adopted.

When the simply supported beam is not able to overpass the main road or other con-trolling feature, the co ntinuous beam shall be used. The continuous beam with a single box single chamber section, is designed a s a fully prestressed member, and the longitudinal and trains--verse prestressing tendon shall be set.

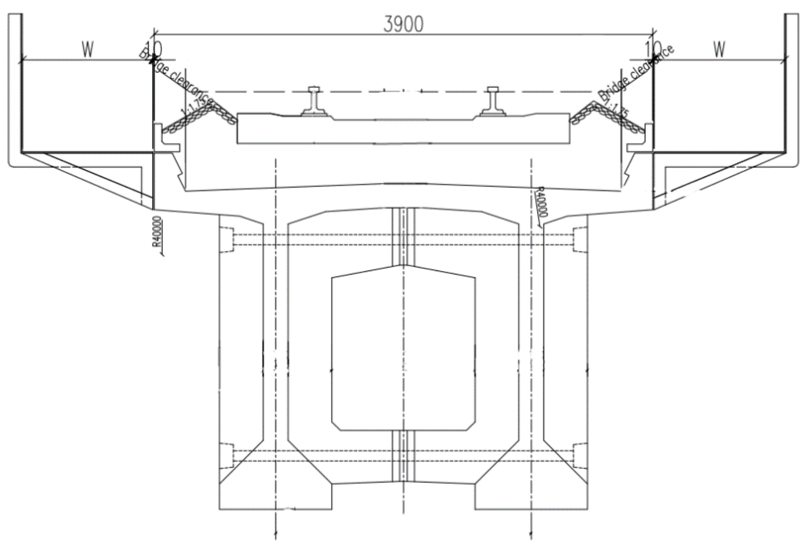


Fig. 3.3: Typical section of T girders (unit: mm)

(2) Abutments and piers

Round-ended solid piers are adopted for piers and T-shaped abutments are adopted.

(3) Foundation

Spread foundation or pile foundation are generally adopted according to different geological, hydrological, and constructional conditions. Spread foundation is preferably adopted when the geological condition is good with little or no groundwater and small excavation depth, and when the foundation lies on a stable layer with small settlement. Based on different geological condition, bored pile with diameters of 1.0m and 1.25m or man-made dug pile can be adopted for pile foundation.

(4) Frame bridges

When bridge across rivers or roads is constrained by the level of line, multi-span frames or continuous frame bridges shall be adopted according to local geological and terrain conditions.

(5) Culverts

Culverts opening is determined according to requirements of flood discharge, irrigation, etc. Frame culverts and round culverts are the main forms. The opening of flood discharge culverts should generally be not less than 1.25m.

(6) Highway overpass

When a main highway is to cross the railway, reinforced concrete rectangle girders or prestressed concrete T girders are adopted according to the span, terrain, geology and construction conditions. U-shaped gravity abutments, column light abutments or ribbed abutments are adopted. The column piers are the main choice. Spread foundation or pile foundation is adopted based on the bridge stress and geological condition. There is no highway overpass on the existing line.

(7) Pedestrian overpass

In order to ensure the safety of the people when crossing the railways, the pedestrian overpass is set up in combination with the site geological conditions and the related traffic conditions in the surrounding areas. The reinforced concrete rectangular girders are preferred. The piers are mainly column piers, and the foundation is expanded foundation. There is no pedestrian overpass on the existing line.

3.6.2.3 Construction Methods of Bridges and Culverts

Simply-supported T-beams with the span equal to or less than 32m are generally prefabricated in the beam fabrication yard and placed with erecting machines. Cast-in-place construction is generally adopted for culverts construction.

According to the hydrological conditions, straw-bag cofferdams, steel cofferdams, steel trestles and construction platforms can be adopted when the abutments or piers stand in the river. Temporary diversion of ditches and cast-in-place construction can be adopted when drainage culverts lie within a ditch.

3.6.3 Main Works Contents for Bridges, Underpass, overpass and Level Crossing

3.6.3.1 Existing Railway Rehabilitation

- **Port Harcourt (AK0) (included)-Aba (AK63) (excluded)**

There are 5 existing railway bridges and 38 culverts, all of which are utilized in the original way through repair and reinforcement.

- **Aba (AK63) (included)-Kafanchan (AK737) (excluded)**

There are 48 existing railway bridges and 707 existing culverts. Except that one bridge shall be demolished and rebuilt due to the loss of load-carrying capacity, the rest are utilized in the original way through repair and reinforcement. 6 new railway bridges with a total length of 4298.3m and 363 new culverts with a total length of 7378m in this line shall be built.

- **Kafanchan (AK737) (included)-Kuru (AK803) (excluded)**

There are 7 existing railway bridges and 95 existing culverts, all of which are utilized in the original way through repair and reinforcement.1 new railway bridges with a total length of 539.2m and 3 new culverts with a total length of 61m in this line shall be built.

- **Kuru (AK803) (included)-Maiduguri (AK1443) (excluded)**

There are 74 existing railway bridges, 57 of them are utilized in the original way through repair and reinforcement. 17 bridges were seriously damaged due to the war in the Gombe-Maiduguri section. It is considered to reconstruct them with the corresponding span at the original bridge site. There are 827 existing culverts, all of them are utilized in the original way through repair and reinforcement. 7 new culverts with a total length of 142m in this section shall be built.

- **Branch line: Kafanchan (LK0) (excluded)-Kaduna (LK179) (included)**

There are 21 existing railway bridges and 308 culverts, all of which are utilized in the original way through repair and reinforcement.

- **Connecting line: Kuru (ZAK0) (excluded)-Jos (ZAK35) (included)**

There are 2 existing railway bridges and 87 culverts, all of which are utilized in the original way through repair and reinforcement.

See in the table 3.14 for the bridges distribution statistics of existing lines.

Table 3.14 Existing Railway Bridges and Culverts to Be Repaired

Units	Total length	Existing Railway Bridges to be Repaired	New Railway Bridges	Existing Culverts to be Repaired	New Railway Culverts
	km	No.-linear meter	No.-linear meter	No.	No.-linear meter
Port Harcourt-Aba	63	5-262.1	0	38	0
Aba-Kafanchan	674	47-1361.1	6-4362.3	707	363-7378
Kafanchan-Kuru	66	7-194.8	1-539.2	95	3-61
Kuru-Maiduguri	640	57-1278.7	17-684.0	827	7-142
Kafanchan-Rigachikun	179	22-682.5	0	340	0
Kuru-Jos	35	2-42.7	0	87	0

Source: CCECC, 2020

3.6.3.2 New Line

- **New Goniri (XAK0) (excluded)-Gashua (XAK216) (included)**

The line includes in total 1 super-large bridge, 6 major and medium bridges, 2 frame bridges, 535 culverts, 2 highway-over-railway overpasses and 3 pedestrian overpasses. See in the table 3.15 – 3.17,

Table 3.15 Pedestrian overpass bridge table

No.	Center mileage	Layout form	Deck width（m）	Deck square mete
1	AK050+635.00	20m girder bridge	3	60
2	AK051+495.00	20m girder bridge	3	60
3	AK148+940.00	20m girder bridge	3	60
Total	/	/	/	180.0

Source: CCECC, 2020

Table 3.16 Highway overpass bridge table

No.	Center mileage	Layout form	Deck width（m）	Deck square mete
1	AK003+616.00	12m+16m+12m girder bridge	14.95	598.0
2	AK045+153.00	12m+16m+12m girder bridge	14.95	598.0
Total	/	/	/	1196.0

Source: CCECC, 2020

Table 3.17 Main quantities of bridges and culverts works

Total Length of the Line	Super-large Bridge	Major Bridge	Medium Bridge	Frame bridge	Culvert	Highway-over-railway Overpass	Pedestrian overpass
Km	No.-linear meter	No.-linear meter	No.-linear meter	No.- deck square meter	No.- horizontal linear meter	No.- deck square meter	No.- deck square meter
216.729	1-506.5	3-800.1	3-211.5	2-336	267-5437	2-1196	3-240
Technical index (/km)	7.01 linear meter			1.55 deck square meter	1.24	5.52 deck square meter	1.11 deck square meter
Proportion of bridge length (%)	0.70			/	/	/	/

Source: CCECC, 2020

3.7 Station and Yard

3.7.1 Design Principles of Rehabilitation and Reconstruction Works

- **Reconstruction works of existing narrow-gauge railway station**

i. For Passing loops, 1 receiving-departure track shall be rehabilitated and reconstructed generally. If two Passing loops are adjacent, for one of them, 2 receiving-departure tracks shall be rehabilitated and reconstructed.

ii. For station which only handles passenger service, 2 receiving-departure tracks shall be rehabilitated and reconstructed.

iii. For large stations which handle passenger and freight services, the scope of rehabilitation and reconstruction works is determined according to the function of the station and the layout of locomotive and rolling stock depots.

iv. The plane and profile of tracks in existing stations within the scope of rehabilitation and reconstruction works of the existing station shall be maintained.

v. Station track laying: Remove 80% of the existing rails, sleepers, fasteners, etc. of the station lines within the repair range of each station, and re-lay the rails and sleepers that have been removed from the main line and can continue to be used after testing. The sleeper spacing is 0.658m, and the sleeper laying criteria is 1520 pieces per kilometer.

vi. Ballast cleaning and ballast supplementation for the station tracks: ballast cleaning shall be conducted within the scope of rehabilitation and reconstruction works of each station, and ballast shall be supplemented as per 30% of the ballast quantity estimated at 0.3m thick and 2.53m wide of the top surface of the track bed.

vii. The existing location and type of the turnouts shall be maintained, and the turnouts in the scope of rehabilitation and reconstruction works of each station shall not be replaced.

viii. The ditch shall be dredged and repaired: the side ditch (earth ditch) and the longitudinal ditch with cover are considered to be cleaned by 33.3% and repaired as per by 66.7%. The appropriate addition of the longitudinal ditch with cover is considered in the large station.

ix. The station platform of Passing loop will be rehabilitated according to the scale of 50m*5m*0.3m, and the rest of the stations will be rehabilitated according to the scale of 120m*8m*0.55m equivalent to 5 passenger cars formation.

x. Due to the lack of data of sub-station traffic volume, rehabilitation and reconstruction work of this design only includes freight yard junction, and does not include freight tracks, freight platform and ground inside the freight yard.

- **New narrow-gauge station**

i. The Passing loop shall be provided with 1 receiving-departure track, which shall not be set one after another.

ii. The intermediate station shall be provided with 2-3 receiving-departure tracks.

iii. The effective length of the receiving-departure track is the same as the Kuru (excluded)-Maiduguri (included) section, and the effective length is 450m.

iv. New station track: the rails, sleepers, etc. removed from the main line, which still can be used after inspection, shall be used for the new station track, with a spacing of 0.65m.

v. New turnout: On the receiving-departure tracks, single No.12 wooden sleeper turnouts are used, and single No.8.5 wooden sleeper turnouts are used on the rest of the station tracks.

vi. Ballast supplementation: single layer crushed stone ballast is 0.3m thick; the top surface width of the ballasted bed is 2.53m; and the slope rate is 1:1.5.

vii. New ditch: the earth ditch is used for the side ditch which is temporarily considered as per b=0.3m and h=0.6m;

viii. New station platform: 50m*5m*0.3m platforms will be set in Passing loops; 120m*8m*0.55m platforms will be set in the rest of the stations.

ix. Due to the lack of data of sub-station traffic volume, this design only considers the junction turnout of freight yard, and does not include the freight tracks, freight platform and ground in the freight yard.

3.7.2 Main Content of Rehabilitation Works for stations

There are 104 existing stations in the main line. 43 stations will be closed and 61 stations will be rehabilitated and reconstructed in the short term. 30 stations will be closed and 74 stations will be rehabilitated and reconstructed in the medium and long term.

There are 13 existing stations in the connecting line from Kafanchan (excluding) to Rigachikun (excluding), and 8 existing stations will be closed in the short, medium and long term, and 5 stations will need to reconstructed and rehabilitated.

There are 3 existing stations in the Jos branch line. 1 station will be closed and 2 stations will be rehabilitated and reconstructed in the short, medium and long term.

A total of 4 new stations will be provided in the new Goniri-Gashua branch line in the short, medium and long term.

New Rigchikun transshipment station will be built in Kaduna connecting line in the short term.
Asa transshipment station will be built at the same time as the coastal railway. See table 3.27 for the main content of rehabilitation and reconstruction works.

Table 3.27 Main content of rehabilitation and reconstruction works

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
Port Harcourt (included)-Aba (excluded)				
1	Port Harcourt	AK0+000	Intermediate Station	Demolish and lay 6 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate locomotive turnaround depot and passenger train technical servicing point.
3	Ubuzor	AK35+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
4	Umugo	AK53+000	Passing loop	Demolish and lay 1 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
Aba (included)-Kafanchan (included)				
5	Aba	AK63+000	Intermediate Station	Demolish and lay 3 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m; set 1 new comprehensive maintenance section and 1 locomotive holding track.
6	Umueze	AK85+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
				50m*5m*0.3m;
7	Umuahia-Ibeku	AK113+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
8	Nkpa	AK137+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
9	Ozara	AK163+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
10	Eziator Quarry	AK190+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
11	Nomeh	AK204+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
12	Agbani	AK222+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
13	Enugu	AK243+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 322m*6m; set 1 new comprehensive maintenance section.
14	Ogbaho	AK270+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
15	Eha Amufu	AK290+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m; set 1 new comprehensive maintenance section.
16	Igbede	AK304+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
17	Igunmale	AK320+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
18	Utonkon	AK338+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
19	Otobi	AK359+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
20	Oturkpo	AK375+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
21	Taraku	AK391+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
22	Kinga	AK409+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
23	Moi-Igbo	AK426+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
24	Agana	AK444+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
25	Adeke	AK457+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
26	Makurdi	AK463+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m; set 1 new comprehensive maintenance section.
27	Achakpa	AK486+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
28	Udei	AK515+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
29	Kaderko	AK528+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
30	Agyaragu	AK550+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
31	Lafia	AK565+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m; set 1 new comprehensive maintenance section.
32	Barakin Abdullahi	AK586+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
33	Langa Langa	AK613+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
34	Gudi	AK632+000	Intermediate Station	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
35	Moroa River	AK653+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
36	Wasa	AK674+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
37	Jagindi	AK697+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
38	Gerti	AK714+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; repair the platform with a scale of 50m*5m*0.3m.
39	Kafanchan	AK737+000	Intermediate Station/Junction Station	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate one comprehensive maintenance depot and one locomotive and rolling stock depot.
Kafanchan (excluded)-Kuru(included)				
40	Manchok	AK764+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
41	Kuru	AK803+000	Intermediate Station/Junction	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
			Station	ditches and repair part of ditches; set one new comprehensive maintenance depot.
Kuru (excluded)-Maiduguri(included)				
42	Bakin Kogi	AK838+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
43	Zongo	AK877+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
44	Tafawa Balewa	AK901+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
45	Liman Katagum	AK940+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
46	Bauchi	AK975+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and 2 new freight tracks, and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
47	Dindimaji	AK1010+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
48	Alkalere	AK1030+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
49	Bundu Faruku	AK1057+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
50	Zongoma	AK1088+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
51	Bomala	AK1112+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
52	Gombe	AK1141+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and 1 new freight track, and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; set 1 new comprehensive maintenance section.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
53	Daba Fulani	AK1168+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
54	Tongo	AK1200+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
55	Bajoga	AK1220+000	Intermediate Station	Demolish and lay 3 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m; set 1 new comprehensive maintenance section.
56	Gabai	AK1258+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
57	Buni/Jiri	AK1300+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
58	Goniri	AK1340+000	Intermediate Station/Junction Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
59	Borgozo	AK1381+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
60	Duwari	AK1421+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
61	Maiduguri	AK1443+000	District Station	Demolish and lay 3 new receiving-departure tracks (excluding the main line) and 2 new freight tracks, and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m; rehabilitate the locomotive turnaround point, and set new passenger train-set stabling siding, side repair handling yard and comprehensive maintenance depot.
Kafanchan (excluding)- Rigachikun (excluding) connecting line				
62	Zonkwa	LAK30+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
63	Kurmin Biri	LAK80+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
64	Kutura	LAK125+000	Passing loop	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
65	Kankomi	LAK154+000	Passing loop	Demolish and lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 50m*5m*0.3m.
66	Kaduna Junction	LAK179+000	Intermediate Station	Demolish and lay 3 new receiving-departure tracks (excluding the main line) and 1 new freight track, and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; repair the platform with a scale of 120m*8m*0.55m; rehabilitate the locomotive turnaround point, and set new passenger train-set stabling siding, side repair handling yard and comprehensive maintenance section.
Jos branch line				
67	Bukuru	ZAK19+000	Intermediate Station	Demolish and lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m.
68	Jos	ZAK35+000	Intermediate Station	Demolish and lay 3 new receiving-departure tracks (excluding the main line) and 1 new freight track, and corresponding turnouts; remove and lay new ballasts; desilt the ditches and repair part of ditches; rehabilitate the platform with a scale of 120m*8m*0.55m; set new locomotive holding track, passenger train-set stabling siding and side repair handling

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
				yard.
New Goniri-Gashua branch line				
69	Damaturu	XAK50+000	Intermediate Station	Lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; lay new ballasts; set new ditches and new platform with a scale of 120m*8m*0.55m; set new comprehensive maintenance section.
70	Lantewa	XAK111+000	Passing loop	Lay 1 new receiving-departure track (excluding the main line) and corresponding turnouts; lay new ballasts; set new ditches and new platform with a scale of 50m*5m*0.3m.
71	Baiomari	XAK175+000	Passing loop	Lay 2 new receiving-departure tracks (excluding the main line) and corresponding turnouts; lay new ballasts; set new ditches and new platform with a scale of 50m*5m*0.3m.
72	Gashua	XAK216+000	Intermediate Station	Lay 3 new receiving-departure tracks (excluding the main line), 1 new freight track, 2 shunting necks and corresponding turnouts; lay new ballasts; set new ditches and new platform with a scale of 120m*8m*0.55m; set new locomotive turnaround point, train-set stabling siding and side repair handling yard.
New Rigachikun transshipment station				
73	Rigachikun	LAK200+000	Transshipment Station	①Narrow-gauge receiving-departure yard: demolish 2 receiving-departure tracks and replace them(excluding the main line; remove and lay new ballasts; build new ditches; build a 120m*8m*0.55m platform; set one new locomotive turnaround point, one side repair track and two

No.	Station	Station center kilometerage	Type	Content of rehabilitation and reconstruction works
				passenger car stabling sidings; ②Standard-gauge receiving-departure yard: set three new standard-gauge receiving-departure tracks (including main line); ③ Standard and narrow gauge transshipment yard: set a new 90m*18m gantry crane, a 70m*9m flat goods section and 70m* 18m warehouse; set 3 new narrow-gauge freight tracks and 3 standard-gauge freight tracks.
New Asa transshipment station				
74	Asa	CAK565+000(coastal railway)	Transshipment Station	In the long term, set a new 90m*18m gantry crane, a 112m*9m flat goods section and 126m* 18m warehouse; set 3 new narrow-gauge freight tracks and 3 new standard-gauge freight tracks.

(1) Port Harcourt Station

The main rehabilitation and reconstruction work of this station are

- Remove the existing No. 1, 2, 4-7 tracks;
- Replace with the rails, sleepers and other materials removed from the main line which can continue to be used after inspection;
- Repair the longitudinal drainage ditches between the tracks and the side ditches of the existing station;
- Rehabilitate locomotive turnaround depot and passenger train technical servicing point;
- Set aside repair handling siding.

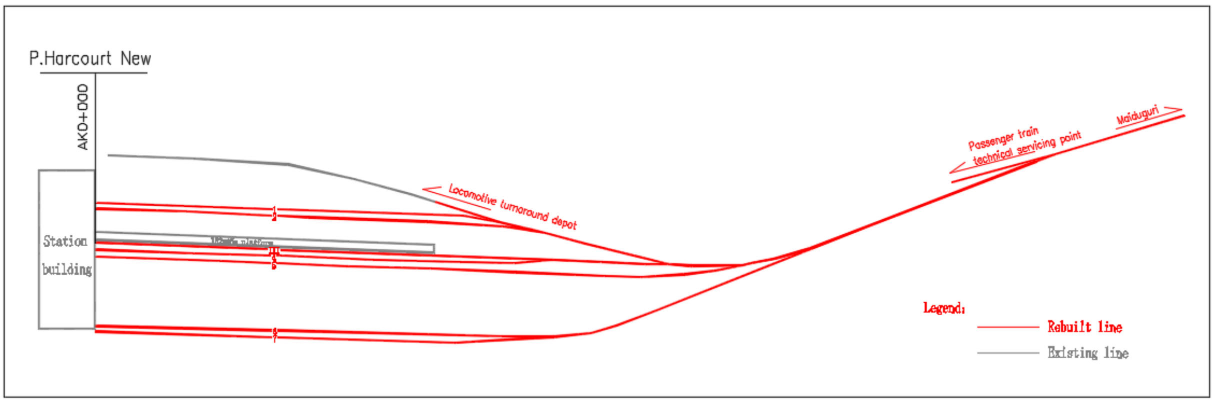


Figure 3.4 Rehabilitation Scheme of Port Harcourt New Station

(2) Kafanchan Station

The main rehabilitation and reconstruction work of this station are

- Remove the existing No. 1, 3, 6 and 14 tracks;
- Replace with the rails, sleepers and other materials removed from the main line which can continue to be used after inspection;
- Repair the longitudinal drainage ditches between the tracks and the side ditches of the existing station;
- Rehabilitate comprehensive maintenance depot and locomotive and rolling stock depot.

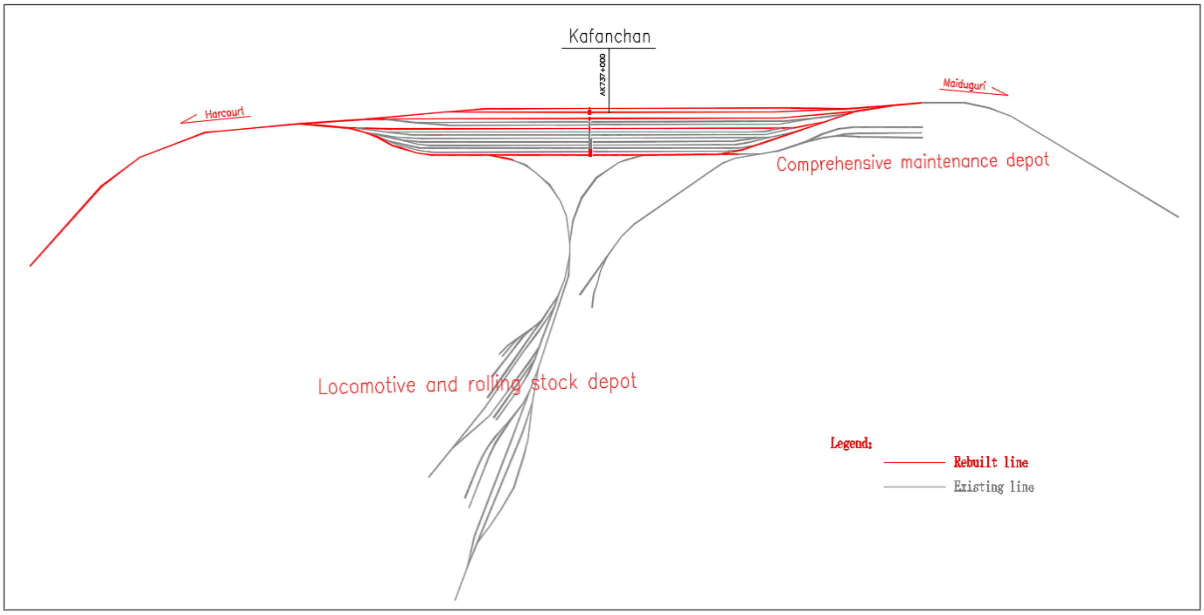


Figure 3.5 Rehabilitation Scheme of Kafanchan Station

(3) Maiduguri Station

The main rehabilitation and reconstruction work of this station are

- Remove the existing No. 1, 3, 4 and 8 tracks;
- Replace with the rails, sleepers and other materials removed from the main line which can continue to be used after inspection;
- Repair the longitudinal drainage ditches between the tracks and the side ditches of the existing station;
- Rehabilitate platform with a scale of 120m*8m*0.55m, to rehabilitate locomotive turnaround depot;
- Set new passenger train-set stabling siding, side repair handling yard and comprehensive maintenance depot.

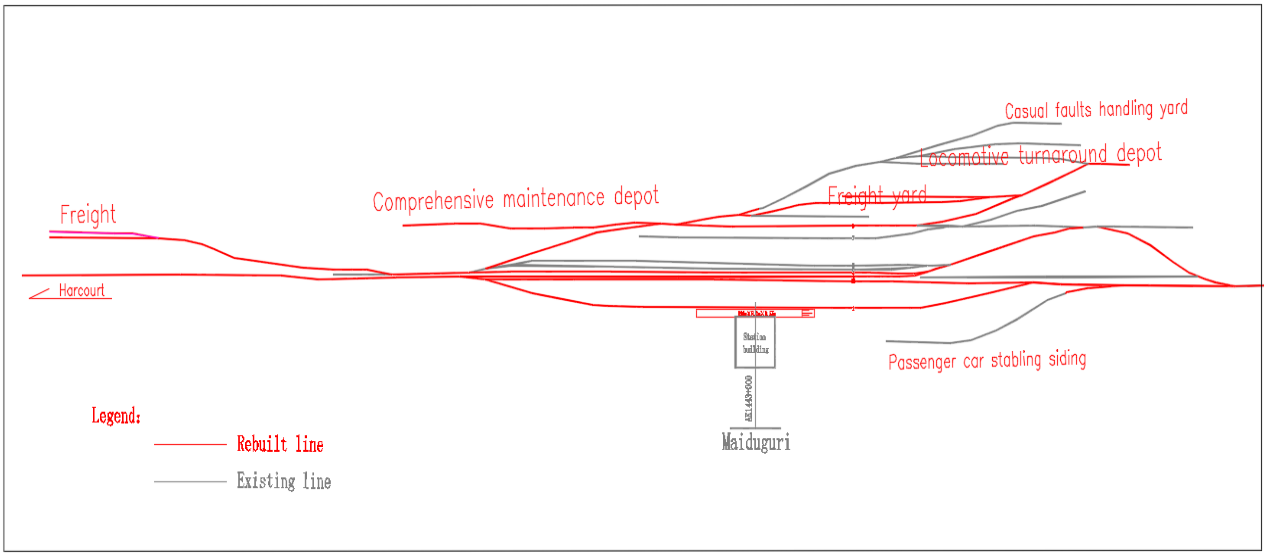


Figure 3.6 Rehabilitation Scheme of Maiduguri Station

(4) Bauchi Station

The main rehabilitation and reconstruction works of this station are

- Remove the existing No. 1, 3, 6 and 7 tracks;
- Replace the rails, sleepers, etc. removed from the main line which can continue to be used after inspection;
- Rehabilitate platform with a scale of 120m*8m*0.55m;
- Rehabilitate longitudinal drainage ditches between the tracks and the side ditches of the existing station.

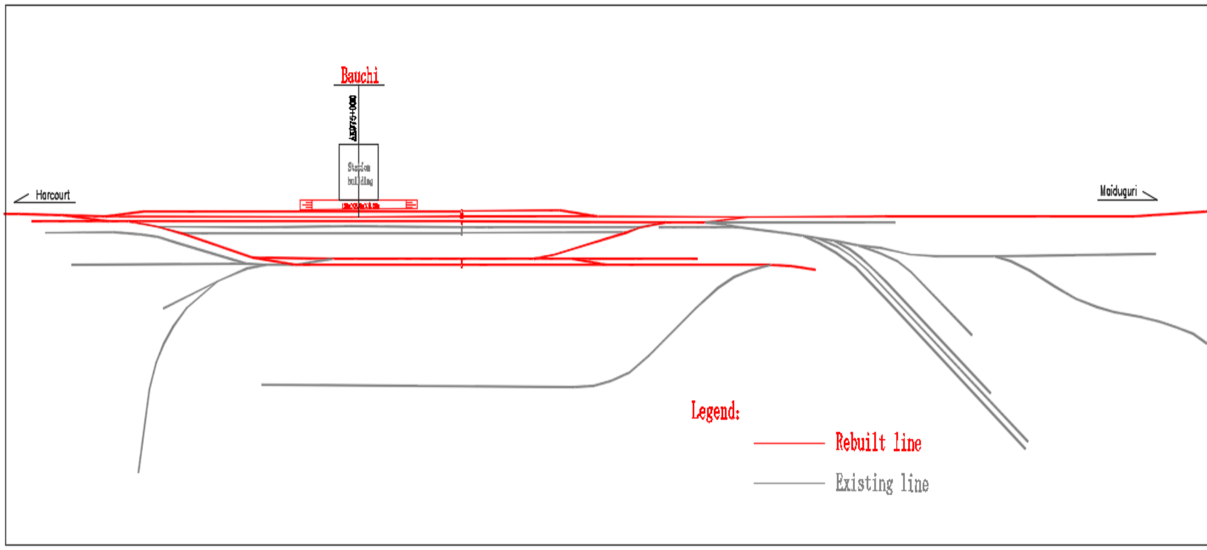


Figure 3.7 Rehabilitation Scheme of Bauchi New Station

(5) Kaduna Junction Station

The main rehabilitation and reconstruction works of this station are

- Remove the existing No. 1, 3, 4 and 5 tracks;
- Replace with the rails, sleepers and other materials removed from the main line which can continue to be used after inspection;
- Repair longitudinal drainage ditches between the tracks and the side ditches of the existing station;
- Set a new comprehensive maintenance section.

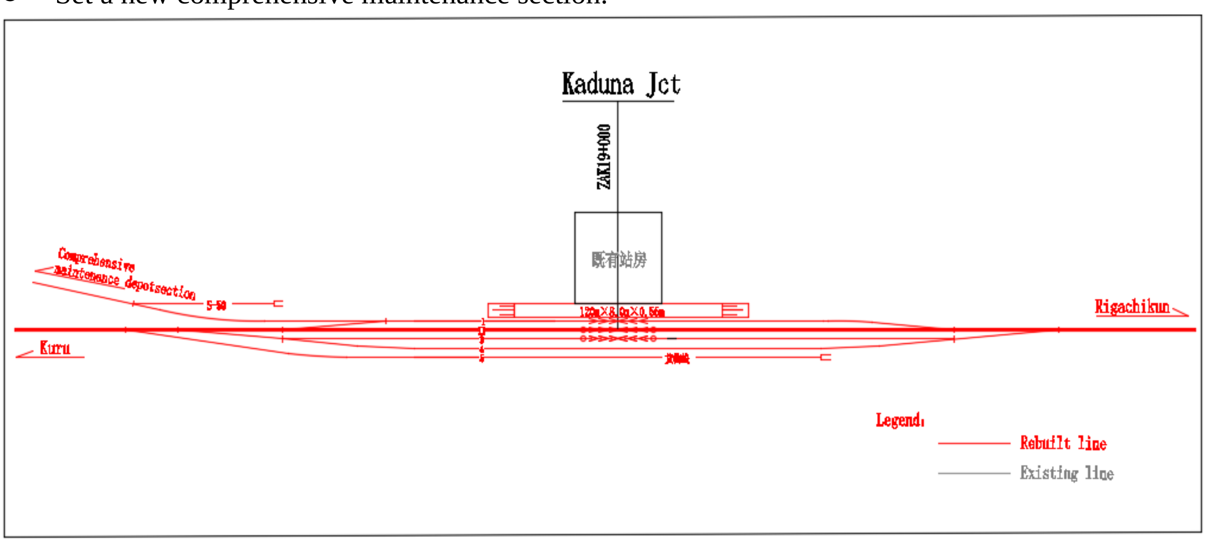


Figure 3.8 Rehabilitation Scheme of Kaduna Junction Station

(6) Jos Station

The main rehabilitation and reconstruction work of this station are

- Remove the existing No. 1, 3, 4 and 5 tracks;
- Replace the rails, sleepers, etc. removed from the main line which can continue to be used after inspection;
- Rehabilitate longitudinal drainage ditches between the tracks and the side ditches of the existing station;
- Rehabilitate platform with a scale of 120m*8m*0.55m is to be repaired;
- Set new passenger car stabling siding and a locomotive holding track.

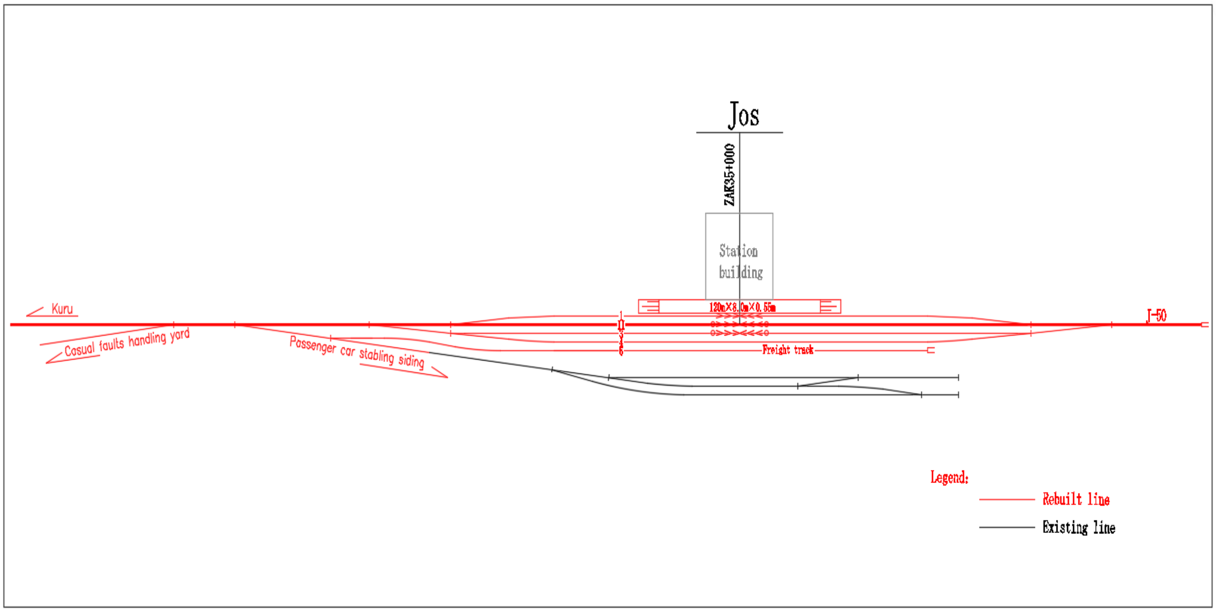


Figure 3.9 Rehabilitation Scheme of Jos Station

(7) Gashua Station

- 4 new receiving-departure tracks (including the main line) are provided, with effective length of 450m;
- 2 shunting necks are provided, with effective length of 250m;
- A platform with a scale of 120m*8m*0.55m is provided;
- A freight yard, a passenger train-set stabling siding, a locomotive turnaround point and a comprehensive maintenance section are provided in the station.

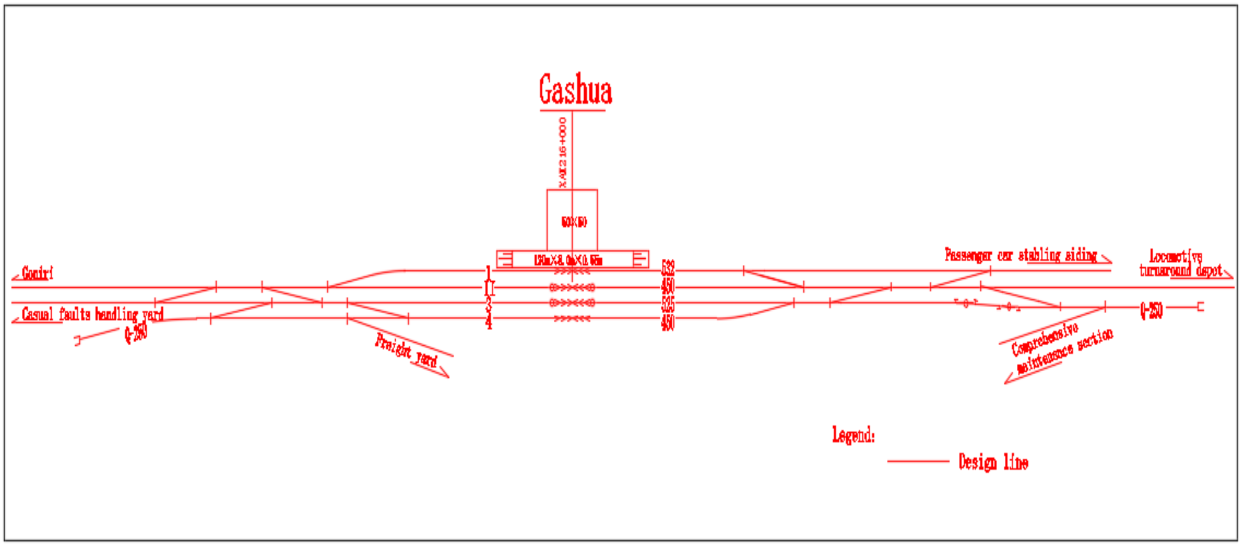


Figure 3.10 Gashua Station Scheme

(8) **Rigachikun Transshipment Station**

Narrow-gauge receiving-departure yard: remove the existing No. I-1 and I-3 tracks; lay the new station tracks (using the rails, sleepers, etc. removed from the main line which can continue to be used after inspection); narrow-gauge shall use the old turnouts; build new ditches; set a new platform with a scale of 120m*8m*0.55m; set new locomotive turnaround point, one side repair track and two passenger car stabling sidings.

Standard-gauge receiving-departure yard: set three new standard-gauge receiving-departure tracks (including main line), with effective length of 880m;

Standard and narrow-gauge transshipment yard: set a new 90m*18m gantry crane, a 70m*9m flat goods section and 70m* 18m warehouse in the short term. The gantry crane is equipped with one standard-gauge and one narrow-gauge freight track, with the effective loading and unloading length of 90m. The standard-gauge and narrow-gauge tracks are transshipped by the gantry crane.

One standard-gauge freight track is set on the left side of the warehouse, and one narrow-gauge freight track is set on the right side, with the effective loading and unloading length of 70m. The standard-gauge and narrow-gauge tracks are transshipped by forklift. One standard-gauge freight track is set on the left side of the flat goods section, and one narrow-gauge freight track is set on the right side, with the effective loading and unloading length of 70m. The standard-gauge and narrow-gauge tracks are transshipped by forklift.

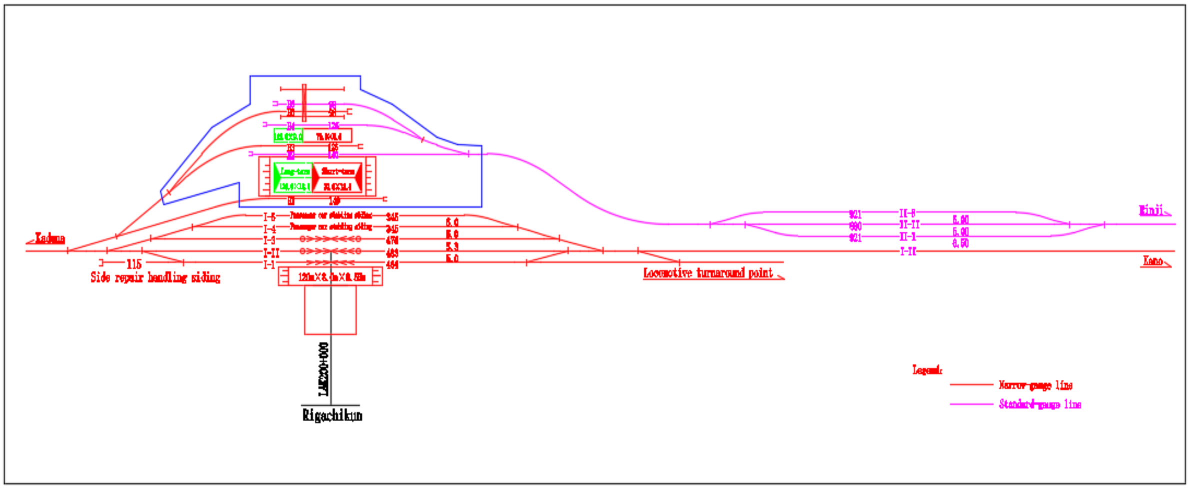


Figure 3.11 Rigachikun Transshipment Station Scheme

3.8 Locomotive

3.8.1 Design Principle

The locomotive facilities shall be provided based on the existing track conditions, the traction type, the station distribution, the train operation organization characteristics, the goods flow direction, the natural conditions and living conditions along the line, and operation conditions and railway network planning of the adjacent lines.

Existing or proposed locomotive operation maintenance facilities in the area shall be fully utilized to undertake the operation and maintenance tasks of locomotives on this line.

The locomotive facilities should be set up according to the centralized repair principle.

for locomotive allocation, new locomotives shall be purchased. Locomotive shall use the diesel narrow-gauge locomotives made in China.

3.8.2 Designed Locomotive Routing

According to data of the traffic volume and train operation organization, designed locomotive routing is as follow.

Passenger locomotive routing:

(1) Diesel narrow-gauge locomotives made in China allocated in Kafanchan Locomotive and Rolling Stock Depot are responsible for passenger locomotive routing from Kafanchan to Harcourt, Rigachikun, Jos, Gashua and Maiduguri.

(2) Diesel narrow-gauge locomotives made in China allocated in Harcourt Locomotive Servicing Point are responsible for passenger locomotive routing from Port Harcourt to Aba.

Freight locomotive routing:

(1) Diesel narrow-gauge locomotives made in China allocated in Kafanchan Locomotive and Rolling Stock Depot are used for freight locomotive routing from Kafanchan to Elelenwo, Rigachikun, Jos, Gashua and Maiduguri. At the same time, they will be used for freight locomotive routing from Kafanchan to Asa in the medium term.

(2) Diesel narrow-gauge locomotives made in China allocated in Elelenwo Locomotive Turnaround Depot are used for freight locomotive routing from Elelenwo to Port Harcourt, and Aba

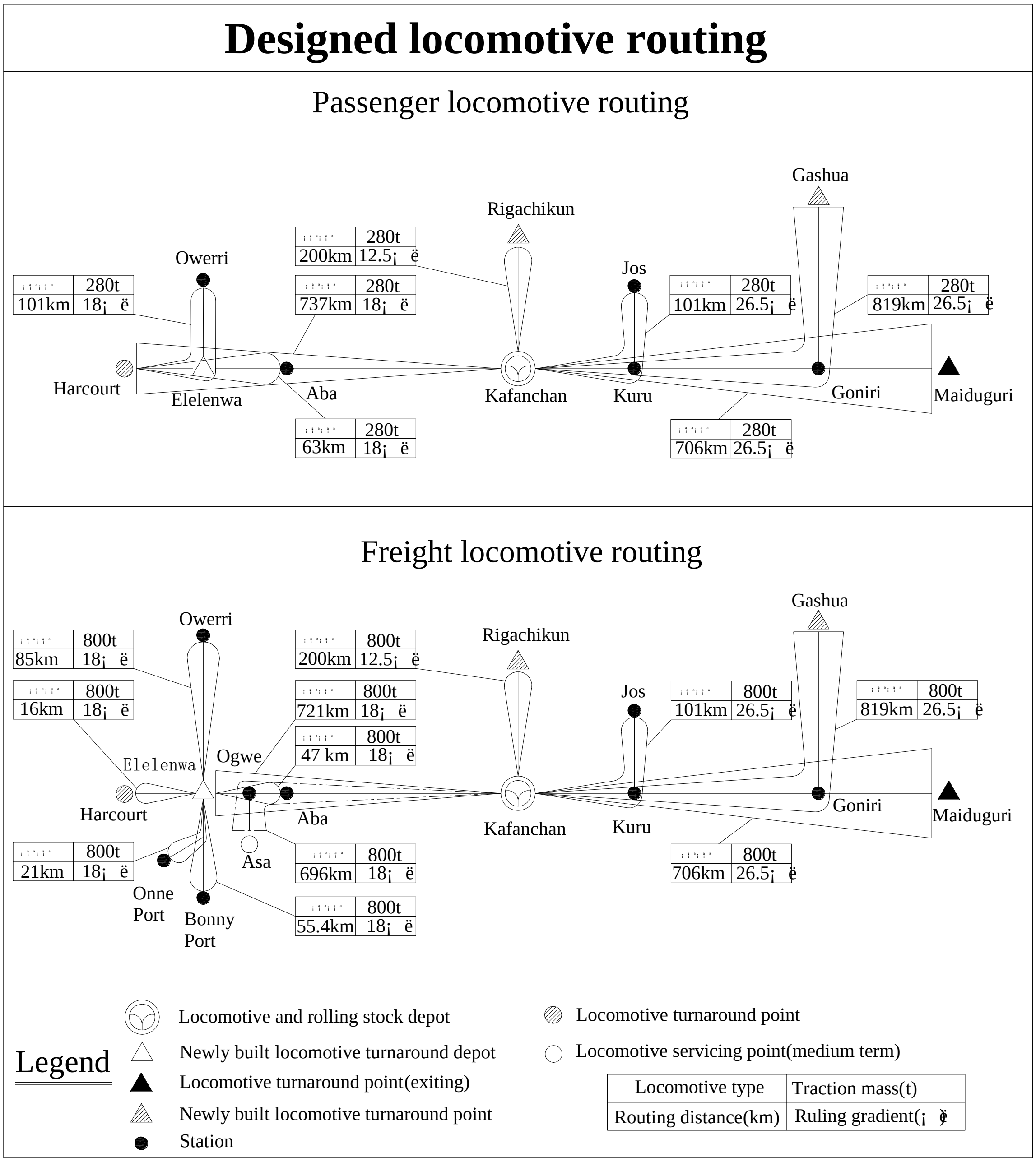


Fig. 3.12 Designed locomotive routing

3.8.3 Distribution, nature and scale of designed locomotive facilities

(1) Harcourt Locomotive Servicing Point

Harcourt Locomotive Servicing Point shall be rehabilitated, reconstructed and expanded to be responsible for the servicing task of locomotives.

(2) Elelenwo Locomotive Turnaround Depot

New locomotive turnaround depot is provided at Elelenwo to be responsible for the servicing and low-level auxiliary repair tasks of locomotives.

(3) Kafanchan Locomotive and Rolling Stock Depot

Kafanchan Locomotive and Rolling Stock Depot shall be rehabilitated, reconstructed and expanded to be responsible for the servicing, high-level repair and low-level repair tasks of locomotives. It is also responsible for the depot repair, operation and maintenance management of freight cars and passenger cars within jurisdiction scope. At the same time, it is responsible for maintenance task of the large maintenance machinery.

(4) Rigachikun Locomotive Turnaround Point

New Rigachikun locomotive turnaround point is provided at Rigachikun to be responsible for the servicing task of narrow-gauge locomotives before turnaround.

(5) Gashua Locomotive Turnaround Point

New Gashua locomotive turnaround point is provided at Gashua to be responsible for the servicing task of locomotives before turnaround.

(6) Maiduguri Locomotive Turnaround Point

Maiduguri Locomotive Turnaround Point shall be rehabilitated, reconstructed and expanded to be responsible for the servicing and casual repair tasks of locomotives before turnaround.

(7) Asa Locomotive Servicing Point

New locomotive servicing point will be provided at Asa to be responsible for the servicing task of narrow-gauge locomotives before turnaround in the medium term.

(8) Locomotive waiting track

Locomotive waiting track shall be respectively provided at Aba, and Jos to be responsible for the waiting task before turnaround.

3.8.4 Distribution and class of rescue equipment

In this design, a 160t rescue crane and its auxiliary rescue equipment shall be provided at Kafanchan Diesel Locomotive and Rolling Stock Depot. The simple rescue and recovery machines and tools shall be respectively provided at Elelenwo Locomotive Turnaround Depot, Rigachikun Locomotive Turnaround Point, Gashua Locomotive Turnround Point and Maiduguri Locomotive Turnround Point.

3.8.5 Allocation of locomotive

For the project of Port Harcourt-Maiduguri main line, Kafanchan-Rigachikun connecting line, Kuru-Jos branch line and Goniri-Gashua branch line, locomotive shall use the diesel narrow-gauge locomotives made in China. Locomotive allocation in the initial term is as follow table 3.28:

Table 3.28 Locomotive allocation of main line and the branch line in the initial term

Locomotive	Unit	Qty.	Remarks
Passenger locomotive	Nr	15	Diesel narrow-gauge locomotives made in China
Freight locomotive	Nr	42	Diesel narrow-gauge locomotives made in China
Shunting locomotive	Nr	3	Diesel narrow-gauge locomotives made in China

Source: CCECC 2020

3.9 Rolling stock

3.9.1 Design principle

For the design of passenger cars, corresponding maintenance equipment and facilities shall be provided according to the type and allocated number of maintenances, operation and maintenance rolling stocks, etc.

Maintenance facilities of passenger train shall be set as concentrated as possible, making full use of the maintenance capacity of passenger trains at existing or adjacent lines.

Since freight trains are not allocated in a fixed manner, maintenance workload and maintenance capacity of rolling stocks of the whole line shall be comprehensively considered. And maintenance capacity of freight trains at existing or adjacent lines shall be fully utilized.

In this design, for rolling stock allocation, new ones shall be purchased. Rolling stock shall use the narrow-gauge passenger car and freight car made in China.

In this design, trace hotbox detection system (THDS) equipment is excluded.

3.9.2 Distribution, nature and scale of designed rolling stock facilities

(1) Kafanchan Locomotive and Rolling Stock Depot

Kafanchan Locomotive and Rolling Stock Depot shall be rehabilitated, reconstructed and extended to be responsible for the servicing, high-level repair and low-level repair tasks of locomotives. It is also responsible for the depot repair, operation and maintenance management of freight cars and passenger cars.

(2) Harcourt Passenger Car Technical Servicing Point

Harcourt Passenger Car Technical Servicing Point shall be rehabilitated, reconstructed and extended to be responsible for the servicing, operation, stabling and casual repair tasks of passenger cars.

(3) Passenger Trainset stabling sidings

One trainset stabling siding is respectively provided at Rigachikun, Jos, Gashua and Maiduguri to be responsible for the stabling and servicing tasks of passenger cars.

(4) Freight train inspection yard, freight car inspection post at loading yard and side repair track

One freight train inspection yard and one side repair track is respectively provided at Elelenwo and Maiduguri to be responsible for the freight train inspection and casual repair.

One freight train inspection yard at loading yard is provided at Rigachikun to be responsible for technical inspection, train-care and promotion tasks of freight cars.

(5) THDS equipment

THDS equipment is excluded in this design.

3.9.3 Rolling stock allocation

For the project of Port Harcourt-Maiduguri main line, Kafanchan-Rigachikun connecting line, Kuru-Jos branch line and Goniri-Gashua branch line, rolling stock shall use the narrow-gauge passenger car and freight car made in China. Rolling stock allocation in the initial term is as follow:

Table 3.29 Rolling stock allocation of main line and the branch line in the initial term

Rolling stock	Unit	Qty.	Remarks
Passenger car	Nr	82	
Freight car	Nr	709	

Source: CCECC, 2020

3.10 Machinery

3.10.1 Infrastructure maintenance facilities

(1) Set-up principle of maintenance organization

The comprehensive maintenance principle shall be adopted for the fixed equipment of the railway. The main set-up principles are as follows:

- Maintenance of this railway adopts the large maintenance machinery.
- Comprehensive maintenance organization layout will be re-planned. The maintenance organizations shall be of 3 levels: comprehensive maintenance depot, comprehensive maintenance section and comprehensive maintenance point.
- Three comprehensive maintenance depots shall be provided at the whole line. One comprehensive maintenance section shall be set about every 80-120km in accordance with station distribution and conditions of station and yard. Comprehensive maintenance point shall be set in the station without comprehensive maintenance depot or section.

(2) Main design contents

One comprehensive maintenance depot shall be respectively provided at Enugu, Kanfanchan and Maiduguri, 3 in total. One comprehensive maintenance section shall be respectively provided at Elelenwo, Aba, Eha Amufu, Makurdi, Lafia, Gudi, Kuru, Tafawa Balewa, Alkalere, Gombe, Bajoga, Zonkwa, Kaduna Junction, Damaturu and Gashua, 15 in total.

One comprehensive maintenance point shall be respectively provided for the rest stations without comprehensive maintenance depot or section, 62 in total. For the project of Asa transshipment station in the medium term, one comprehensive maintenance point shall be provided at Asa, 1 in total.

Two sets of large maintenance machinery are equipped, each set of large maintenance machinery is mainly composed of one tamping car, one power stabilizing car, one ballast shaping car and auxiliary vehicles.

3.10.2 Handling machinery allocation

(1) **Handling machinery allocation at existing freight yard**

The cargo category of the existing freight yard is considered as packed goods. On the basis of making full use of the existing handling equipment, 19 new forklifts will be added.

(2) Handling machinery allocation at transshipment station

According to the cargo category and traffic volume at Rigachikun, Transshipment Station, allocation of main handling machinery in the near future is as follows table 3.30:

Table 3.30 Allocation of main handling machinery

S/N	Name of mechanical equipment	Qty.	Unit
1	Diesel forklift	2	Nr
2	Rail mounted container crane	1	Nr

Source: CCECC 2020

For the project of Asa transshipment station in the medium term, according to the cargo category and traffic volume at Asa transshipment station, allocation of main handling machinery is as follows:

Table 3.31 Allocation of main handling machinery

S/N	Name of mechanical equipment	Qty.	Unit
1	Diesel forklift	2	Nr
2	Gantry crane	1	Nr

3.10.3 Water supply system

This project will give priority to the use of existing water supply facility. If the existing water supply facility is not good for reuse purpose or the capacity of existing water supply facility is insufficient, new water supply facility will be added.

New water will be obtained from municipal water supply firstly, if without municipal water supply pipes, water will be obtained from well water. Well water is treated by integrated water purification facilities (including coagulation, sedimentation, filtration, disinfection and other treatment processes) to meet the requirements of domestic production and firefighting. The water quality, water pressure and water volume should meet the requirements of use.

Water will be required for the following activities:

- Water use by earthwork teams required for compaction during construction;
- Water use for dust suppression along service and access roads during construction;
- Water use for concrete production during construction; and
- Domestic Water use in the camp sites during construction phase and in the staff housing estate during operational phase.

The amount of surface water needed for the various construction activities over the project construction period, is estimated at 1,850,000 m^3. Over the operations period, water use is minimal, and will be limited primarily to domestic water use at the stations.

Water is sourced from the rivers traversed by the proposed railway alignment. Where surface water was not available or where quality was deemed inadequate, boreholes will be constructed.

The Contractors will acquire the necessary water use permit required for water abstraction prior to any abstraction.

Table 3.32a shows the potential targeted water sources along the route.

Rivers	Locations	Status
River	Rivers / Abia States	Perennial
Ekulu River	Emene, Enugu State	Perennial
River Benue	Benue State	Perennial
Mada River	Nasarawa State	Perennial
Gongola River	Bauchi State	Perennial

Source: PGM Fieldwork, 2020

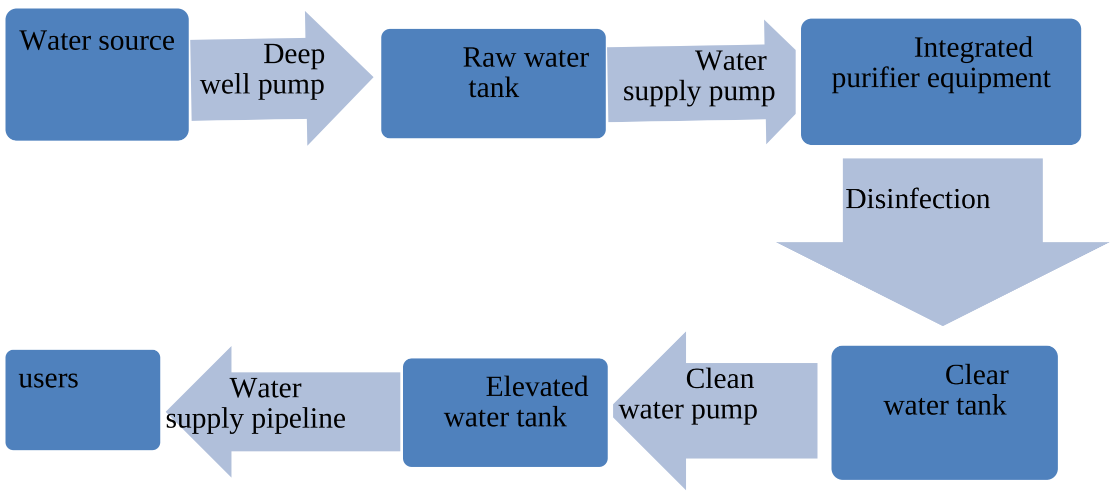


Fig 3.13 Water supply process Take Aba Station as an example

3.10.4 Waste-water management systems

The domestic sewage is collected by the pipeline system, and then pretreated by the septic tank, and then discharged into the domestic sewage treatment facility for treatment, to meet regulatory standards, prior to being discharged. The canteen domestic sewage is discharged after reaching the standard by being treated by grease trap.

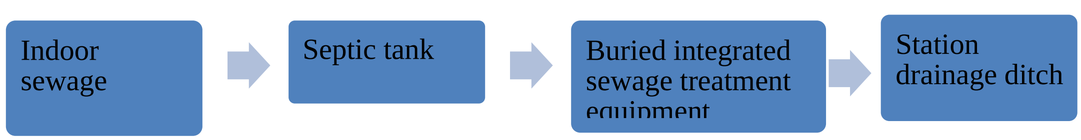


Fig 3.14 Sewage treatment process (Take Aba Station as an example)

3.10.5 Fire water supply system

This project will give priority to the use of existing fire protection facility. If the existing fire facility is not good for reuse purpose or the capacity of existing fire facility is insufficient, new fire facility will be added. All stations and sections shall be equipped with outdoor fire water supply system in accordance with the requirements of the code.

3.11 Communication

3.11.1 Design Principle of Communication System

Communication system shall be rehabilitated and reconstructed in line with the principles of using economic and practical products with proven technology that meet the digitization requirements.

The communication system mainly includes data communication system, telephone switching system, radio communication system, power supply, lightning protection and grounding system.

3.11.2 Communication Lines

The capacity and type of long-distance communication cables shall not only satisfy the need of transmission in short term, but also reserve sufficient margin for development in long term.

One $GYTA_{53}$ 24-core long-distance trunk optical cable is directly buried along one side of the railway.

$GYTA_{53}$ optical cables and $HYAT_{53}$ local electrical cables shall be laid in stations and yards according to user's demand.

3.11.3 Communication Network Composition and Main Communication Equipment

a. Data communication system

Data communication system mainly bears the service of IP soft switch system, and satisfies the transmission need of the whole line. Data communication system mainly consists of station routers, convergence routers, core routers and other equipment.

Data network access router and switch are equipped in the new communication cabinet of each station. Convergence router shall be equipped in the suitable station according to the station's operation status. Core router and data communication system network management equipment are equipped in Kafanchan communication station.

b. Telephone switching system

Telephone switching system mainly meet the requirement of voice communication along the whole line. Telephone switching system mainly consists of IP soft switch central equipment, station switches, IP telephones, and analogue phones, etc.

IP soft switch central equipment is equipped in Kafanchan communication station.

IP-PBX switch and access gateway are equipped in each station to build up the telephone switching system of this line. The station switches access to the soft switch central equipment through the channel provided by data network.

c. Radio communication system

Radio communication system is setup in each station to satisfy the need of radio communication within the station areas and realize the radio communication between drivers and station watchman near the stations.

Radio communication system mainly consists of station radio host equipment, antenna and feeder system and handsets. Radio station host equipment is setup in each station and handsets are equipped for station staff to complete the wireless communication in station. The radio communication system uses the existing work frequency band.

3.12 Information

3.12.1 Main Design Principles of Information System

The information system shall conform to the following design principles:

- Equipment which are widely used,
- readily available and easy to maintain shall be considered to meet the basic information needs.

3.12.2 Main Project Contents

3.12.2.1 Public Address System

Each passenger station is provided with new passenger public address system. The single station management mode is applied to realize the function of passengers' information broadcasting and announcement.

3.12.2.2 Tickeing System

New ticketing system is set up at Rigachikun station which is the junction station between this line and the Ibadan-Kano Railway. The system setting standards shall be consistent with Kaduna-Kano Railway.

Other stations shall maintain the existing model: tickets are printed in advance. Then dates are written on them for sale.

3.12.2.3 Power Supply System, Lightning Protection and Grounding System

The equipment of public address system shall be powered by the UPS designed by communication discipline.

Equipment grounding uses shared grounding system of the building, which means that the equipment integrated grounding, protective grounding, equipment lightnings protection grounding and building grounding share one set of grounding electrode.

3.13 Signal

Based on the existing situation, with the target of restoration and opening of the line, the existing signal equipment are repaired and replaced. All semaphore signals, switches transition devices with guide wheel and pipe installation shall be restored based on station layout of Port Harcourt-Maiduguri main line.

Existing block devices shall be restored and used again. The manually operated switches transition devices which were operated in non-centralized manner will be restored by station and yard discipline.

The standards for all new branch lines, Kafanchan-Rigachikun connecting line, Kuru-Jos branch line, and New Goniri-Gashua branch line will be consistent with the existing standards.

On the New Rigachikun transshipment station, the switches transition device with guide wheel and pipe installation shall be set separately for standard-gauge railway and narrow-gauge railway. The control handles of switches should be set centrally for the operation needs as a whole.

3.14 Power Supply

3.14.1 Design principles

The capacity of the existing substation is too small, and because it has not been maintained and repaired for a long time, most of the power equipment has been damaged and cannot be utilized. According to the principle of economic applicability and mature technology, the power equipment will be repaired and transformed.

3.14.2 Power supply scheme

The new substation shall be provided for each station along the railway. The power source of substation shall be led from the local power grid. A diesel generator room shall be set up at the station as the backup power after the power failure of the transformer.

The new substation or box-type substation shall be provided for locomotive turnround point, comprehensive maintenance work section, freight yard, etc. The power source of substation or box-type substation shall be led from the local power grid. The diesel generator room shall be set up in locomotive turnround point, comprehensive maintenance section, freight yard, etc. as a backup power supply after the power failure of transformer.

Nigeria counterpart shall be responsible for the external power supply works of the new substation or box-type substation in this project. When the parallel or crossing distance between all kinds of power lines and railway cannot meet requirements, Nigeria counterpart is responsible for the relocation of such power lines.

3.14.3 Main technical standard

- Cable laying shall be adopted for low-voltage lines. Copper core XLPE insulated steel tape armored PVC sheathed power cable shall be adopted for low-voltage cable.

- Compact switchgear shall be adopted for the ring main unit. Whole set low voltage switchgear shall be used for low voltage distribution cabinet. The SCB11 dry-type power transformer shall be adopted for the indoor transformer, Box-type substation shall be used in the place where the load is more concentrated.

- Throat area, freight yard, station yard and so on use projector tower or lamp post lighting. Passenger platform use lamp post lighting. Projector tower, lamp post, column lamp and so on are centrally controlled in indoor. Outdoor and indoor lighting sources all use LED lamp.

3.15 Building

3.15.1 Building and Structure

3.15.1.1 Scope of institution jurisdiction and staffing

(1) Scope of institution jurisdiction: This project falls within the jurisdiction of Nigerian Railways Corporation.

(2) Staffing: In this study, the staffing is made according to the operation needs of each discipline. A total of 2892 new staff are provided in this study.

3.15.1.2 Allocation of buildings

(1) Production (Fabrication) buildings: According to the existing conditions and requirements of each discipline as well as the needs of production and transportation, the production buildings shall be renovated or new production buildings shall be added.

(2) Passenger station building: According to the current situation of the station building, the station building shall be renovated or renovated and expanded. The station buildings which do not meet the structural safety requirement and cannot be renovated shall be demolished and new ones shall be built.

(3) Production ancillary buildings: according to existing conditions and the need of production process, the ancillary buildings shall be renovated or new building shall be added. Among them, the staff dormitory shall be considered in the new stations, depots and points. The staff dormitory shall be provided in accordance with 50% of the total new staff, with $18m^2$ per bed on average.

3.15.1.3 Preliminary opinion on station area planning and station building design, and construction standards for building

(1) Planning of station area

This considers the rehabilitation and renewal of the existing buildings of the Port Harcourt-Maiduguri main line, the Kafanchan-Rigachikun connecting line and the Kuru-Jos branch line. The size of the buildings remains unchanged. For new Goniri-Gashua branch line, new standard gauge connecting line of Rigachikun (excluded)-Rinji, new Rigachikun transshipment station of Kaduna branch line and their construction scale shall be determined according to the existing ones.

There are 104 stations on the existing eastern narrow gauge railway line from Port Harcourt to Maiduguri section, among which 61 stations shall be renovated. There are 14 stations on the Kafanchan (excluded) - Rigachikun railway line, among which 6 stations shall be renovated. There are 3 stations on existing Jos branch line, among which 2 stations shall be renovated. There are 4 new stations on new Gashua branch line.

The overall layout of the station building would conform to the urban master plan, the traffic network plan, and meet the requirements of the urban environmental protection and urban landscape. The station should be in harmony with the urban planning of area where it is located, and should become an integral part of current area. At the same time, due consideration should be given to long-term development, with room reserved for future development.

(2) Preliminary opinion on station building design

The existing stations will remain unchanged in terms of the scale and will be internally and externally renovated. The new station shall be built as per the scale of the existing station.

Station renovation or design of new building should consider protective measures against natural disasters such as fire, flooding, lightning strikes, and wind, etc. The layout of the station building should be compact with reasonable function division. It shall have convenient traffic and convenience for operation management and equipment arrangement. The station should have good ventilation, lighting, sanitation, disaster prevention and other conditions. Its decoration design and structural design should widely adopt economical and practical building materials that meet the requirements of fire protection, moisture protection, durability and easy maintenance.

The architectural style of the new station shall reasonably position its architectural image based on urban planning and landscape requirements.

(3) Description of building construction standards, structural types and decoration standards

The fire resistance rating and roof waterproofing grade of new buildings should meet local standards, and the reasonable service life of the buildings is 50 years.

For the building renovation, it shall consider the following. Part of existing structures shall be reinforced. The damaged color steel plate of roof shall be replaced. Ordinary decoration shall be adopted. The main buildings of the project are the renovated stations and new stations. The decoration standards should be appropriately raised. The high-grade paint or facing bricks shall be adopted for exterior wall; the medium-grade cement paint finish shall be adopted for interior wall; and damaged color steel plate of roof shall be replaced. The new general small-scale production and office buildings adopt frame structure and ordinary decoration.

(4) Principles for the treatment of foundations of main building along the line

According to specific geological conditions, strip foundation and independent foundation under the column should be adopted, and replacement with sand-gravel cushion or pile foundation should be adopted locally.

(5) Allocation of structures

For existing stations in this project, the repair for damaged structures such as platform surface, platform canopy and ground pavement and so on shall be considered. For the new structures, the platform surface, platform canopy, platform wall, ground pavement, greening and other structures shall be considered.

3.15.1.4 Total floor area of buildings

In this design, the total floor area of renovation building is 39920 m^2, and the total floor area of new buildings is 116041 m^2. For details, see in the table 3.33

3.15.1.5 Environmental protection measures

(1) The measures for noise elimination, sound insulation and shock absorbing should be taken in the equipment, pipelines and structures of the equipment rooms with noise hazard, such as boiler room and cooling water machine room.

(2) Environmentally-friendly building materials should be used.

(3) Green area of production area should be limited within 20%. Green area of living area should be not less than 30% of site area.

3.15.1.6 Energy-saving measures

In order to increase energy efficiency and improve indoor and outdoor thermal environment, under the conditions of guaranteeing building functions and satisfying requirements of indoor ambient temperatures and air quality, energy consumption of the buildings should be limited to the specified level by improving heat preservation and thermal insulation performance of enclosing structure of buildings, controlling the window-wall ratio, and other technical means.

Table 3.33 Building Area Table – Port Harcourt (AK0) (including) -Aba (PK63) (excluding)

S/N	Category	Station name	Area of each station (m^2)	Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger and freight station	Port Harcourt New	1500	1	1500	1200	300	It is estimated that 80% of the total area shall be for renovation and restoration area and 20% of the total area shall be demolished and reconstruction area. The area of each station includes the area of station buildings and ancillary buildings
2		Elelenwo	1500	1	1500	1200	300	
3	Passing station	Ubuzor	460	1	460	368	92	
4		Umugo	460	1	460	368	92	
5	Locomotive servicing point	Port Harcourt New	1030	1	1030		1030	
6	Locomotive turnaround depot	Elelenwo	4770	1	4770		4770	
7	Passenger train	Port Harcourt New	1960	1	1960		1960	

S/N	Category	Station name	Area of each station (m^2)	Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
	technical servicing post							
8	Incidental repair yard	Elelenwo	810	1	810		810	
9	Freight train inspection and servicing yard	Elelenwo	400	1	400		400	
	Total			9	12890	3136	9754	

Source: CCECC 2020

Table 3.34 Building Area: Aba (AK63) (including) -Kafanchan (AK737) (including)

S/N	Category	Station name	Area of each station (m^2)	Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger and freight station	Umuahia-Ibeku	1500	1	1500	1200	300	Estimate 80% of the total area for renovation and restoration area and estimate 20% of the total area for demolition and reconstruction area. The area of each station includes the area of station buildings and ancillary buildings
2		Enugu	1500	1	1500	1200	300	
3		Makurdi	1500	1	1500	1200	300	
4		Lafia	1500	1	1500	1200	300	
5		Aba	1500	1	1500	1200	300	
6	Passenger station	Nkpa	750	1	750	600	150	
7		Agbani	750	1	750	600	150	
8		Eha Amufu	750	1	750	600	150	
9		Oturkpo	750	1	750	600	150	
10		Gudi	750	1	750	600	150	
11		Jagindi	750	1	750	600	150	
12		Kafanchan	750	1	750	600	150	
13	Passing station	Umueze	460	1	460	368	92	
14		Ozara	460	1	460	368	92	
15		Eziator Quarry	460	1	460	368	92	
16		Nomeh	460	1	460	368	92	
17		Ogbaho	460	1	460	368	92	
18		Igbede	460	1	460	368	92	
19		Igunmale	460	1	460	368	92	
20		Utonkon	460	1	460	368	92	
21		Otobi	460	1	460	368	92	

S/N	Category	Station name	Area of each station (m^2)	Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
22		Taraku	460	1	460	368	92	
23		Kinga	460	1	460	368	92	
24		Moi-Igbo	460	1	460	368	92	
25		Agana	460	1	460	368	92	
26		Adeke	460	1	460	368	92	
27		Achakpa	460	1	460	368	92	
28		Udei	460	1	460	368	92	
29		Kaderko	460	1	460	368	92	
30		Agyaragu	460	1	460	368	92	
31		Barakin Abdullahi	460	1	460	368	92	
32		Langa Langa	460	1	460	368	92	
33		Moroa River	460	1	460	368	92	
34		Wasa	460	1	460	368	92	
35		Gerti	460	1	460	368	92	
36	Locomotive and rolling stock depot	Kafanchan		1	16130		16130	
37	Comprehensive maintenance depot	Kafanchan		1	4680		4680	
38		Enugu		1	4680		4680	
39	Comprehensive maintenance section	Eha Amufu		1	2470		2470	
40		Makurdi		1	2470		2470	
41		Lafia		1	2470		2470	
42		Gudi		1	2470		2470	
43		Aba		1	2470		2470	
44	Locomotive waiting track	Aba	40	1	40		40	
	Total			44	61210	18664	42546	

Source: CCECC 2020

Table 3.35 Building Area : Kafanchan(AK737) (excluding) - Kuru(AK803) (including)

S/N	Category	Station name	Area of each station (m^2)	Station Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger station	Manchok	750	1	750	600	150	

S/N	Category	Station name	Area of each station (m^2)	Station Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
2		Kuru	750	1	750	600	150	Estimate 80% of the total area for renovation and restoration area and estimate 20% of the total area for demolition and reconstruction area. The area of each station includes the area of station buildings and ancillary buildings
3	Comprehensive maintenance section	Kuru		1	2470		2470	
	Total			3	3970	1200	2770	

Source: CCECC 2020

Table 3.36 Building Area ：Kuru(AK803) (excluding) - Maiduguri(AK1443) (including)

S/N	Category	Station name	Area of each station (m^2)	Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger and freight station	Bauchi	1500	1	1650	1320	330	Estimate 80% of the total area for renovation and restoration area and estimate 20% of the total area for demolition and reconstruction area. The area of each station includes the area of station buildings and ancillary buildings
2		Gombe	1500	1	1650	1320	330	
3		Maiduguri	1500	1	1650	1320	330	
4	Passenger station	Tafawa Balewa	750	1	750	600	150	
5		Alkalere	750	1	750	600	150	
6		Bajoga	750	1	750	600	150	
7		Goniri	750	1	750	600	150	
8	Passing station	Bakin Kogi	450	1	450	360	90	
9		Zongo	450	1	450	360	90	
10		Liman Katagum	450	1	450	360	90	
11		Dindimaj	450	1	450	360	90	
12		Bundu Faruku	450	1	450	360	90	
13		Zongoma	450	1	450	360	90	
14		Bomala	450	1	450	360	90	
15		Daba Fulani	450	1	450	360	90	
16		Tongo	450	1	450	360	90	
17		Gabai	450	1	450	360	90	

S/N	Category	Station name	Area of each station (m^2)	Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
18		Buni/Jiri	450	1	450	360	90	
19		Borgozo	450	1	450	360	90	
20		Duwari	450	1	450	360	90	
21	Locomotive return point	Maiduguri		1	1700		1700	
22	Passenger trainset stabling siding	Maiduguri		1	318		318	
23	Incidental repair yard	Maiduguri		1	810		810	
24	Comprehensive maintenance depot	Maiduguri		1	4680		4680	
25	Freight train inspection and servicing yard	Maiduguri		1	400		400	
26	Comprehensive maintenance section	Tafawa Balewa		1	2470		2470	
27		Alkalere		1	2470		2470	
28		Gombe		1	2470		2470	
29		Bajoga		1	2470		2470	
	Total			29	31588	11040	20548	

Source: CCECC 2020

Table 3.37 Building Area: Kafanchan(LAK0) (excluding) -Rigachikun(LAK200) (excluding)

S/N	Category	Station name	Area of each station (m^2)	Station Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger and freight station	Kaduna Junction	1500	1	1500	1200	300	Estimate 80% of the total area for renovation and restoration area and estimate 20% of the total area for demolition and reconstruction area. The area of each station includes the area of station buildings and ancillary buildings
2	Passenger station	Zonkwa	750	1	750	600	150	
3	Passing station	Kurmin Biri	450	1	450	360	90	
4		Kutura	450	1	450	360	90	
5		Kankomi	450	1	450	360	90	
6	Comprehensive maintenance section	Kaduna Junction		1	2470		2470	
7		Zonkwa		1	2470		2470	
	Total			7	8540	2880	5660	

Source: CCECC 2020

Table 3.38 Building Area: Kuru (ZAK0) (excluding) -Jos (ZAK35) (including)

S/N	Category	Station name	Area of each station (m^2)	Station Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger and freight station	Jos	1500	1	1500	1200	300	Estimate 80% of the total area for renovation and restoration area and estimate 20% of the total area for demolition and reconstruction area. The area of each station includes the area of station buildings and ancillary buildings
2	Passenger station	Bukuru	750	1	750	600	150	
3	Passenger trainset stabling siding	Jos		1	318		318	
4	Locomotive waiting track		40	1	40		40	
	Total			4	2608	1800	808	

Source: CCECC 2020

Table 3.39 Building Area: Buni (XAK0) (excluding) -Gashua (XAK216) (including)

S/N	Category	Station name	Area of each station (m^2)	Station Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger and freight station	Gashua	1500	1	1500		1500	
2	Passenger station	Damaturu	750	1	750		750	
3	Passing station	Lantewa	450	1	450		450	
		Baiomari	450	1	450		450	
4	Locomotive return point	Gashua		1	1700		1700	
5	Passenger trainset stabling siding	Gashua		1	318		318	
6	Comprehensive maintenance section	Gashua		1	2470		2470	
7	Comprehensive maintenance section	Damaturu		1	2470		2470	
	Total			8	10108		10108	

Source: CCECC 2020

Table 3.39 Building Area: Rigachikun (LBK0) (including)

S/N	Category	Station name	Area of each station (m^2)	Station Number	Area subtotal (m^2)	Renovation and restoration area (m^2)	Newly built area (m^2)	Remark
1	Passenger and freight station	Rigachikun	1500	1	1500	1200	300	Estimated 80% of the reconstruction and repair quantity and estimated 20% of the demolition and reconstruction quantity, the area of each station includes the area of station buildings and attached houses
2	Warehouse	Rigachikun	2875	1	2875		2875	
3	Locomotive return point	Rigachikun		1	1700		1700	
4	Passenger trainset stabling siding	Rigachikun		1	318		318	
5	freight car inspection post at loading yard	Rigachikun		1	224		224	
	Total			5	6617	1200	5417	

Source: CCECC 2020

3.16 Waste Management

3.16.1 Waste Streams and Management at Site

The Contractors will subcontract a licensed and reputable waste management company for the collection, transport and disposal of waste produced across the four phases of the project (Pre-construction, Construction, Operation and Decommissioning/Abandonment Phases).

Wastes Generated shall be segregated and collected at the temporary waste collection areas (WCA), with separate storage segments for prime recyclables (scrap metals, tyres, plastic, wooden material), and separate segment for other hazardous waste including waste oils, oil filters, etc. Special care is taken to ensure that liquid wastes are kept in a segment with secondary containment of 110% capacity.

Proper waste segregation will be maintained at all times. Environmental labelling including visual communication elements shall be applied to the area/ on the containers where appropriate.

Table 3.40 shows the waste streams, sources and end use for all waste anticipated during the pre-construction demolition phase.

Table 3.40 Waste streams, Quantities and Management during pre-construction demolition phase

Waste type	Quantity	Source, Character and Management
Medical Wastes	1-2 kg/day	All medical wastes are treated as hazardous waste, collected, transported and removed separately from domestic wastes. Medical wastes are collected in specially coded containers in the clinic and also, they are stored in designated area in a safe place. Approved medical disposal waste form is stored by HSE department and clinic
Recyclable Wastes (Paper, Cardboard, Metallic Scraps from abandoned wagons, coaches, metallic sleeper, etc)	80-100tons per month	Paper and card waste from train stations, offices and domestic type sources are segregated, if practicable and sent for recycling by third party contractor. Separately collected recyclable wastes are taken to the WCA and be ready for transfer to recyclers. Recyclable wastes mainly resulting from 1st phase decommissioning (metal scraps from coaches, wagons, metallic sleepers etc) are collected in designated areas and transferred to the WCAs. Recyclable wastes are stored in WCA until taken by third party subcontractors.
Domestic Sewage	10 m^3/day of sewage based on per capita consumption of 80 litres/day, 80% becomes waste	This includes wastes from the bathrooms, toilets etc. This waste is collected and treated in the wastewater treatment plants.

Source: PGM Fieldwork, 2020

Table 3.41 shows the waste streams, sources and end use for all waste anticipated during the construction phase.

Table 3.41 Waste streams, Quantities and Management during Construction Phase

Waste type	Quantity	Source	Character	Management
Medical Wastes	8-10 kg/day	All six camps have clinics which produce medical wastes.	All medical wastes are treated as hazardous waste,	Collected, transported and removed separately from domestic wastes. Medical wastes are collected in specially coded containers in the clinic and also, they are stored in designated area

Waste type	Quantity	Source	Character	Management
				in a safe place. Approved medical disposal waste form is stored by HSE department and clinic
Domestic Wastes (Solid wastes)	0.45 tons of Solid Wastes based on generation rate of 0.3 kg/day	camp areas.	MSW	Domestic solid waste from the personnel is collected in closed containers located at various points. Domestic solid waste generated in construction sites is transferred to main camp areas daily basis by site responsible. These solid wastes are collected in containers and at certain intervals are transported to the nearest authorized dumps site.
Domestic Sewage	96 m^3/day of sewage based on per capita consumption of 80 litres/day, 80% becomes waste	This includes wastes from the bathrooms, toilets etc.	Sewage	This waste is collected and treated in the wastewater treatment plant at the camp sites.
Waste Oils	4- 7 m^3 per Month	The maintenance process of the project vehicles is carried out within the facilities located in camp areas.	Hazardous	Waste oil is collected in a closed temporary waste storage area with leak-proof floor and covered with a shelter constructed nearest location to the maintenance facility and/or also in WCA. The oil collected is given to a licensed waste oil recovery company. Also, waste vegetative occurs in the cafeterias of the camp sites. These wastes are collected and stored separate from other wastes and stored in segregated segment in WCA till disposal by third party. These segments differ from others with a structure (secondary containment) to avoid spilling and leakage, soil pollution accordingly.

Waste type	Quantity	Source	Character	Management
Batteries, Accumulators, Tonners, Cartridges	800-1000 batteries per year	Waste batteries are stored in collection points located in office areas and are delivered to third party subcontractors. Waste accumulators (vehicle batteries) are stored in the temporary storage areas (WCA) until final disposal. Toners and cartridges are stored in separated bins in WCAs by IT team.		
Filters	1,000-1,250 per month	The maintenance process of the vehicles to be used during Project phases will be carried within the facilities located in camp areas.		Waste oil filters are collected in waste bins with secondary containment and transferred to the WCA for final disposal by third party sub-contractor. Air filters also are collected in waste air filter bins and then transferred to the WCA for final disposal by third party sub-contractor.
Recyclable Wastes (Paper, Cardboard, Metallic Scraps from abandoned wagons, coaches, metallic sleeper, etc)	10-30tons per month	Paper and card waste from train stations, offices and domestic type sources are		segregated, if practicable and sent for recycling by third party contractor. Separately collected recyclable wastes are taken to the WCA and be ready for transfer to recyclers. Recyclable wastes mainly resulting from preconstruction demolition (metal scraps from coaches, wagons, metallic sleepers etc) are collected in designated areas and transferred to the WCAs. Recyclable wastes are stored in WCA until taken by third party subcontractors.
Concrete Debris	0.8-1ton per week	Waste concrete debris is stored in designated areas temporarily and used as filling material during alignment		

Waste type	Quantity	Source	Character	Management
		works.		
Spoil Soil	5,268,000 m^3	This unwanted soil, which does not have good bearing capacity, shall be removed from the footprint of the railway. The spoil soil is dumped in dumping areas located along the Project sites.		
Wastewater from Concrete Batching Plants	10 -20m^3 per month	Concrete wash out pits is used to allow sediments to settle and water will be re-used for dust control activities. If water is not able to re-use, acidic chemicals is added to balance pH into the range for discharge standards and will be discharged to the environment. Daily pH Control shall be undertaken to ensure compliance to discharge standards.		

Source: PGM fieldwork, 2020

Table 3.42 shows the waste streams, sources and end use for all waste anticipated during the operation phase.

Table 3.42 Waste streams, Quantities and Management during Operation Phase

Waste type	Quantity	Source	Character	Management
Medical Wastes	80-100 kg/day	104 Stations have clinics which produce medical wastes.	All medical wastes are treated as hazardous waste,	Collected, transported and removed separately from domestic wastes. Medical wastes are collected in specially coded containers in the clinic and also, they are stored in designated area in a safe place. Approved medical disposal waste form is stored by HSE department and clinic

Waste type	Quantity	Source	Character	Management
Domestic Wastes (Solid wastes)	290 tons of Solid Wastes based on generation rate of 2 tons/day	Railway stations.	MSW	Domestic solid waste from the personnel is collected in closed containers located at various points. Domestic solid waste generated in construction sites is transferred to main camp areas daily basis by site responsible. These solid wastes are collected in containers and at certain intervals are transported to the nearest authorized dumps site.
Domestic Sewage	$900m^3$/day of sewage based on per capita consumption of 50 litres/day, 80% becomes waste	This includes wastes from the bathrooms, toilets etc.	Sewage	This waste is collected and treated in the wastewater treatment plant at the camp sites.
Waste Oils	4- 7 m^3 per Month	The maintenance process of the project vehicles is carried out within the facilities located in camp areas.	Hazardous	Waste oil is collected in a closed temporary waste storage area with leak-proof floor and covered with a shelter constructed nearest location to the maintenance facility and/or also in WCA. The oil collected is given to a licensed waste oil recovery company. Also, waste vegetative occurs in the cafeterias of the camp sites. These wastes are collected and stored separate from other wastes and stored in segregated segment in WCA till disposal by third party. These segments differ from others with a structure (secondary containment) to avoid spilling and leakage, soil pollution accordingly.

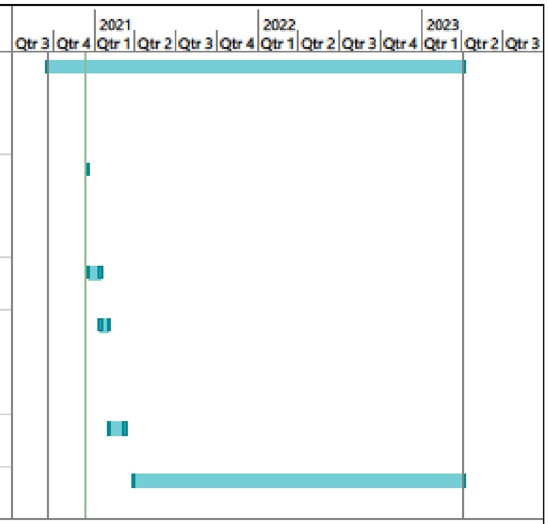
Waste type	Quantity	Source	Character	Management
Batteries, Accumulators, Tonners, Cartridges	800-1000 batteries per year	Waste batteries are stored in collection points located in office areas and are delivered to third party subcontractors. Waste accumulators (vehicle batteries) are stored in the temporary storage areas (WCA) until final disposal. Toners and cartridges are stored in separated bins in WCAs by IT team.		
Filters	1,000-1,250 per month	The maintenance process of the vehicles to be used during Project phases will be carried within the facilities located in camp areas.		Waste oil filters are collected in waste bins with secondary containment and transferred to the WCA for final disposal by third party sub-contractor. Air filters also are collected in waste air filter bins and then transferred to the WCA for final disposal by third party sub-contractor.
Recyclable Wastes (Paper, Cardboard, Metallic Scraps from abandoned wagons, coaches, metallic sleeper, etc)	10-30tons per month	Paper and card waste from train stations, offices and domestic type sources are		segregated, if practicable and sent for recycling by third party contractor. Separately collected recyclable wastes are taken to the WCA and be ready for transfer to recyclers. Recyclable wastes mainly resulting from preconstruction demolition (metal scraps from coaches, wagons, metallic sleepers etc) are collected in designated areas and transferred to the WCAs. Recyclable wastes are stored in WCA until taken by third party subcontractors.

Source: PGM fieldwork, 2020

3.17 Construction Period

According to the track alignment, key controlling works, track-laying scheme of this railway line, etc., the total construction period of this project is considered to be 3 years.

ID		Task Mode	Task Name	Duration	Start	Finish
1			Schedule for the ESIA of the proposed Rehabilitation of the Eastern Rail line	665 days	Fri 9/18/20	Thu 4/6/23
2			Draft Report	2 days	Wed 12/16/20	Thu 12/17/20
3			Technical Review by FMEnv	21 days	Sat 12/19/20	Fri 1/15/21
4			Final Report	12 days	Sat 1/16/21	Mon 2/1/21
5			EIA Approval by FMEnv	26 days	Wed 2/3/21	Wed 3/10/21
6			Rehabilitation of the Eastern railway	527 days	Wed 3/31/21	Thu 4/6/23



Project: Rehabilitation of the Ea
Date: Mon 12/14/20

Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
Milestone	Duration-only	Deadline
Summary	Manual Summary Rollup	Progress
Project Summary	Manual Summary	Manual Progress
Inactive Task	Start-only	
Inactive Milestone	Finish-only	

Page 1

Figure 3.15 Project Schedule will be here

CHAPTER 4

DESCRIPTION OF EXISTING ENVIRONMENT

4.1 General

The prevailing ecological conditions of the environment within which the railway project is sited, as well as the socio-economic and health profiles of the affected settlements are presented in this chapter.

Components described include the physico-chemical environment (meteorology, geology, sediment/soil type and distribution, surface/groundwater characteristics), biological environment (location and distribution of benthos, plankton, fisheries flora and fauna characteristics), as well as socio-economic and health conditions describing the demographic structure, culture, heritage sites, social and health status of the people and their environment, including outcomes of consultations held.

The summary of baseline conditions is based on information sourced from literatures (see relevant sections) as well as findings from a one season field sampling program supplemented by approved secondary data, laboratory analyses of samples obtained and socio-economic and health surveys specific to this ESIA. The data acquired will be used in further environmental management decisions and future monitoring of changes, if any, in the environmental components.

4.2 Scope of Study

Field studies and data collection for characterization of the baseline conditions of the project environment covered, in line with the TOR approved by the FMEnv.:

Climate and meteorology;

Air quality and noise levels;

Geology/hydrogeology;

Surface and ground water;

Soil and sediment;

vegetation & fauna wildlife;

Hydrobiology, fisheries; and

Socio economics/health impact, demography and community characteristics.

4.2.1 Baseline Data Acquisition Methods

The acquisition of data basically involved field data gathering, measurements and the collection of representative samples used to establish the environmental conditions of the study area.

This exercise involved a multi-disciplinary approach and was executed within the framework of a QHSE Management System approach. This approach assured that the required data and samples were collected in accordance with agreed requirements (scientific and regulatory) using the best available equipment, materials and personnel. Elements of this approach include:

review of existing reports that contain environmental information on the study area;

designing and development of field sampling strategies to meet work scope and regulatory requirements;

pre-mobilization activities (assembling of field team, sampling equipment/materials calibrations/checks, review of work plan and schedule with team, and job hazard analysis);

mobilization to field;

fieldwork implementation - sample collection (including positioning and field observations), handling, documentation and storage protocols and procedures;

Demobilization from field; and

transfer of sample custody to the laboratory for analyses.

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

4.2.2 Desktop Studies

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

4.2.3 Field Sampling/Measurement

In order to effectively establish the environmental characteristics of study area, a one season field data gathering exercise (as approved by FMEnv, refer to scoping report) was performed between 9th through 21th November, 2020. The specific objectives of the ecological field sampling were to:

i. determine the ambient air quality and noise level of the study area;

ii. determine the physico-chemical and microbiological characteristics of the soil within the study area;

iii. determine the physico-chemical and biological characterization of water and sediment samples within the study area;

iv. determine the hydrobiology and fisheries resources of the study area;

v. determine contemporary wildlife abundance and diversity of the study area and environs;

vi. determine the vegetation characteristics of the area; and

vii. establish the socio-economic and health status of the host and impacted communities.

Surface water was collected as appropriate (see Table 4.26 and Figure 4.29 for sampling locations). The exercise involved in situ measurement of salinity, temperature, turbidity, pH, dissolved oxygen and conductivity. Samples were taken at defined sample points using bottle sampler for water quality determinants. These were stored and preserved as appropriate for each analysis. Water samples were collected for laboratory analyses using

2-litre plastic bottle for water samples for physicochemical analysis;

2-litre plastic bottle for water samples for heavy metal analysis;

1-litre plastic bottle for water samples for microbiological analysis; and

1-litre glass bottle with Teflon seal cap for water samples to be analysed for hydrocarbon content (oil and grease, etc.).

All water samples were preserved in cool boxes for onward transmission to Akwa Ibom State Ministry of Environment/Science and Technology laboratory.

The Eckman grab was deployed in the collection of sediment samples from twelve (16) stations. The grab is made up of stainless steel that consists of two jaws that automatically close when it is lowered onto the river bed. On reaching the bottom of the river, sediment is trapped in the jaws and is gradually pulled back to the surface. A single grab bite was collected per station. The surface of sediment (1 - 2cm) were collected in a stainless-steel basin and homogenized for the analysis of physico-chemical parameters and Total Hydrocarbon Content (THC).

The residual sediment was washed for benthos and collected in a plastic container, while any residual sediment was thrown back into the river. Samples for physico-chemical analyses were collected in polythene bags and stored for analysis. In-situ measurements such as pH, and temperature were carried out on sediment samples. The sediment samples for microbial analyses were collected in sterile plastic containers and stored in coolers containing ice block. After each sampling, the grab samplers were washed thoroughly to remove any adhering particles from previous sampling.

Soil samples were collected with hand auger at two depth intervals (0-15cm and 15-30cm). These samples were preserved in plastic bags and stored in coolers.

4.2.4 Spatial Boundary and Size

A 500m wide spatial boundary from each side of the railway Right of Way (RoW) was taken as the spatial boundary for the study. The spatial boundary is therefore 1 km from the RoW.

4.3 Field Study & Sampling Design

Sampling was designed to comprehensively capture all the ecological and socio-economic components peculiar to the study area. The coverage of various environmental attributes considered recipients and sensitivity of impacted areas. Design of field activities was made prior to mobilization. This was aided by information obtained during reconnaissance survey of the project area.

Sampling locations were decided as waypoints in Geographic Position System (GPS) and later plotted in a sampling map used during the field studies. Locations for biophysical sampling considered ecological types around the project areas, vulnerable environmental attributes with regards to the potential and associated impacts of the environment and control or buffer zones.

Socio economic and health impact studies on the other hand, considered human habitations, infrastructure, cultural heritage sites and prevailing health conditions of people within the sphere of influence to the project area. Table 4.2 presents an inventory of the biophysical and socioeconomics/health details collected during field studies. The spatial location maps of the sampled points are presented in the respective component sections.

Table 4.2 Inventory of Biophysical and Social Samples

SN.	Environmental Component	Parameter/Details	No. of Samples approved by FMEnv in the scoping report	Actual No. of Samples Collected
1	Soil samples	Soil type, grain size, Total organic matter, soil microbiology, soil colour, texture, porosity, bulk density and permeability.	Upto 25 samples and control	28 soil sample + 7 controls
2	Surface water	PH, temperature, salinity, conductivity, biological and chemical Oxygen demand, carbon oxygen demand, Turbidity, dissolved and suspended solids, hydrocarbons, oil and grease, heavy metals and nutrients	Upstream and downstream, in 12 rivers	Upstream and downstream in 12 surface water samples + 4 contols

SN.	Environmental Component	Parameter/Details	No. of Samples approved by FMEnv in the scoping report	Actual No. of Samples Collected
3	Groundwater	depth to and thickness, hydraulics, recharge, colour, PH and temperature, Salinity and conductivity, Hardness, Heavy metals (Cu, Pb, Fe, K, Ba), Phosphate, SO_4, NO_3, Biological and chemical oxygen demand (BOD and COD), Carbon oxygen demand, Turbidity, Dissolved and suspended solids, Total hydrocarbons (THC), Oil and grease (mineral and FOG), VOC and SVOC including BTEX, Nutrients microbiology	Upto 12 samples and control	15 groundwater samples + 5 controls
4	Ambient Air	Carbon oxides; Sulphur oxides; Nitrogen oxides; Volatile organic compounds (VOC); Oxygen (O_2); Hydrogen sulphide (H_2S); Particulate matter (PM); and Combustible gas.		50 air samples + 8 controls
5	Noise	Acoustical measurements using a Type I or Type II integrating sound level meter will be taken. All measurements will be taken in decibels (dB). The continuous attended noise measurements will record continuous equivalent sound measurements (LAmax, LAmin, LA1, LA5, LA10, LA50, LA90, LA95, LA99) at each of the sampling points.		50 noise samples + 8 controls
6	Fauna and Flora	Fauna and flora including:		

SN.	Environmental Component	Parameter/Details	No. of Samples approved by FMEnv in the scoping report	Actual No. of Samples Collected
		• Freshwater ecology (including plankton and fish); • Wildlife • Birds; and Vegetation		

4.3.1 Analytical Methods

Samples collected from the field were analysed in Akwa Ibom State Ministry of Science and Technology laboratory using the various methods shown in Table 4.3. Also shown on the table are the equipment detection limits for the different parameters analysed.

Table 4.3 Laboratory Analytical Methods

Parameters	Methods	Detection Limits
Ground Water Samples		
Temperature (°C)	APHA 2110B	-
pH	APHA 4500H^+B	-
Turbidity (NTU)	APHA 2130B	1.0
Salinity (mg/l)	APHA 2520B	0.01
TSS (mg/l)	APHA 2540D	1
TDS (mg/l)	APHA 2510A	-
Conductivity (µS/cm)	APHA 2510A	-
THC (mg/l)	ASTM D3921	1.0
DO (mg/l)	APHA 4500-O G	-
BOD (mg/l)	APHA 5210A	0.5
COD (mg/l)	APHA 5220D	0.8
Reactive Silica (mg/l)	APHA 4500-SiO_2	0.1
Nitrate (mg/l)	EPA 352.1	0.02
Phosphate (mg/l)	APHA4500-P D	0.002
Ammonium (mg/l)	APHA 4500-NH_3	0.02
Calcium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Magnesium (mg/l)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Sodium (mg/l)	APHA 3111B/ASTM D3561	0.1
Lead (mg/l)	APHA 3111B	0.20
Total Iron (mg/l)	APHA 3111B	0.05
Copper (mg/l)	APHA 3111B	0.05
Polychlorinated biphenyls (PCBs)	EPA8082A	0.1
Zinc (mg/l)	APHA 3111B	0.05
Manganese (mg/l)	APHA 3111B	0.10

Parameters	Methods	Detection Limits
Cadmium (mg/l)	APHA 3111B	0.02
Total Chromium (mg/l)	APHA 3111B	0.10
Mercury (mg/l)	APHA 3112B	0.0002
Arsenic (mg/l)	APHA 3030B/3114B	0.001
Soil samples		
pH (H_2O)	ASTM D4972	-
TOC/TOM (mg/kg)	BS 1377	-
Conductivity (mg/kg)	APHA 2510B	-
THC (mg/kg)	ASTM D3921	10.0
Nitrate (mg/kg)	EPA 352.1	0.02
Phosphate (mg/kg)	APHA 4500-P D/CAEM	0.002
Sulphate (mg/kg)	EPA 9038	1.0
PSD (mg/kg)	ASTM D422	-
Calcium (mg/kg)	APHA 3111D	0.1
Magnesium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Sodium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Zinc (mg/kg)	ASTM D5198/APHA 3111B	0.05
Lead (mg/kg)	ASTM D3111B /D5198	0.20
Mercury (mg/kg)	APHA 3112B/ASTM D 326 + 5033	0.0002
Arsenic (mg/kg)	APHA 3030F/3114B	0.001
Total Iron (mg/kg)	APHA 3111B/ASTM D5198	0.05
Copper (mg/kg)	APHA 3111B/ASTM D5198	0.05
Cadmium (mg/kg)	APHA 3111D/ASTM D5198	0.02
Polychlorinated biphenyls (PCBs)	EPA 9078	0.5
Total Chromium (mg/kg)	APHA 3111B/ASTM D5198	0.10

Source: Akwa Ibom State Ministry of Science and Technology Laboratory

4.3.2 Study Team

Field studies, analyses and report writing were undertaken by a multidisciplinary team from Resourcefield Limited. The key experts involved in this study include ecologists (flora and fauna), engineers, air quality specialists, waste experts, Geologist, soil experts and socio-economic experts. The full team list, their qualifications and designation are as shown in the List of ESIA preparers.

4.4 Biophysical Sample Collection

4.4.1 Meterological Data Acquisition

The existing meteorological and climatic data from PortHarcourt and Maiduguri meteorological stations will be used for the write-up. The measurements of the meteorological parameters were carried out using in situ portable pieces of equipment as shown in table 4.4. However, 58 field data were collected for atmospheric pressure, relative humidity, temperature, wind speed and wind direction.

Table 4.4: Meteorological Instruments

Parameter	Equipment
Atmospheric pressure, Relative humidity, Temperature	Multipurpose Hygro, Baro and Thermo (Hygro 20-100%, Thermo 10-50ºC, Baro 740-777mmHg Model:- Baro, Germany
Wind speed	Portable wind vane Model:- Deuta Anemo Wind speed indicator (0-35m/s)
Wind direction	Digital compass

Source: PGM Fieldwork 2020

4.4.2 Gaseous Emission Data Acquisition

Concentrations of air pollutants were measured at 58 locations. Highly sensitive digital portable meters were used for the measurement of NO_2, SO_2, H_2S, HCN, CH_4, NH_3 Cl_2, CO, CO_2, $PM_{2.5}$, PM_{10}, TVOC and CH_2O. The portable meters used in the measurement of gaseous pollutants are presented in table 4.5

Plate 4.1: Pictures of some in-situ digital meters used to measure ambient air conditions

Table 4.5: Gaseous Emissions and Noise Measuring Instruments

Parameter	Equipment	Range	Alarm levels
Sulphur dioxide (SO_2)	SO_2 Crowcon Gasman S/N: 19648H	0-10ppm	2.0ppm
Nitrogen dioxide (NO_2)	NO_2 Crowcon Gasman S/N: 19831N	0-10ppm	3.0ppm
Hydrogen sulphide (H_2S)	H_2S Crowcon Gasman S/N: 19502H	0-50ppm	10ppm
Carbon monoxide (CO)	CO Crowcon Gasman S/N: 19252H	0-500ppm	50ppm
Ammonia (NH_3)	NH_3 Crowcon Gasman S/N: 19730H	0-50ppm	25ppm
Chlorine (Cl_2)	Cl_2 Crowcon Gasman S/N: 19812H	0-5ppm	0.5ppm
Hydrogen Cyanide (HCN)	HCN Crowcon Gasman S/N: 19773H	0-25ppm	5ppm
Methane (CH_4)	XP-3160	0-5,000 ppm	250 or 500 ppm
Suspended particulate monitor (SPM)	Haz-Dust TM 10µg/m^3 particulate monitor	0.1-200 10µg/m^3	+1-0.0210µg/m^3
Noise Level Meter	NM 102	Auto Ranging(30-130dB)	-

Source: PGM Fieldwork 2020 Unit for gaseous pollutants is ppm.

Table 4.6: Methods for sampling of air pollutants

Method No.	Parameter measured	Method
TM-4	Sulfur dioxide (SO_2)	USEPA (2000) Method 6 or 6A or 6B or USEPA (1996) Method 6C or ISO (1989) Method 7934 or ISO (1992) Method 7935 or ISO (1993) Method 10396 or ISO (1998) Method 11632 (as appropriate)
TM-5	Hydrogen sulfide (H_2S)	USEPA (2000) Method 11 or USEPA (2000) Method 15 or USEPA (2000) Method 16 or Environment Canada (1992) Reference Method EPS1/RM/6 (as appropriate)
TM-7	Chlorine (Cl_2)	USEPA (2000) 26A
TM-11	Nitrogen dioxide (NO_2)	USEPA (2000) Method 7 or 7A or 7B or 7C or 7D or USEPA (1990) Method 7E or USEPA (1996) Method 20 or ISO (1993) Method 10396 (as appropriate). NOx analyzers may be substituted in Method 7E provided the performance specifications of the method are met.
TM-32	Carbon monoxide (CO)	USEPA (1996) Method 10
TM-34	Volatile organic compounds (VOC)	USEPA (2000) Method 18 or USEPA (2000) Method 25 or 25A or 25B or 25C or 25D or 25E (as appropriate)
OM-5	'Fine' particulates ($PM_{2.5}$)	USEPA (1997) Method 201 or 201A (as appropriate)
AM-22	Particulate matter – PM_{10} – TEOM	AS 3580.9.8-2001
OTM-29	Hydrogen cyanide (HCN)	US EPA, Method OTM-29
Method 323	Formaldehyde	US EPA, 40 CFR Part 63, Method 323

Source: PGM Fieldwork 2020

Table 4.7: Methods for measuring field meteorological parameter

Element	Unit	Measuring Instrument
Temperature	Degree Celsius (°C)	Thermometer
Relative humidity	%	Hygrometer
Atmospheric pressure	hectopascal (hPa)	Barometer
Wind speed	m/s	Anemometer
Wind direction	deg. clockwise from North	Digital Barometer

Source: PGM Fieldwork 2020

Plate 4.2: Pictures of some in-situ digital meters used to measure ambient air conditions

Measurements were conducted between 08:00 and 19:00hrs Nigerian time, for air measurements. Specific locations for measurements were selected with consideration for concentrations of human receptors such as residential areas, commercial areas, hospitals, churches, schools, and farmlands.

4.4.3 Precaution/Quality Assurance/Quality Control

In marking sampling location (table 4.8), special preference was given to the following:

- Accessibility
- Availability of open space with good configuration free from shed
- Meteorological consideration of upward and downward directions
- Areas with minimal local influence from vehicular moment.
- In sampling, consideration was given to: Sensitivity and stability of equipment used
- Re-calibration of equipment
- Reproducibility of results.

Table 4.8: Air/Noise Sampling Cordinated

Sample Code	Description of the Location	Northing	Easting	Elevation
AQ_1	Rumuibekwe Road by Woji Railway Junction	4º50’15.2”	007º02’53.1”	19
AQ_2	Trans-Amadi Industrial Layout	4º49’47.0”	007º02’12.4”	15
AQ_3	Elekahia Estate Road, PortHarcourt	4º49’07.7”	007º01’48.6”	18
AQ_4	Ikwerre Road, PortHarcourt	4º47’14.8”	007º00’12.0”	2
AQ_5	PortHarcourt Railway Terminal	4º45’58.0”	007º00’58.6”	15
AQ_6	Umuawa-Ngu Road, Bende LGA, Abia State	5º38’16.8”	007º33’22.0”	279
AQ_7	Umuahia North Main Station	5º31’51.0”	007º29’30.8”	151
$AQControl_8$	Aba Halt Station by Assembly of God Church, Ogbonna Road, Aba	5º06’39.2”	007º22’13.5”	14
AQ_9	Ishiagu Rail Station, Ebonyi State	5º56’22.5”	007º32’26.6”	68
AQ_{10}	Amaonye Ishiagu, Ebonyi State	5º56’21.8”	007º32’53.0”	71
AQ_{11}	Ndeaobor Junction, Enugu State	6º01’29.7”	007º33’43.1”	58
AQ_{12}	Agbani Junction, Enugu State	6º18’56.5”	007º32’22.5”	13.7
AQ_{13}	Ikeulu River Emene, Enugu State	6º28’35.2”	007º34’44.2”	126
AQ_{14}	Ikeulu Junction, Enugu State	6º28’35.3”	007º34’43.5”	141

Sample Code	Description of the Location	Northing	Easting	Elevation
AQ$_{15}$	Eha-Amufu Train Junction, Enugu State	6°39’16.4”	007°45’51.8”	109
AQ$_{16}$	Otukpo Train Junction, Benue State	7°12’06.1”	008°09’00.1”	196
AQControl$_{17}$	International Learning Spring School, Otukpo, Benue State	7°12’02.2”	008°09’02.3”	201
AQ$_{18}$	Rail Camp Otukpo, Benue State	7°12’09.1”	008°09’02.6”	192
AQ$_{19}$	Taraku Train Camp, Benue State	7°15’30.1”	008°15’23.5”	105
AQ$_{20}$	Taraku Train Junction, Benue State	7°15’30.4”	008°15’26.5”	110
AQ$_{21}$	LGEA Primary School, Taraku, Benue State	7°15’26.1”	008°15’26.0”	94
AQControl$_{22}$	NYSC Secretariat, Makurdi, Benue State	7°43’37.9”	008°31’56.6”	97
AQ$_{23}$	Makurdi Train Camp, Benue State	7°43’34.3”	008°31’54.5”	90
AQ$_{24}$	River Benue, Benue State	7°44’01.9”	008°31’55.5”	63
AQ$_{25}$	Agyaragu Train Camp, Nasarawa State	8°23’46.7”	008°32’46.8”	219
AQ$_{26}$	Agyaragu Train Junction, Nasarawa State	8°23’58.1”	008°32’48.3”	235
AQ$_{27}$	Lafia Train Camp, Nasarawa State	8°29’56.7”	008°30’33.5”	180
AQControl$_{28}$	River Langalanga, Nasarawa State	8°45’31.4”	008°17’52.6”	192
AQ$_{29}$	Mada Train Junction, Nasarawa State	8°43’08.4”	008°17’58.7”	190
AQ$_{30}$	Gudi Palace, Nasarawa State	8°52’51.2”	008°16’13.6”	424
AQ$_{31}$	Gudi Train Quarters, Nasarawa State	8°52’40.1”	008°16’27.1”	430
AQ$_{32}$	Galadima, Kaduna State	9°41’28.2”	008°19’20.7”	819
AQ$_{33}$	Kafanchan Train Junction, Kaduna State	9°35’41.2”	008°18’23.8”	746
AQ$_{34}$	Manchok Train Station, Kaduna State	9°42’01.5”	008°17’14.9”	813
AQ$_{35}$	Gerti Train Station, Kaduna State	9°42’16.9”	008°17’26.3”	825
AQ$_{36}$	Kogum River, Kaduna State	9°42’26.0”	008°17’53.2”	842
AQ$_{37}$	Jagindi Train Station, Kaduna State	9°42’10.4”	008°17’20.1”	840
AQ$_{38}$	Kagoro Train Station, Kaduna State	9°42’50.3”	008°17’30.3”	834
AQControl$_{39}$	Regachikum Train Station, Kaduna State	10°38’40.4”	007°28’14.1”	622
AQ$_{40}$	Kaduna-Zaria Train Junction, Kaduna State	10°38’40.2”	007°28’15.1”	618
AQ$_{41}$	Bajoga Train Camp, Gombe State	10°50’00”	011°26’16.2”	278
AQ$_{42}$	Bajoga Train Junction, Gombe State	10°50’52.6”	011°26’17.8”	281
AQ$_{43}$	Gombe Train Junction	10°16’55.4”	011°11’15.3”	416
AQ$_{44}$	River Congola, Bauchi State	10°14’24.5”	010°04’44.9”	461
AQControl$_{45}$	Bauchi State Rail Junction	10°17’35.2”	009°50’56.3”	608
AQ$_{46}$	Kuru Train Camp, Jos	9°38’51.2”	008°48’50.6”	1240
AQ$_{47}$	Jos Train Junction	9°54’59.9”	008°53’24.9”	1210
AQ$_{48}$	Gashua Junction, Yobe State	12°52’26.5”	11°04’50”	328
AQ$_{49}$	Bakingada River, Gashua, Yobe State	12°51’39.1”	11°02’10”	335
AQControl$_{50}$	EIMA Secondary School, Nguru, Yobe State	12°53’33.0”	10°28’21.4”	356
AQ$_{51}$	Nguru, Yobe State	12°53’27.5”	10°28’24.3”	348
AQ$_{52}$	-do-	12°53’23.4”	10°28’26.3”	360
AQ$_{53}$	Damaturu, Yobe State	11°43’41.2”	12°01’48.2”	327
AQ$_{54}$	-do-	11°43’08.5”	12°01’54.1”	320
AQ$_{55}$	-do-	11°43’10.2”	12°02’03.2”	315
AQ$_{56}$	-do-	11°43’11.7”	12°02’11.2”	352
AQ$_{57}$	-do-	11°43’28.8”	12°02’07.7”	356
AQControl$_{58}$	-do-	11°43’44.6”	12°02’04.4”	347

Source: PGM fieldwork 2020

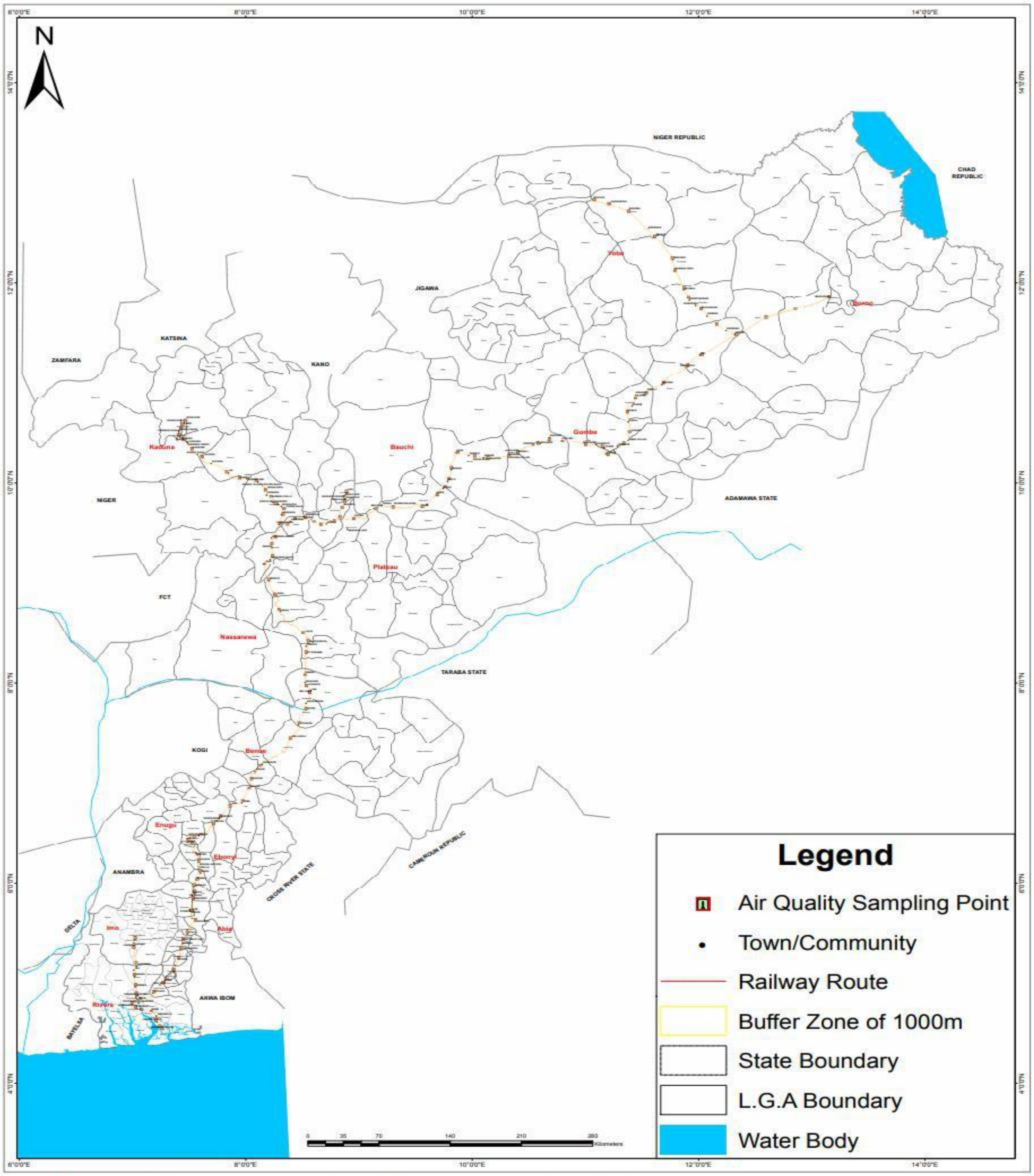


Figure 4.1: Air and Noise Sampling Location Map

4.5 Field Meterology - Results and Discussion

4.5.1 Results

The results of the air quality, noise levels, field meteorology, and microbial characteristics of sediment, soil and water in the study area are presented in tables below.

Table 4.9: Air Quality Measurements

Sample code	NO_2 (ppm)	SO_2 (ppm)	H_2S (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (ppm)	Cl_2 (ppm)	HCN (ppm)	TVOC (mg/m^3)	CH_2O (mg/m^3)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)
AQ_1	0.1	0.1	0.2	2	714	3	0.2	1	1.632	0.301	169	277
AQ_2	0.1	0.2	<0.1	3	706	4	0.3	1	1.403	0.104	136	224
AQ_3	<0.1	0.2	0.1	2	821	3	0.3	<1	1.71	0.063	145	259
AQ_4	0.2	0.1	<0.1	2	536	4	0.4	<1	1.326	0.198	150	293
AQ_5	0.1	0.1	0.1	3	483	1	0.2	<1	1.814	0.236	70	139
AQ_6	0.1	0.2	0.1	4	921	3	0.3	1	2.082	0.269	51	99
AQ_7	0.2	0.2	0.1	4	660	5	0.2	1	1.328	0.067	82	114
AQ_8	0.1	0.2	0.1	4	672	3	0.2	1	0.532	0.084	71	99
AQ_9	0.1	0.1	0.1	2	572	3	0.2	1	0.345	0.059	53	69
AQ_{10}	<0.1	0.1	0.1	2	558	3	0.1	1	0.351	0.191	55	67
AQ_{11}	<0.1	0.1	0.1	1	712	4	0.1	<1	0.447	0.064	57	75
AQ_{12}	0.1	0.1	0.2	2	493	2	0.1	<1	1.201	0.075	54	68
AQ_{13}	0.1	0.1	0.2	2	694	2	0.2	1	1.333	0.042	68	85
AQ_{14}	<0.1	0.1	0.2	3	643	4	0.2	1	1.273	0.041	75	104
AQ_{15}	<0.1	0.2	0.1	3	621	3	0.1	1	1.118	0.037	67	90
AQ_{16}	0.1	0.1	0.1	4	488	3	0.1	<1	0.623	0.051	82	117
AQ_{17}	0.1	0.1	0.1	2	578	3	0.1	<1	0.584	0.055	72	107
AQ_{18}	0.2	0.2	0.1	3	836	4	0.3	1	1.943	0.09	67	155
AQ_{19}	0.1	0.2	0.1	3	496	3	0.3	1	0.121	0.068	52	93
AQ_{20}	0.1	0.1	0.1	3	940	2	0.3	1	1.609	0.204	49	86
AQ_{21}	0.2	0.2	0.1	4	969	3	0.3	2	2.144	0.365	75	121
AQ_{22}	0.1	0.2	0.1	2	664	5	0.3	1	0.392	0.044	47	82
AQ_{23}	0.1	0.1	<0.1	2	650	3	0.4	2	0.424	0.116	45	78
AQ_{24}	0.1	0.2	0.1	5	713	3	0.4	1	0.315	0.048	52	109
AQ_{25}	0.1	0.2	0.1	3	540	3	0.2	2	0.114	0.031	62	99
AQ_{26}	0.2	0.1	0.1	3	623	2	0.2	1	0.123	0.056	54	95
AQ_{27}	0.1	0.1	0.1	4	715	2	0.3	2	0.161	0.025	52	92
AQ_{28}	0.2	0.2	0.1	3	602	5	0.4	1	0.181	0.029	55	97
AQ_{29}	0.1	0.1	0.2	4	1643	3	0.4	2	2.642	0.411	198	367
AQ_{30}	0.1	0.2	0.2	2	1328	5	0.2	1	2.774	0.563	201	428
AQ_{31}	0.1	0.2	0.2	3	1260	3	0.3	1	2.948	0.372	177	314
AQ_{32}	0.2	0.2	0.1	4	1151	4	0.2	1	2.362	0.341	189	351
AQ_{33}	0.2	0.2	0.1	3	1143	2	0.3	1	3.414	0.394	164	348
AQ_{34}	0.1	0.1	0.1	3	1008	5	0.3	1	2.692	0.36	132	322
AQ_{35}	0.1	0.1	0.1	4	911	3	0.2	1	1.143	0.182	77	137
AQ_{36}	0.1	0.1	0.1	4	842	3	0.2	2	1.043	0.09	62	108
AQ_{37}	0.1	0.1	0.1	2	750	2	0.3	1	1.096	0.053	54	88
AQ_{38}	0.1	0.1	0.1	3	1098	3	0.4	1	1.281	0.159	51	91
AQ_{39}	0.2	0.1	0.2	3	1012	2	0.2	1	1.067	0.144	100	189
AQ_{40}	0.2	0.2	0.2	4	934	3	0.4	2	1.892	0.195	101	172
AQ_{41}	0.1	0.2	0.1	4	813	3	0.3	1	2.165	0.283	89	146
AQ_{42}	0.1	0.2	0.1	3	702	4	0.3	1	1.964	0.063	136	305
AQ_{43}	0.1	0.2	0.1	3	1016	4	0.3	1	2.964	0.295	87	101
AQ_{44}	<0.1	0.1	0.1	3	724	3	0.2	1	1.643	0.234	53	79
AQ_{45}	0.1	0.1	0.1	4	916	4	0.4	2	2.158	0.321	64	88
AQ_{46}	0.1	0.2	0.2	2	714	3	0.2	1	1.632	0.301	169	277
AQ_{47}	0.1	0.2	<0.1	3	706	5	0.3	2	1.403	0.104	136	224

AQ$_{48}$	0.1	0.2	0.1	4	921	3	0.3	1	2.082	0.269	51	99
AQ$_{49}$	0.1	0.1	0.1	3	558	4	0.3	1	1.72	0.013	34	59
AQ$_{50}$	0.1	0.2	0.1	3	935	3	0.4	2	1.926	0.214	64	93
AQ$_{51}$	0.1	0.2	0.1	4	1102	2	0.3	2	1.721	0.296	68	102
AQ$_{52}$	0.2	0.2	0.1	4	796	2	0.5	1	1.883	0.384	54	84
AQ$_{53}$	0.2	0.2	0.1	4	840	3	0.3	1	2.114	0.306	62	99
AQ$_{54}$	0.2	0.2	0.2	5	1214	4	0.3	1	2.003	0.096	60	91
AQ$_{55}$	0.1	0.2	0.2	5	1010	4	0.3	1	1.996	0.072	72	115
AQ$_{56}$	0.2	0.2	0.1	3	964	3	0.2	1	1.115	0.105	84	168
AQ$_{57}$	0.1	0.2	0.1	3	1005	3	0.2	2	2.468	0.265	80	123
AQ$_{58}$	0.1	0.1	0.2	2	839	3	0.2	1	1.103	0.213	94	134
Mean	**0.13**	**0.155**	**0.124**	**3.121**	**818.534**	**3.207**	**0.266**	**1.235**	**1.466**	**0.174**	**86.724**	**149.914**
Range	**<0.1-0.2**	**0.1-0.2**	**0.1-0.2**	**1.0-5.0**	**483-1643**	**1.0-5.0**	**0.1-0.5**	**<1.0-2.0**	**0.114-3.414**	**0.013-0.563**	**34-201**	**59-428**
SD	**0.04**	**0.05**	**0.04**	**0.04**	**236.79**	**0.91**	**0.09**	**0.43**	**0.82**	**0.13**	**44.26**	**92.6**
FME Limit (1991)	**0.04-0.06**	**0.01-0.1**	**-**	**10.0-20.0**	**-**	**-**	**-**	**-**	**-**	**-**	**250**	**250**

Source: PGM Fieldwork (2020)

Table 4.10: Noise Level Measurements

Sample Code	Noise Level [dB(A)]	Minimum Noise [dB(A)]	Maximum Noise [dB(A)]
AQ$_{1}$	54.3	44.6	62.4
AQ$_{2}$	62.4	48.9	68.5
AQ$_{3}$	59.2	46.8	63.7
AQ$_{4}$	52.7	43.8	67.8
AQ$_{5}$	60.1	51.3	71.2
AQ$_{6}$	67.6	54.6	73.4
AQ$_{7}$	53.4	43.5	68.1
AQ$_{8}$	48.2	38.8	61.3
AQ$_{9}$	56.6	41.5	70.3
AQ$_{10}$	47.4	37.3	55.6
AQ$_{11}$	59.1	41.7	64.6
AQ$_{12}$	57.6	38.8	67.8
AQ$_{13}$	56.6	40.5	66.5
AQ$_{14}$	62.4	57.4	72.3
AQ$_{15}$	69.2	53.5	77.7
AQ$_{16}$	50.1	42.8	68.3
AQ$_{17}$	67.3	55.7	75.4
AQ$_{18}$	56.7	41.2	66.9
AQ$_{19}$	52.8	37.7	67.2
AQ$_{20}$	53.5	41.5	64.4
AQ$_{21}$	59.6	43.7	67.1
AQ$_{22}$	67.3	51.6	73.8
AQ$_{23}$	53.1	33.7	68.4
AQ$_{24}$	49.2	35.5	62.6
AQ$_{25}$	62.8	47.6	77.7
AQ$_{26}$	61.3	40.9	72.5
AQ$_{27}$	67.8	45.6	78.2
AQ$_{28}$	65.4	47.8	78.9
AQ$_{29}$	60.1	50.4	73.6
AQ$_{30}$	57.8	43.5	68.2
AQ$_{31}$	56.7	42.7	66.4
AQ$_{32}$	52.4	41.1	67.2

Sample Code	Noise Level [dB(A)]	Minimum Noise [dB(A)]	Maximum Noise [dB(A)]
AQ_{33}	58.4	38.7	64.2
AQ_{34}	62.3	44.4	72.2
AQ_{35}	60.5	40.4	70.8
AQ_{36}	59.7	41.4	68.7
AQ_{37}	64.2	47.6	77.4
AQ_{38}	68.5	48.5	79.4
AQ_{39}	69.6	52.1	80.4
AQ_{40}	49.6	34.8	67.4
AQ_{41}	54.3	38.7	66.8
AQ_{42}	62.4	52.5	69.5
AQ_{43}	59.2	41.1	71.2
AQ_{44}	52.7	38.2	68.8
AQ_{45}	60.1	43.4	72.8
AQ_{46}	66.7	52.8	77.4
AQ_{47}	69.3	53.6	78.8
AQ_{48}	60.1	42.6	76.5
AQ_{49}	59.3	37.3	67.1
AQ_{50}	66.4	45.6	77.9
AQ_{51}	56.8	32.8	66.3
AQ_{52}	54.2	33.4	65.6
AQ_{53}	62.9	47.3	73.4
AQ_{54}	65.4	45.7	82.1
AQ_{55}	61.7	54.2	77.3
AQ_{56}	67.1	55.3	84.6
AQ_{57}	63.2	48.8	79.7
AQ_{58}	60.5	42.7	75.6
Mean	**59.583**	**44.481**	**71.033**
Range	**47.4-69.6**	**32.8-57.4**	**55.6-84.6**
SD	**5.86**	**6.21**	**5.94**
FME Limit (1991)	**[90 dB(A)]**		

Source: PGM Fieldwork (2020)

Table 4.11: Field Meteorological Measurements

Sample Code	Temperature (°C)	Rel. Humidity (%)	Pressure (kpa)	Wind Speed (m/s)	Wind Direction
AQ_1	27.2	28.1	1980.5	3.09	226° SW
AQ_2	27.4	28.1	1980.6	2.45	158° SE
AQ_3	27.1	28.3	1980.7	1.9	333° SSW
AQ_4	27.3	28.3	1980.3	1.72	290° WNW
AQ_5	32.4	28.1	1963.2	2	183° S
AQ_6	33.4	28.3	1963.7	1.96	135° SE
AQ_7	34.5	27.5	1963.4	2.75	177° SE
AQ_8	35.6	27.7	1963.4	3.22	270° NW
AQ_9	31.8	73.3	1002.4	0.93	114° ESE
AQ_{10}	31.8	69.1	1002.5	0.99	258° WSW
AQ_{11}	32.3	62.1	1002.2	1.8	282° W
AQ_{12}	32.1	60.3	1002.1	0.81	280° WSW
AQ_{13}	32.3	60.8	1002.6	0.64	270° W
AQ_{14}	32.4	61.2	1989.8	0.71	99° E
AQ_{15}	32.3	61.3	1989.5	0.95	77° ENE
AQ_{16}	32.4	61.3	1989.4	1.64	305° NW
AQ_{17}	32.4	61.3	1993.6	0.34	185° S

Sample Code	Temperature (ºC)	Rel. Humidity (%)	Pressure (kpa)	Wind Speed (m/s)	Wind Direction
AQ_{18}	30.6	62.5	1987.1	2.78	347º NNW
AQ_{19}	33.2	48.3	1987.2	2.9	271º W
AQ_{20}	33.2	42.3	1987.7	0.5	275º WSW
AQ_{21}	33.3	45.6	1897.5	1.27	220º W
AQ_{22}	33.4	46.3	1987.9	2.33	4º N
AQ_{23}	35.7	43.2	1987.4	1.69	349º NW
AQ_{24}	37.3	43.7	1998.6	1.84	84º ENE
AQ_{25}	37.3	45.4	1998.8	2.06	180º SE
AQ_{26}	37.4	45.4	1998.7	1.7	70º ENE
AQ_{27}	36.3	33.2	1981.3	1.22	150º SSE
AQ_{28}	35.5	31.3	1981.1	0.31	144º SE
AQ_{29}	35.7	31.5	1981.4	0.93	216º SSW
AQ_{30}	36.3	44.2	1981.6	1.54	168º SSE
AQ_{31}	35.8	44.3	1981.9	1.72	136º SE
AQ_{32}	37.5	44.1	1981.7	1.04	177º ESE
AQ_{33}	38.7	35.7	1981.4	0.69	220º SW
AQ_{34}	27.7	44.5	924.2	0.68	151º SSE
AQ_{35}	27.8	44.7	924.6	1.19	218º SW
AQ_{36}	34.7	48.3	924.4	2.01	188º S
AQ_{37}	35.5	43.7	924.1	1.93	240º WSW
AQ_{38}	37.4	45.3	936.3	2.4	275º W
AQ_{39}	37.6	45.2	936.7	0.86	288º SSW
AQ_{40}	38.2	45.4	936.5	1.54	134º SE
AQ_{41}	38.3	35.2	936.8	0.37	167º ESE
AQ_{42}	38.4	34.6	936.9	0.43	260º SSW
AQ_{43}	36.8	26.3	1887.4	1.5	76º ENE
AQ_{44}	37.6	26.3	1887.3	1.22	257º WSW
AQ_{45}	38.4	26.4	1881.7	3.86	52º N
AQ_{46}	39.6	25.2	1972.4	2.59	205º SSW
AQ_{47}	40.3	24.8	1972.1	3.18	259º WSW
AQ_{48}	39.2	26.1	1972.3	2.08	220º SW
AQ_{49}	39.2	25.6	1972.5	1.99	136º SE
AQ_{50}	38.8	26.5	1972	1.64	93º ENE
AQ_{51}	39.5	27.7	1972.6	2.33	160º SSE
AQ_{52}	40.1	29.2	1972.8	3.04	184º ESE
AQ_{53}	39.3	29.3	1972.9	1.72	212º SW
AQ_{54}	39.7	29.4	1772.3	1	280º WSW
AQ_{55}	40.3	29.7	1772.5	1.5	302º N
AQ_{56}	40.6	30.5	1772.4	0.93	177º ESE
AQ_{57}	41.2	31.4	1772.5	0.86	175º SE
AQ_{58}	40.4	31.3	1772.6	2.68	304º NW
Mean	**35.319**	**39.909**	**1709.14**	**1.654**	-
Range	**27.1-41.2**	**24.8-73.3**	**924.1-1998.8**	**0.31-3.86**	-
SD	**3.91**	**13.2**	**423.8**	**0.84**	-

Source: PGM Fieldwork (2020)

4.5.2 Discussion

4.5.2.1 Wind Rose

Table 4.12: Wind Rose

Wind Direction	Wind Sped (m/s)		
	0 – 1.50	**1.51 – 2.50**	**2.51 – 3.50**
N	0.31 = 4.31 %	2.37 = 12.38 %	3.22 = 13.18 %
NE	0 = 0 %	2.25 = 11.76 %	0 = 0 %
NNE	0.43 = 5.97 %	1.75 = 9.14 %	2.93 = 11.99 %
E	0 = 0 %	0 = 0 %	0 = 0 %
SE	0.75 = 10.42 %	2.43 = 12.7 %	3.25 = 13.3 %
SSE	1.09 = 15.14 %	1.68 = 8.78 %	3.18 = 13.01 %
S	0 = 0 %	0 = 0 %	0 = 0 %
SW	1.04 = 14.44 %	1.93 = 10.08 %	2.75 = 11.25 %
WSW	1.22 = 16.94 %	2.37 = 12.38 %	3.50 = 14.32 %
W	0 = 0 %	0 = 0 %	0 = 0 %
NW	1.43 = 19.86 %	2.50 = 13.06 %	2.93 = 11.99 %
NNW	0.93 = 12.92 %	1.86 = 9.72 %	2.68 = 10.97 %

Source: PGM Fieldwork 2020

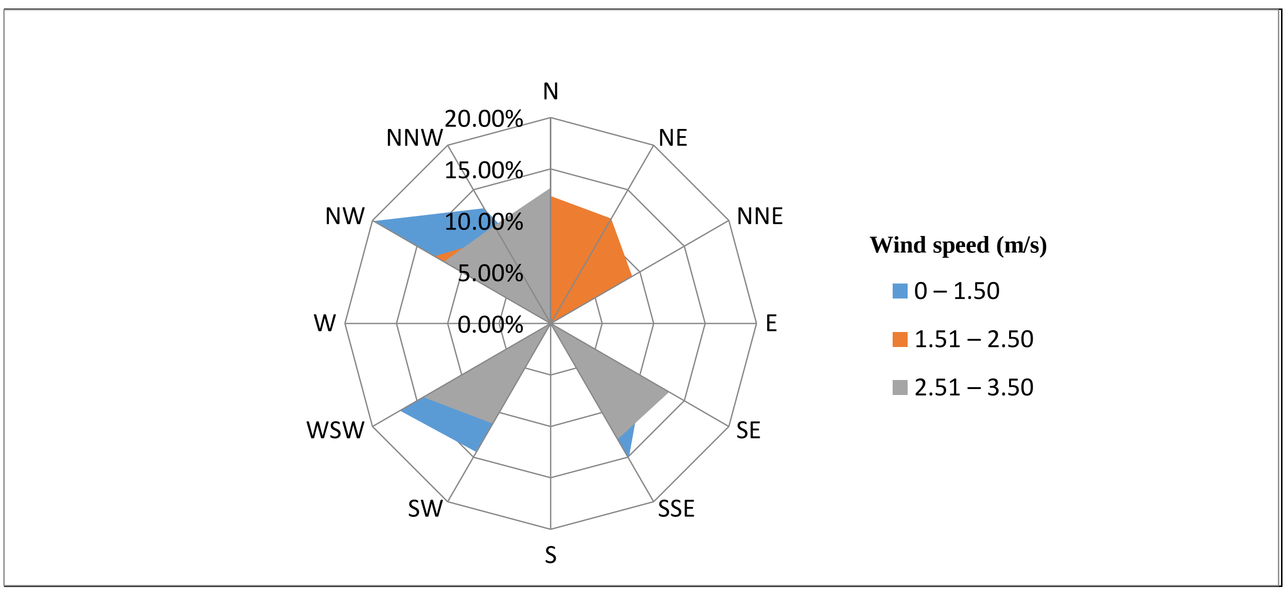


Fig. 4.2: Wind Rose for Proposed Project Based on Microclimatic Data

A wind rose gives a very succinct but information-laden view of how wind speed and direction are typically disturbed at a particular location. Presented in a circular format, the wind rose shows the frequency of winds blowing from the particular directions. The length of each "spoke" around the circle is related to the frequency of time that the wind blows from a particular direction. Each concentric circle represents a different frequency, emanating from zero at the centre to increasing frequency at the outer circles. The frequency categories that show the percentage of time that winds blow from a particular direction and at certain speed ranges.

In figures 4.2 above, wind speeds are indicated by colour. Here, the winds blew mostly at the wind speed denoted by the colours. For the blue section of the "spoke" which indicates winds at 0-1.50. The blue section is between 15 % and 10 %, subtracting these two numbers is equal to 5 %. This means that winds blew from the NW, WSW, SSE at 0-1.50 m/s for 5 % of the time. The red section is between 10 % and 0 %, subtracting these two numbers is equal to 10 %. This means that winds blew from the NE at 1.51-2.50 m/s for 10 % of the time, and the green shows that the winds blew from N at 2.51-3.50 m/s for 10 % of the time.

4.5.2.2 Noise

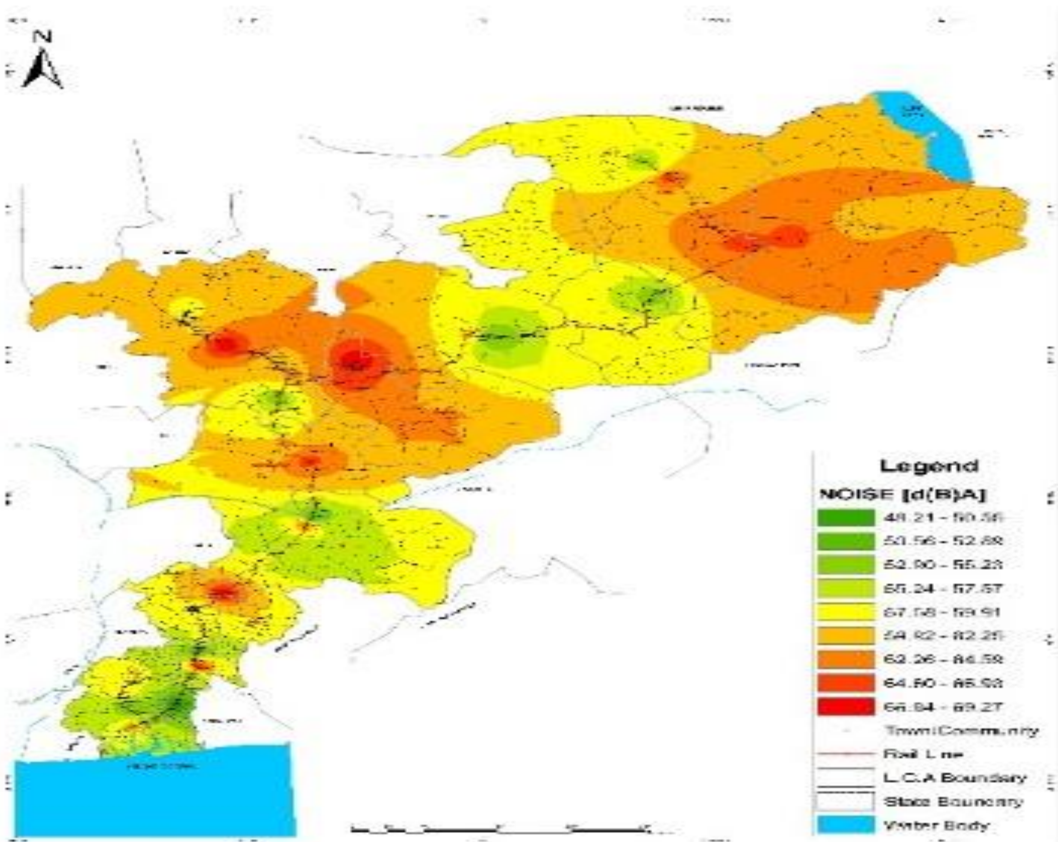


Figure 4.3: Map indicating dispersion model of noise level

About 70% of the study area recorded noise level ranging from 62.26-69.27 [dB(A)]. Lowest noise levels were recorded only in parts of Gombe, Bauchi, Kaduna (south of Kafanchan), Benue and Abia State ranging from 48.21-55.23 [dB(A)].

4.5.2.3 Ambient Air Quality

4.5.2.4 Carbon monoxide (CO)

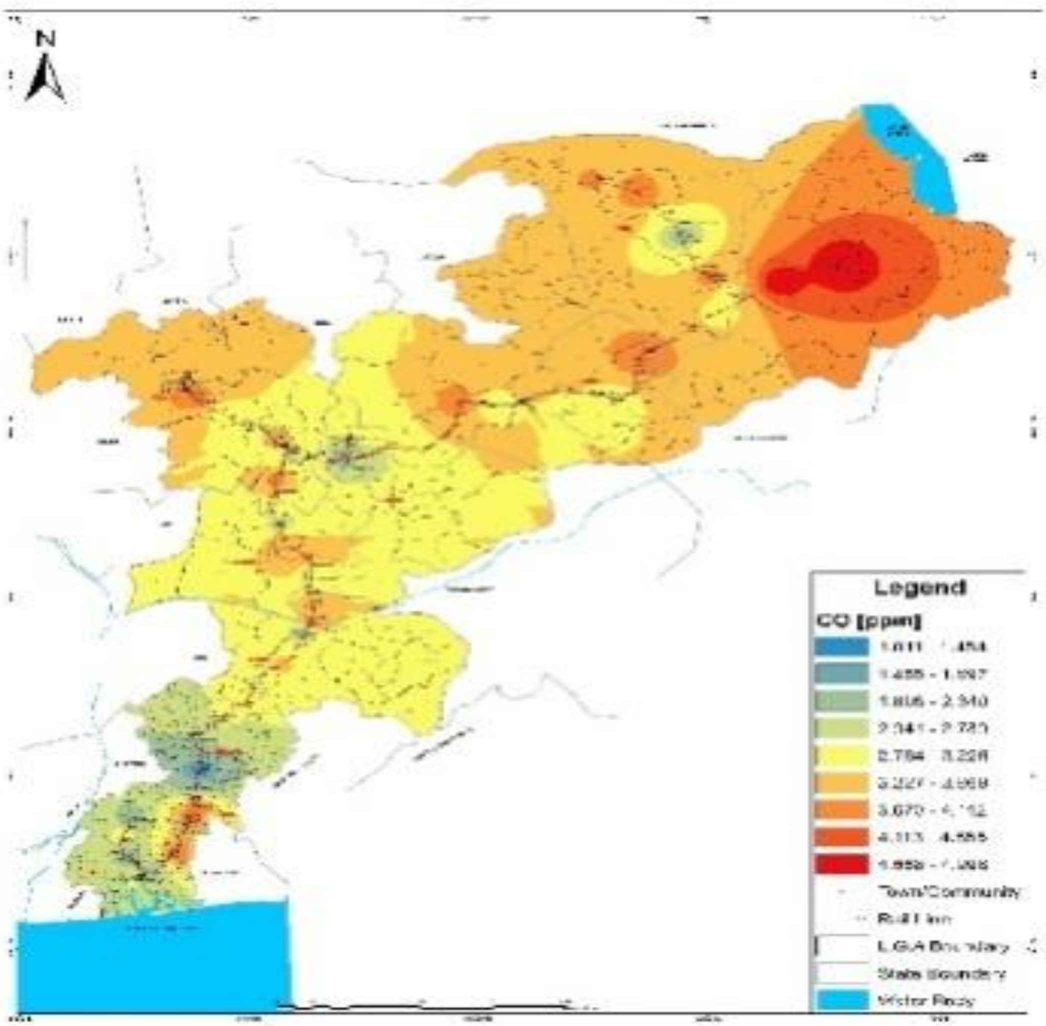


Figure 4.4: Map indicating dispersion model of CO

In the above model, it can be seen that the seemingly highest CO concentrations were recorded in Abia and Maiduguri and their environs ranging from 4.112-4.998 ppm while the lowest point was measured in the south, specifically in Ebonyi, Enugu, Imo and Rivers state ranging between 1.011-2.340 ppm. Moderate concentration was observed in Benue, Nassarawa, Plateau and parts of Kaduna state all ranging between 2.341-3.226 ppm.

4.5.2.5 Carbon dioxide (CO_2)

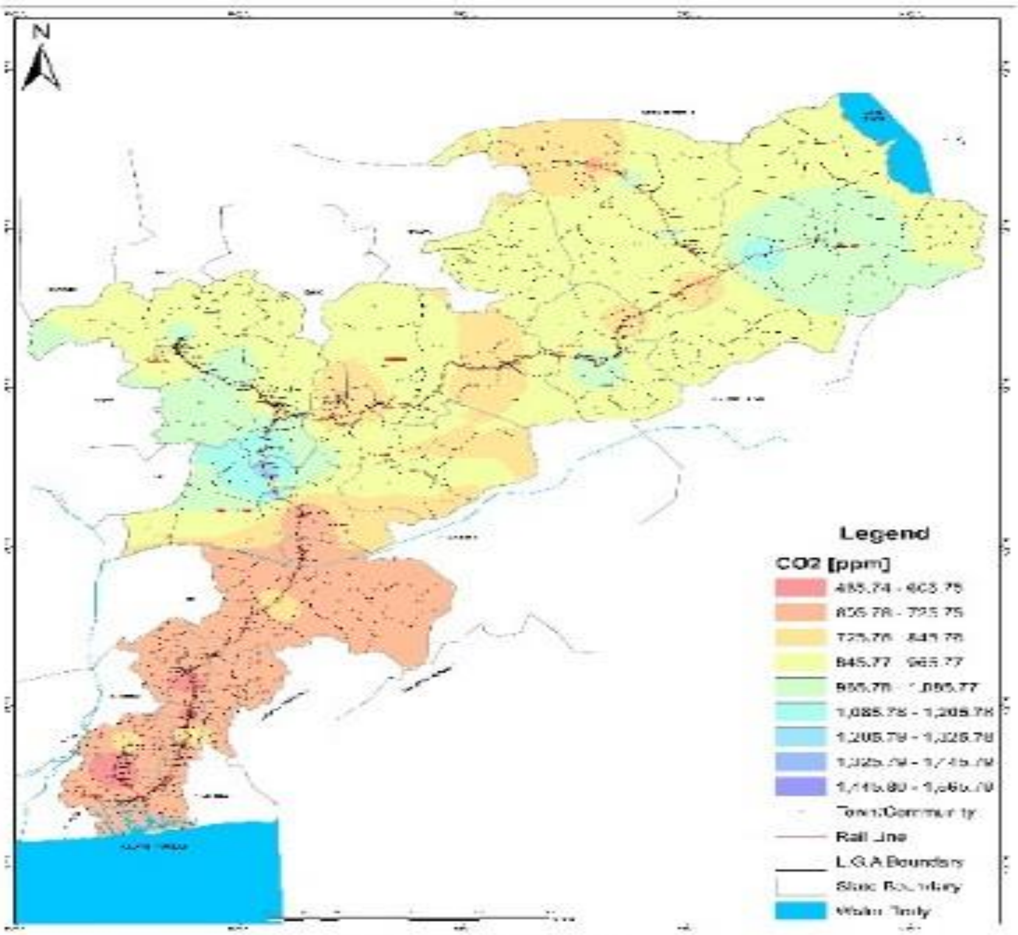


Figure 4.5: Map indicating dispersion model of CO_2

The south and middle belt recorded the lowest concentration of CO_2 which ranges from 485.74-725.75 ppm. Its concentration increased northward ranging from 1205.79-1565.79 ppm.

4.5.2.6 Sulphur dioxide (SO_2)

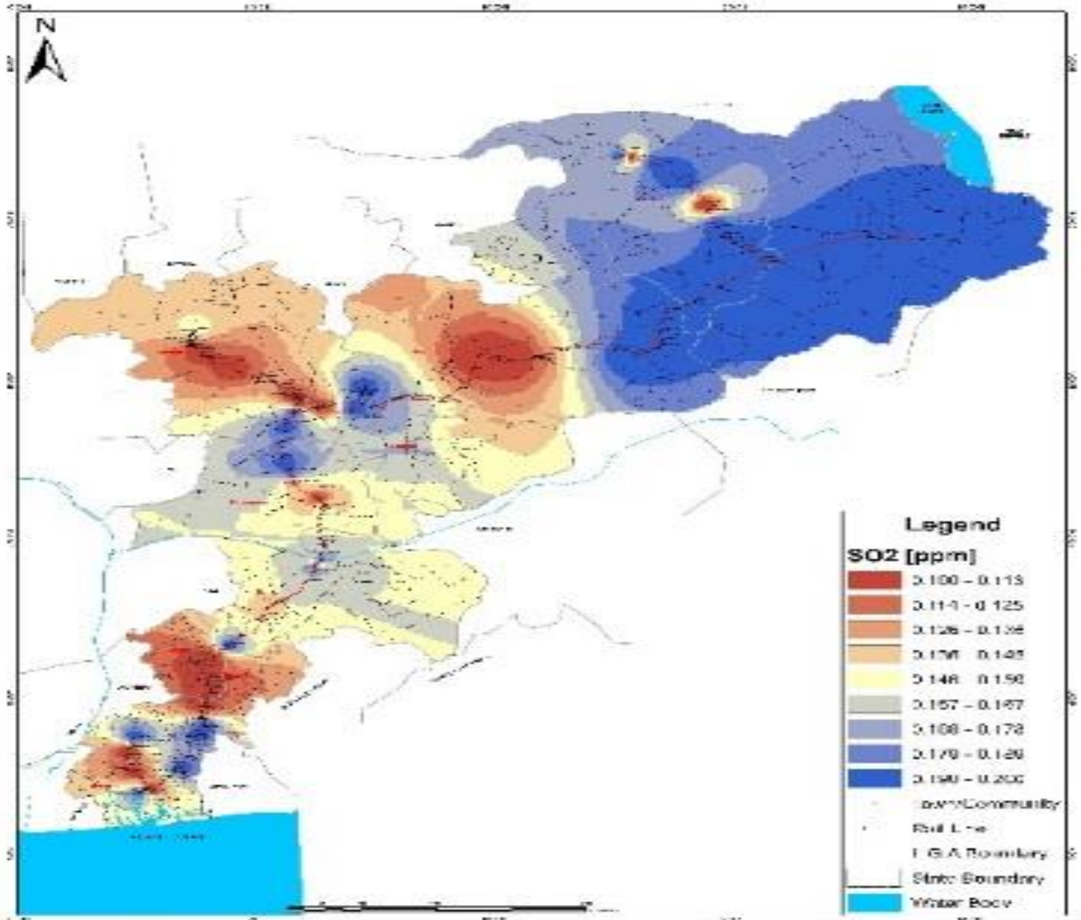


Figure 4.6: Map indicating dispersion model of SO_2

As observed in the model, Kaduna, Bauchi, Ebonyi, Enugu and part of Rivers state all recorded the lowest SO_2 level ranging from 0.100-0.145 ppm. The peak level of SO_2 was captured around Imo, Abia, Jos, Gombe, Borno and Yobe rating between 0.189-0.200 ppm. It was moderate toward middle belt (Benue and Nassarawa axis) as well as parts of Bauchi and Kaduna ranging between 0.136-0.167 ppm.

4.5.2.7 Hydrogen Sulphide (H_2S)

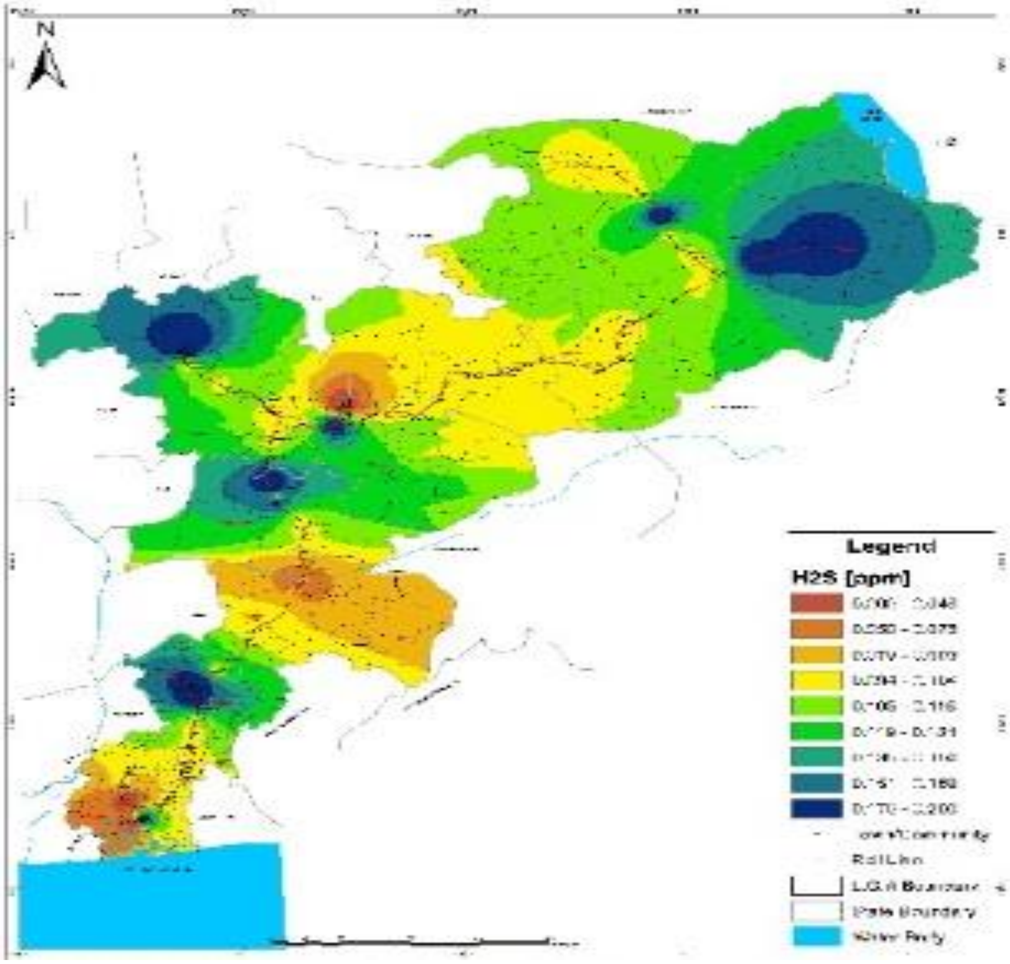


Figure 4.7: Map indicating dispersion model of H_2S

The peak level of H_2S was recorded toward PH, Enugu, Nassarawa, Jos (rail junction), Kaduna (Kaduna south) and Maiduguri ranging from 0.151-0.200 ppm. The lowest point was at Ikwerre, Imo, Markudi and Jos (below 0.093 ppm) while the concentration was moderate in Abia, Gombe, Bauchi and Gashua (Yobe state) ranging from 0.094-0.104 ppm.

4.5.2.8 Nitrogen dioxide (NO_2)

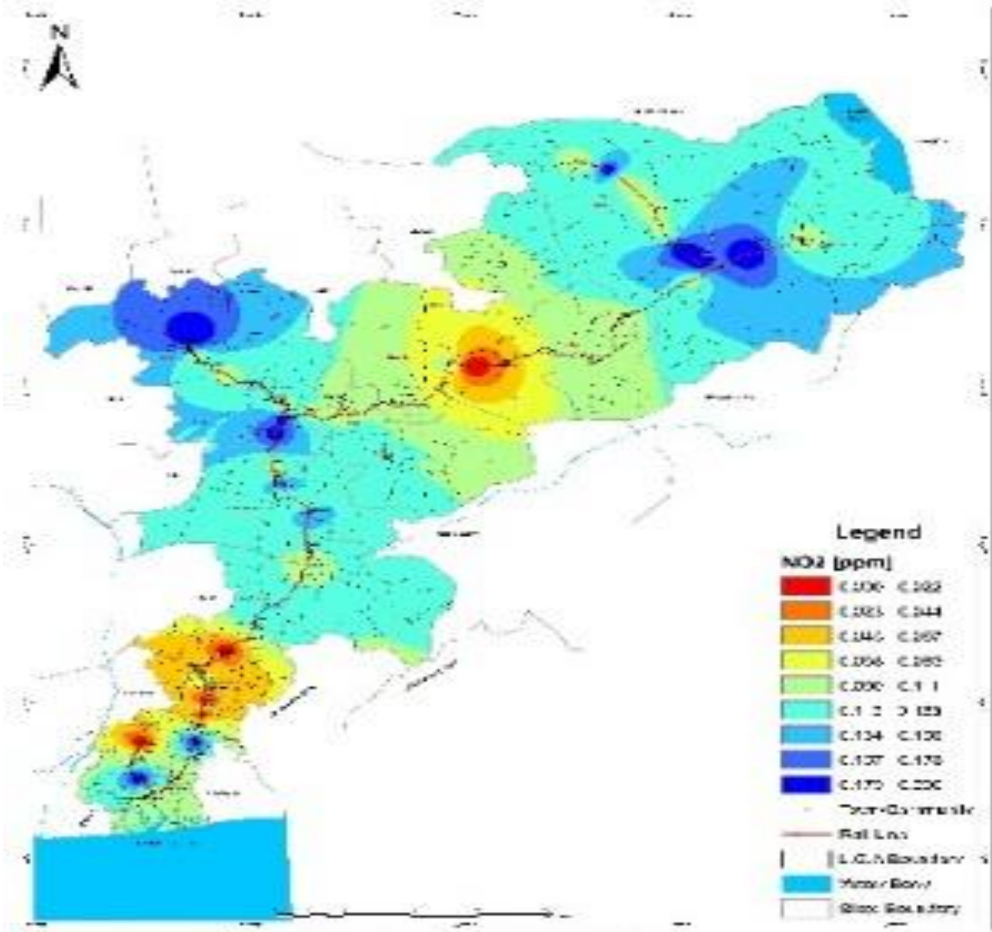


Figure 4.8: Map indicating dispersion model of NO_2

The concentration of NO_2 was observed in the model to be lowest in Enugu, Ebonyi, Imo, north of Abia and Gombe state ranging below 0.044 ppm while its peak level was captured along Kaduna (extreme north), Kafanchan, Borno, Umuahia (Abia) and Ikwerre (Rivers state) ranging from 0.134-0.200 ppm.

4.5.2.9 Ammonia (NH_3)

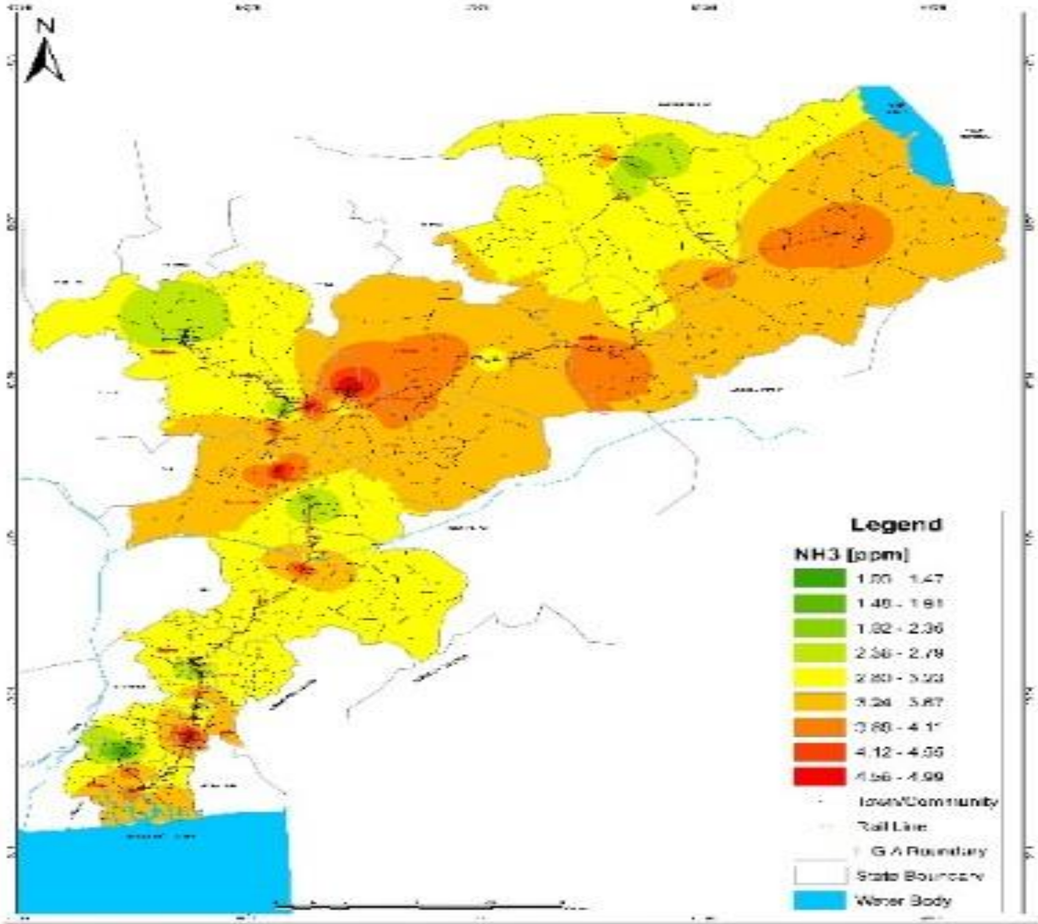


Figure 4.9: Map indicating dispersion model of NH_3

The peak concentration of Ammonia was in the northern part (red ccolour) ranging from 3.68-4.99 ppm. Benue, Ebonyi and Enugu mostly recorded moderate concentration which fell within the range of 2.80-3.67 ppm. The lowest values were captured mostly in Imo, Enugu, Lafia (Nassarawa), Kaduna South and Kafanchan ranging from 1.03-2.35 ppm.

4.5.2.10 Chlorine (Cl_2)

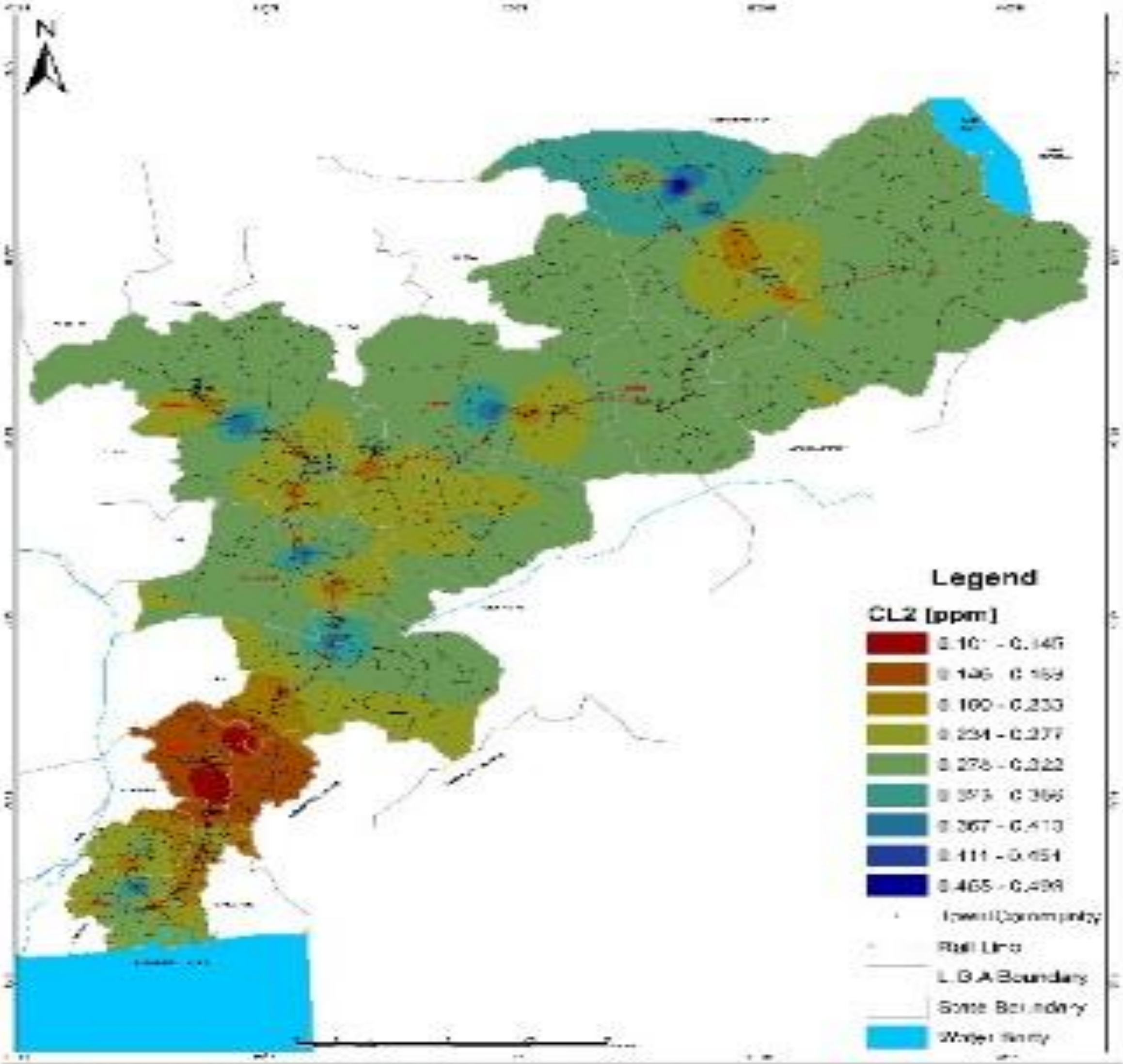


Figure 4.10: Map indicating dispersion model of Cl_2

About 75% of the entire area (predominantly northern part) recorded a moderate concentration of Cl_2 ranging from 0.190-0.366 ppm. On the other hand, Enugu, Ebonyi and parts of Abia recorded the least Cl_2 (0.101-0.233 ppm) while its peak concentration was observed only in Markudi, Yobe, Kaduna and Nassarawa ranging from 0.367-0.498 ppm.

4.5.2.11 Hydrogen Cyanide (HCN)

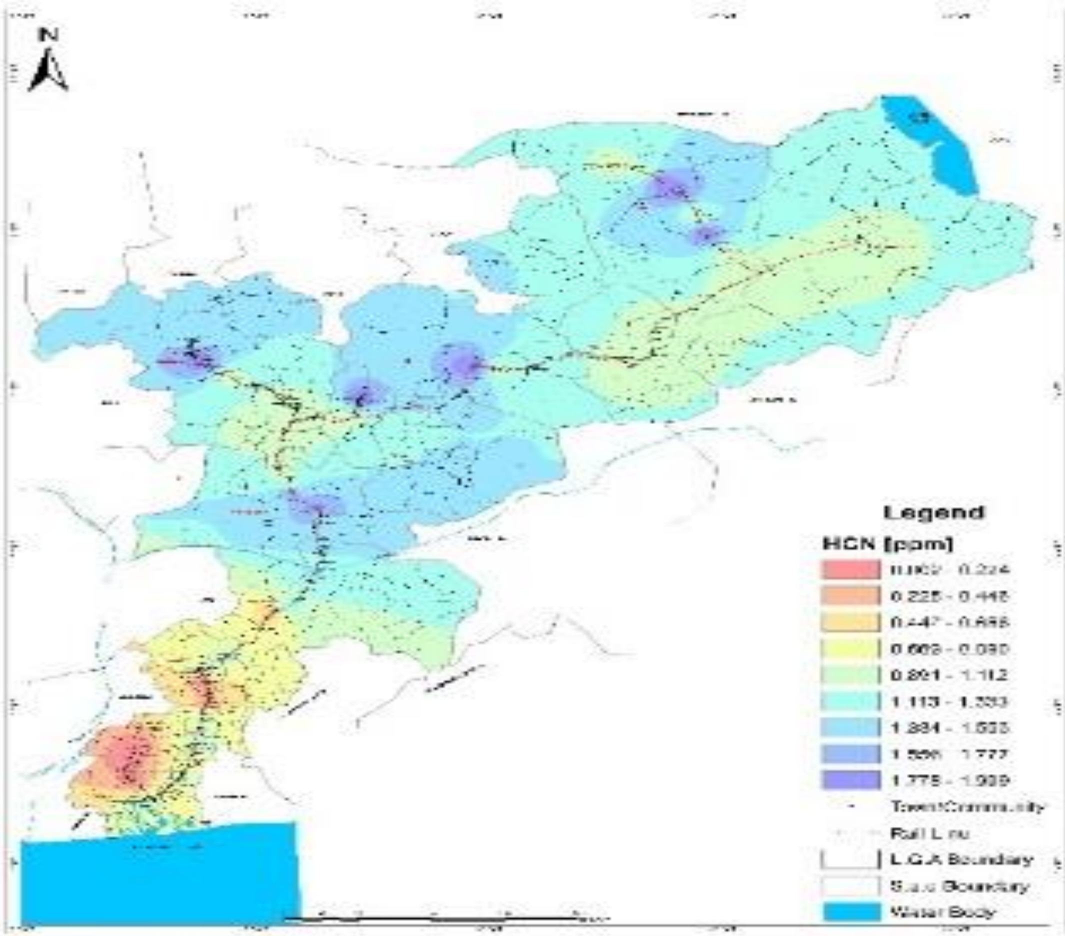


Figure 4.11: Map indicating dispersion model of HCN

The model shows that the concentration of HCN follows a unique pattern in the south, recording the lowest in Rivers, Imo, Abia, Ebonyi, Enugu and parts of Benue ranging from 0.002-0.890 ppm. The concentration increased northward with its peak at Kaduna, Jos, Yobe, Bauchi and Nassarawa central which ranged from 1.556-1.999 ppm. Moderate level of HCN was recorded along Gombe, Borno and part of Yobe recording 0.891-1.112 ppm.

4.5.2.12 Particulate Matter (PM)

4.5.2.12.1 $PM_{2.5}$

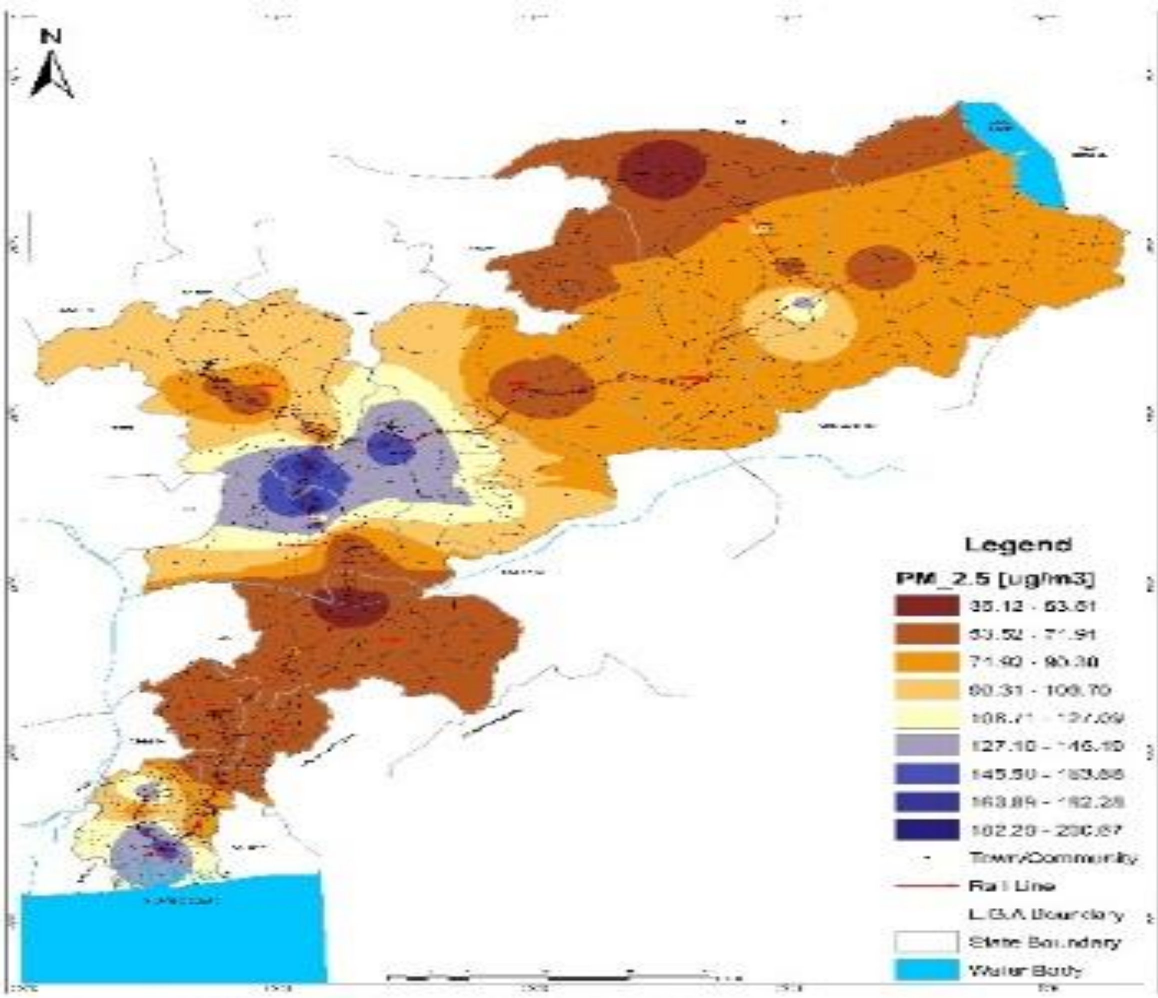


Figure 4.12: Map indicating dispersion model of $PM_{2.5}$

Apart from Kafanchan axis, Jos, Imo and Rivers state that recorded peak concentration of $PM_{2.5}$ ranging from 127.10-200.67 µg/m^3, others parts of the rail line recorded unique level of $PM_{2.5}$ ranging from 35.12-100.70 µg/m^3.

4.5.2.12.2 PM_{10}

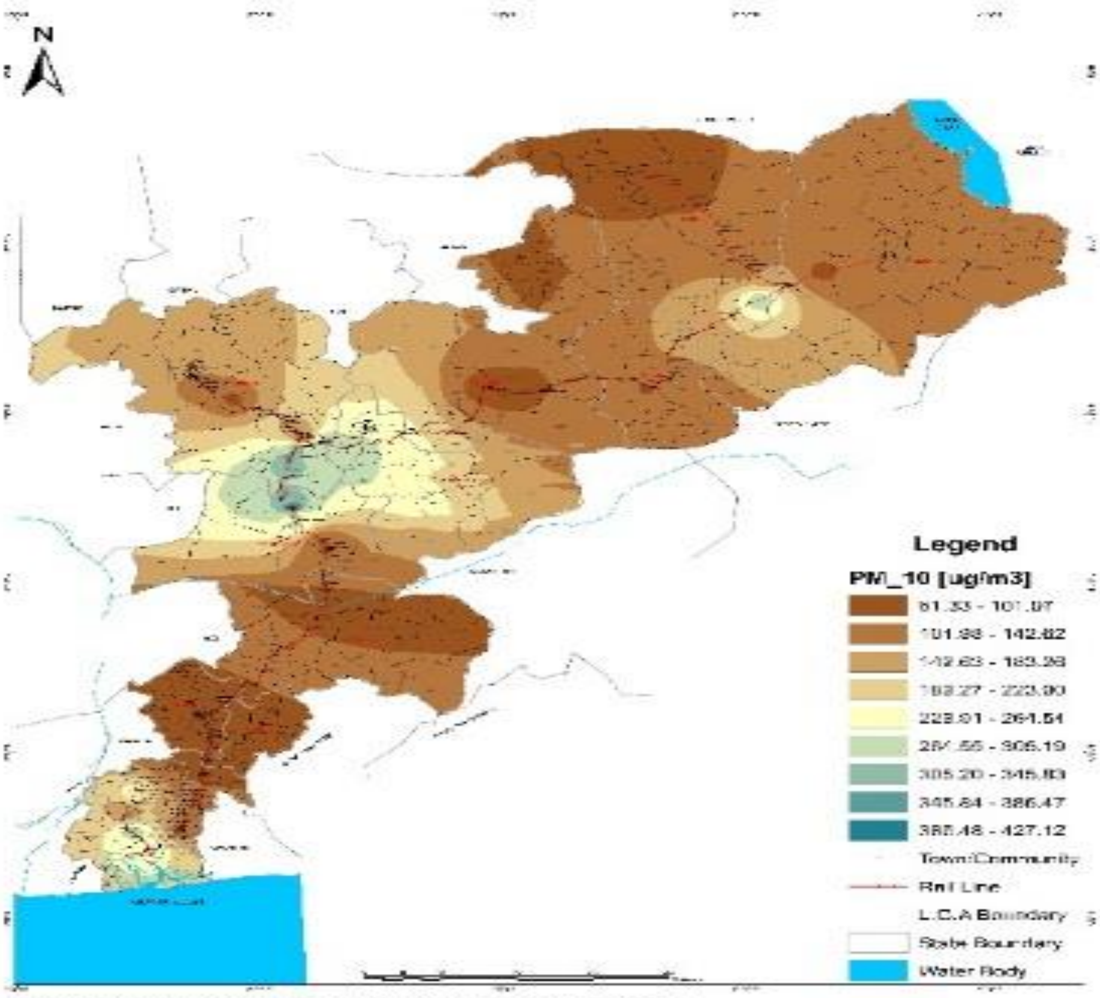


Figure 4.13: Map indicating dispersion model of PM_{10}

Parts of Kaduna (Kafanchan axis), Plateau and Nassarawa States had the highest concentrations of PM_{10} ranging from 264.55-427.12 µg/m^3. PM_{10} was moderate toward Rivers and Imo state ranging from 183.27-261.54 µg/m^3 while the least concentration was observed in Abia, Enugu, Ebony, Benue, Bauchi, Borno and Yobe state ranging from 61.33-183.26 µg/m^3.

4.5.4.13 Total Volatile Organic Compounds (TVOCs)

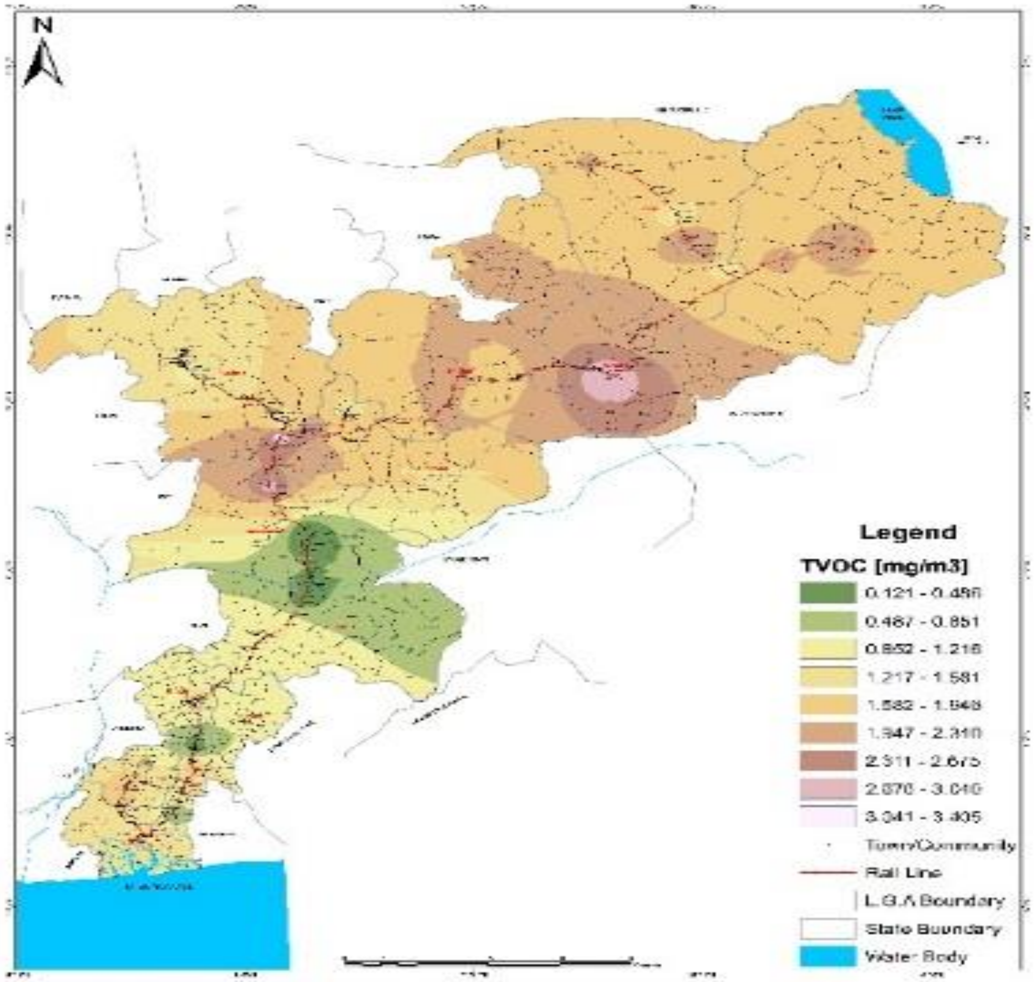


Figure 4.14: Map indicating dispersion model of TVOC

In Kafanchan, Gombe and Maiduguri surroundings, TVOC recorded maximum concentration which ranged from 2.311-3.405 mg/m^3 while Benue, Nassarawa and parts of Abia recorded least (0.121-0.851 mg/m^3). Other parts of the rail line recorded a moderate level of TVOC which fell within 0.852-1.946 mg/m^3.

4.5.4.14 Formaldehyde (CH_2O)

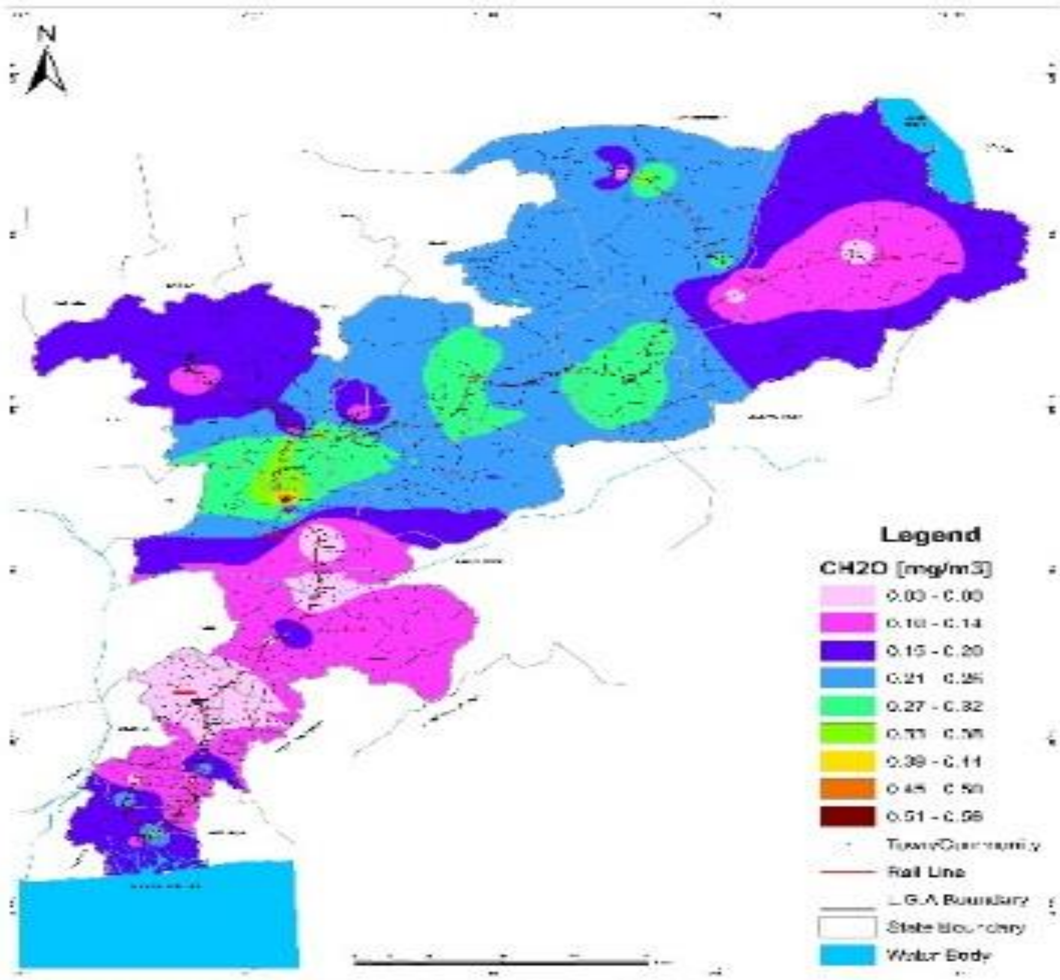


Figure 4.15: Map indicating dispersion model of CH_2O

In the dispersion model above, Formaldehyde recorded lowest concentration around Maiduguri, Jos, Markudi, Lafia, Enugu, Ebonyi, Imo and Abia ranging from 0.03-0.14 mg/m^3. The increase in Rivers State did not exceeding 0.20 mg/m^3. It was moderately dispersed northward between 0.27-0.38 mg/m^3 in parts of Gombe and Bauchi. The peak level was recorded in Gudi (Nassarawa) and southern parts of Kaduna state ranging from 0.39-0.56 mg/m^3.

4.6 Geology, Hydrogeology and Hydrology

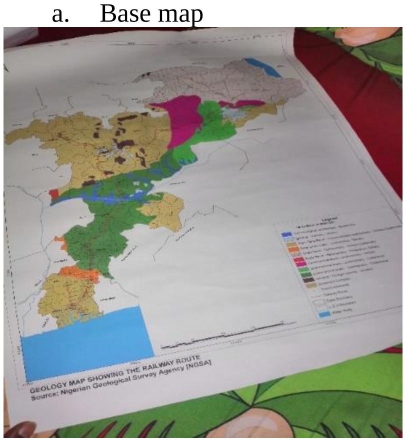
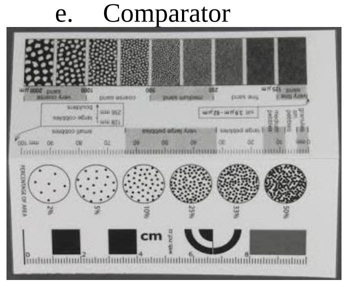
4.6.1 Methodology

The geologic study for the proposed project involves geologic field studies such as geologic mapping, hydrogeology study, fossils identification (if any), geologic structure and lithological identifications.

This study was carried out, in November 2020, through field studies and high impact approved papers of previous research carried out within the various encountered geologic terrain. These researches addressed various aspects such as basin evolution and tectonics, biostratigraphy, sedimentology, sequence stratigraphy etc.

4.6.1.1 Field equipment used for this study

For this study, some of the field equipment used are outlined in table 4.13;

a. Base map  It is used for outcrop identification.	b. Geologic Hammer  Geologic hammer is used for collection of geologic samples and where necessary used to create fresh surfaces and minerals within it can be described.	c.  Global Positioning System (GPS) For Navigation
d. Compass clinometer  Is used to measure the orientation of geological bedding planes such as the dip and strike of beds.	e. Comparator  This is used for classification of sandstone with respect to grain sizes, texture and sorting.	

Source: PGM Fieldwork 2020

4.6.2 Regional Geology

The geological setting of the study area falls Majorly within 5 sedimentary basins (Niger Delta Basin, Anambra Basin, Lower Benue basin, Upper Benue basin and Chad Basin) and a basement complex in Nigeria. Geologically, **sedimentary basin** is a low area in the Earth's crust, of tectonic origin, in which sediments accumulate.

The Tertiary **Niger Delta Basin** located in southern Nigeria at the inland margin of the Gulf of Guinea is situated at the southernmost extremity of the elongated intra-continental Benue Trough. The basin is bounded by the Calabar Flank in the east, Benin Flank in the west, Gulf of Guinea in the south and in the north by older (Cretaceous) tectonic elements such as the Anambra Basin and Afikpo Syncline (Tuttle et al. 1999). The Niger Delta basin has area coverage of about 75,000 km2 and consists of an overall regressive clastic sequence which reaches a maximum thickness of about 12,000 m in the central part of the basin where there is maximum subsidence (Merki 1972).

The basin consists of progradational, paralic sequences of Akata, Agbada and Benin Formations which builds southwards into the deep waters and this account for the Delta Complex in the Oligocene–Miocene times (Doust and Omatsola 1990). Throughout its history, the delta has been fed by the Niger, Benue and Cross rivers, which between them drain more than 10^6 km^2 of continental lowland savannah. Its present morphology is that of a wave-dominated delta, with a smoothly seaward-convex coastline transverse by distributary channel (Brook J., 1990).

The **Benue Trough (Figure 4.16)** is a rift basin formed under similar tectonic conditions and sedimentary environments that form other sedimentary basins of Nigeria [Nwachukwu, 1972]. It extends NNE-SSW for about 800 km in length and 150 km in width. The southern limit is the northern boundary of the Niger Delta, while the northern limit is the southern boundary of the Chad Basin (Adeigbe & Salufu, 2010). The trough contains up to 6,000 m of Cretaceous - Tertiary sediments of which those pre-existing mid-Santonian sediments have been compressionally folded, faulted, and uplifted in several places.

The Santonian thermo tectonic event uplifted the Albian-Coniacian sediments of Benue Trough into Abakaliki Anticlinorium with Anambra basin to the west and Afikpo Synclinorium to the east, and were filled with post-Santonian sediments (Nwajide & Reijers, 1996).

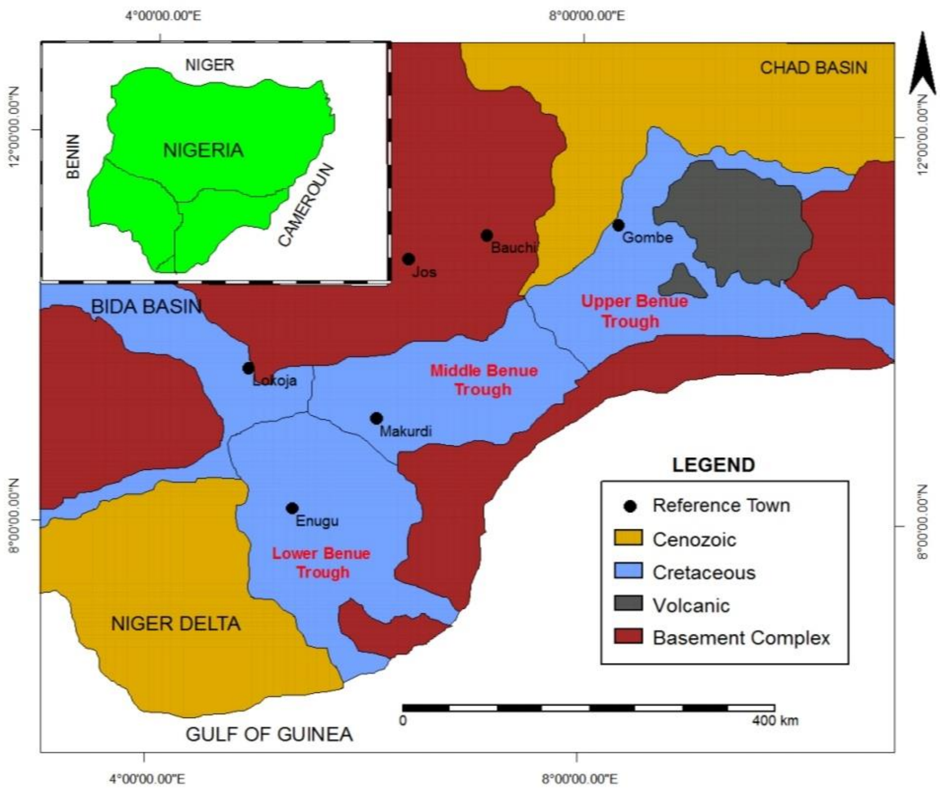


Figure 4.16: Geological Map showing the Benue trough

The Nigerian sector of the **Chad Basin** is known as the Bornu Basin and is one-tenth of the total area of the Chad Basin. The basin belongs to the Western Central African Rift System, that was formed in response to the mechanical separation of the African crustal blocks in the cretaceous (Genik, 1992). The Bornu basin is adjoining with the North - South aligned part of the upper Benue Trough called the Gongola Arm or Gongola Basin. The Benue Trough and Bornu Basin form an integral part of the "West and Central African Rift System" (Keller et al., 1995).

Using a model for the regional framework and tectonic evolution of the Cretaceous – Paleogene rift basins of Niger, Chad and the Central African Republic (Genik, 1992), the Bornu basin is divisible into four phases;

- Pan African crustal consolidation (750-550Ma): During this period, major basement lineament and faults were produced. The formed structures are essential structures for the formation of rift basins (Guiraud, 1993).
- Early rift stage (130 – 98Ma): This was the period of the rift basin formation. The Benue Trough and Bornu basin represent the third and failed arm of the triple junction rift system, which was formed during the break – up of Gondwanaland (Fairhead & Blinks, 1991), "that's the start of the separation of the African and South American continents in the Early Cretaceous".

- Late rift stage (98 – 75Ma): This period, there was rise in sea level which led to transgressions from South Atlantic via Algeria, Niger and the Benue Trough into the Basin (Dike,1993).
- Post rift stage (66 – 0Ma): There was no significant tectonic activity during this phase. The Earth movement ceased within the basin before 66Ma which represents Paleocene, hence no faulting and significant folding has been observed in the Tertiary and younger strata (haruna, 2017).

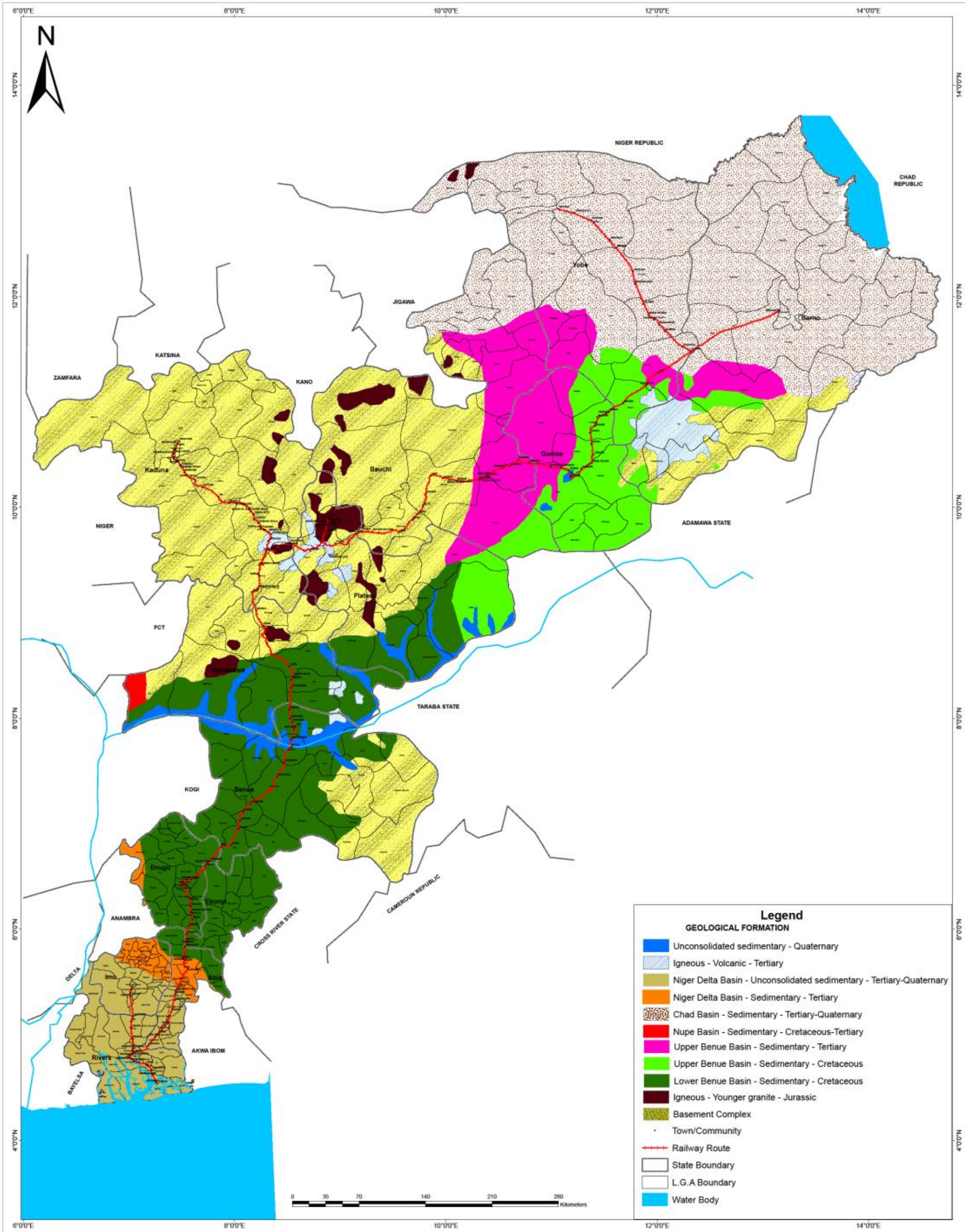
4.6.3 Local Geology

The geological setting of the study area falls Majorly within 6 geologic formations as outlined in table 4.14 and Figure 4.17

Table 4.14: Encountered geologic formations

	Encountered Geologic Formations		Lateral Extent along the Railway route
1	Niger Delta Sedimentary Basin		Rivers, Imo and Umuahia.
2	Anambra Sedimentary Basin		Ozalla, Nara, Ndeaboh and Mgbowo axis, all in Enugu State.
3	Middle Benue Trough		Oturkpo, Taraku, Chongke, Ukpiam, Utomkon and Makurdi axis all in Benue State and part of Nasarawa State (Lafia axis).
4	North Central Nigerian Basement Complex		Gudi and Akwanga axis (Nassarawa State), Kaduna State, Jos and part of Bauchi State.
5	Upper Benue Trough	Gongola Sedimentary Basin	Watsira, Bagali, Badara and Cheledi axis all in Bauchi State and part of Gombe State (Tonde and Wurisato axis)
		Yola Sedimentary Basin	Part of Gombe State (Jerikom, Dukul, Tongo, Ashaka axis) and part of Yobe State (
6	Bornu Basin (Nigerian part of Chad Basin)		Maiduguri, and part of Yobe State (Damaturu, Mogono, Yelawa , Gashua axis)

Source: PGM Fieldwork 2020



GEOLOGY MAP SHOWING THE RAILWAY ROUTE
Source: Nigerian Geological Survey Agency [NGSA]

Figure 4.17: Geological Map of the study area showing the Geologic Formations encountered

1. Niger Delta sedimentary Basin

The southern part of the Railway falls within south eastern part of the **Niger Delta Basin.** Three lithostratigraphic units have been recognized in the subsurface of the Niger Delta. The stratigraphic sequence comprises an upward-coarsening regressive sediments upto 12 km thick (Evamy et al. 1978). These are from the oldest to the youngest, the Akata, Agbada and Benin Formations as shown in the table 4.15.

Table 4.15: Stratigraphic column showing the three Formations of the Niger Delta Basin

Age	Formations	Lithology
Pliocene	Benin Formation	Continental sands
Miocene		
Oligocene	Agada Formation	Paralic/Deltaic deposits
Eocene		
Paleocene	Akata shale	Marine shales

Source: www.springer.com/978-3-319-44626-4 (Modified)

The Akata Formation (Paleocene–Recent) is the oldest lithostratigraphic unit in the Niger Delta. It is a marine sedimentary succession that is laid in front of the advancing delta and ranges from 1,968 to 19,680ft in thickness. It consists of mainly uniform under-compacted shales, clays, and silts at the base of the known delta sequence with lenses of sandstone of abnormally high pressure at the top (Avbovbo 1978).

The Agbada Formation (Eocene–Recent) is characterized by paralic interbedded sandstone and shale with a thickness of over 3000m (Reijers 1996). These indicate a delta-front, delta-topset, and fluvio-deltaic environments.

The Benin Formation is the youngest lithostratigraphic unit in the Niger Delta. It is Miocene - Recent in age with a minimum thickness of more than 6000ft and made up of continental sands and sandstones (>90%) with few shale intercalations as observed close to the wharf road.

This area is made up of lithofacies, alternation of sandstones, siltstones and claystones, in which the sand percentage increases upwards as observed in Plate 4.3.

Alternation of Claystone and Siltstones
(Location: .549021N, 7.56161E)

Continental Sands
(Location: 4.765094N, 7.016467E)

Plate 4.3: Outcrops observed within the study area in Niger Delta Basin

2. Anambra sedimentary Basin

Next in sequence after Niger Delta Basin is the Anambra Basin which was deposited after the Santonian period of non-deposition, folding and faulting followed by uplifting and erosion of sediments. the intensive Middle–Santonian deformation and magmatism in the Benue Trough. Post deformational sedimentation in this basin constitutes the Anambra Basin

Sedimentation in the Anambra Basin thus commenced with the Early Campanian – Early Maastrichtian (Figure 4.18) of the Enugu and Nkporo Formations which consist of a sequence of bluish to dark grey shale and mudstone locally with sandy shales, thin sandstones and shelly limestone beds. The Enugu and Nkporo Formations is overlain by the Lower Maastrichtian sandstones, shales, siltstones and mudstones and the inter-bedded coal seams of the deltaic Mamu Formation. The deltaic facies grade laterally into the overlying marginal marine sandstones of the Ajali and Nsukka Formations. The marine shales of the Imo and Nsukka Formations were deposited in the Paleocene. The Nsukka Formation and the Imo Shale mark the onset of another transgression in the Anambra Basin during the Paleocene. Imo and Nsukka Formations are overlain by the tidal Nanka Sandstone of Eocene age. The Eocene Nanka Sands mark the return to regressive conditions.

Anambra formations as observed along the Okigwe – Enugu roadcut (Plate 4.4), the facies grade into mudstones, shales, sandstones and siltstones

Million years (m.y)	GEOLOGIC AGE	FORMATIONS	
30	Oligocene	Ogwashi-Asaba Formation	ANAMBRA SEDIMENTARY BASIN (STUDY AREA)
54	Eocene	Nsugbe Sandstone Nanka Formation (Ameki Group)	
65	Paleocene	Imo Formation Nsukka Formation	
73	Maastrichtian	Ajali Formation/ Mamu Formation	
83-87.5	Campanian	Nkporo Formation/ Enugu Shale	
	Santonian		LOWER BENUE TROUGH
88.5	Coniacian	Agbani Sandstone/Agwu Shale	
93 100 119	Turonian	Eze Aku Group	
	Cenomanian-Albian	Asu River Group	
Precambrian		Basement Complex	

Figure 4.18: Chart showing early Cretaceous-Tertiary strata in southeastern Nigeria (modified; Nwajide, 1990)

A (Location: 6.233727N, 7.471254E) B & C (Location: 6.2390278N, 7.46805556E)

Plate 4.4: Outcrops observed within the study area in Anambra Basin

3. Middle Benue Trough

The area is within the southwestern margin of the middle Benue valley. It is included in the Benue trough in which a thick pile of marine and fluvio-deltaic sediments was deposited during the lower Cretaceous. The deposition commenced in the Albian with the emplacement of the Gboko Formation of marine sediments as outlined in table 4.16 Sediments within the trough became folded in the Santonian, with the fold axes mostly trending northeast-southwest. The study area comprises mainly of shales, sandstones and limestone were faulted and eroded.

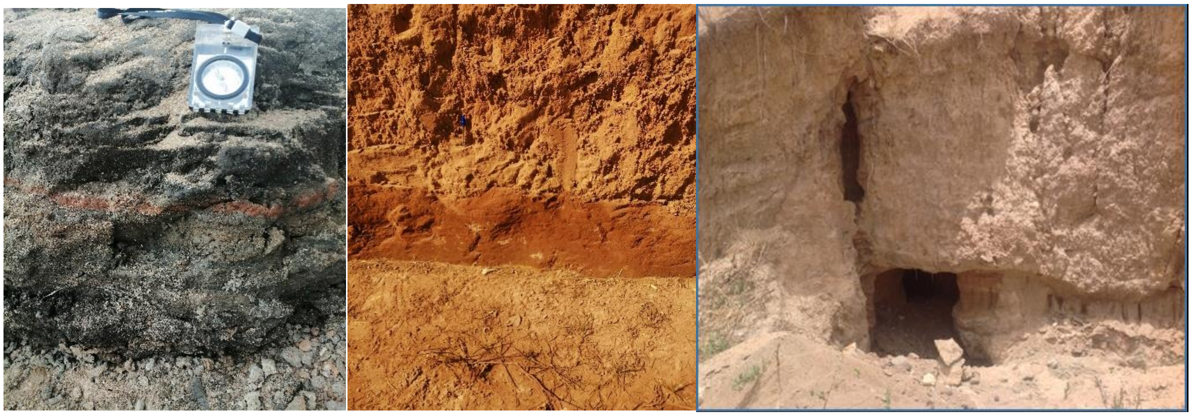
The erosion activity continued until the igneous activities began in the post-Santonian times (Offodile, 1976). Probably the igneous activities of this time gave rise to the extrusive and intrusive rocks in the mapped area.

The Lafia Formation is sedimentary formation that is exposed in the study area observed in Lafia town. The formation was deposited under continental condition (fluviatile) in the Maastrichtian. It is lithologically characterized by ferruginized sandstones, red, loose sands, flaggy mudstones, clays and claystones.

The study area comprises low-lands of about 300ft above sea level, near the banks of River Benue. There are some scattered hills occurring in the area to form a nearly undulating topography. Most parts of the low-lying areas fall below 500ft above sea level.

Table 4.16: Stratigraphic column showing the Formations of the Middle Benue Trough (modified, Goodluck K. Anudu 2020).

Geologic Age	**Formations**	**Lithology**
Quaternary	Volcanics	Extrusive and intrusive rocks
Pilocene		
Miocene		
Oligocene		
Eocene		
Palaeocene		
Maastrichtian	Lafia Formation	Sandstone, Siltstone, Claystone
Campanian	Period of Non-Deposition	Folding and Faulting
Santonian		
Coniacian	Awgu Formation	Shale, Siltstone, Coal, Sandstone, Limestone
Turonian	Ezeaku Formation	Shale, Sandstone, Limestone and Siltstone
Cenomanian	Keana/Awe	Sandstone, Siltstone and Clay
Albian – Upper Jurassic	Arufu-Uomba-Gboko Formation	Shale, Limestone, Siltstone
Precambrian	Basement Complex	



A & B (Location: 7.733699N, 8.549581E) C(Location: 7.15201N, 8.168876E)

Plate 4.5: Outcrops observed within the study area in Middle Benue Trough

4. Basement Complex/Crystalline Formation

The Project corridor falls within the northcentral Nigerian Basement Complex. The area is underplayed by four lithological units of schists, gneisses, migmatites, and granites, with pegmatite’s and quartz veins as minor intrusions. The first lithological unit, the schist, mostly mica schist covers about 5 % and occurs to in part of Nasarawa State. The second lithological unit, the gneisses, mostly coarse and porphyroblastic gneisses and little fine -grained gneiss cover about 60 % of the crystalline Formation of the study area. The third lithological unit, the migmatite, covers nearly 25 %. The last units, the granite, which covers about 10 % of the area, are mostly exposed on the northwestern parts of the study area.

The lithology of the crystalline formation is mostly coarse-grained granite and porphyritic granite. Apart from these four major rock types, there are other rocks types occurring inform of minor intrusions such as pegmatite’s and quartz veins. They are closely associated with the granitic rocks and the gneisses. These cut across one another and are generally characterized by coarse to medium grained textures. The intrusive rocks of the area consist of a dolerite stock and a plug of felsic area. The volcanic rock (porphyritic basalt) extruded over the host sandstone rock.

Plate 4.6: Outcrops observed within the Crystalline Formation of the study area in Jos and within Mada river (8.757563N, 8.29582E)

5. Upper Benue Trough: Gongola Basin and Yola Basin

The Upper Benue trough is a major NE-SW trending rift basin of 50-150 km in width. It extends for over 1000 km, starting from the northern margin of the Niger Delta in the south to the southern margin of the Chad Basin in the north. The trough is believed to have formed from extensional process during the Late Jurassic to the Early Cretaceous separation of the continents of Africa and South America (Grant, 1971).

The Upper Benue Trough is Y-shaped made up of two arms namely: The E-W trending Yola Arm and N-S trending Gongola Arm (Dike, 2002) (Figure. 4.19).

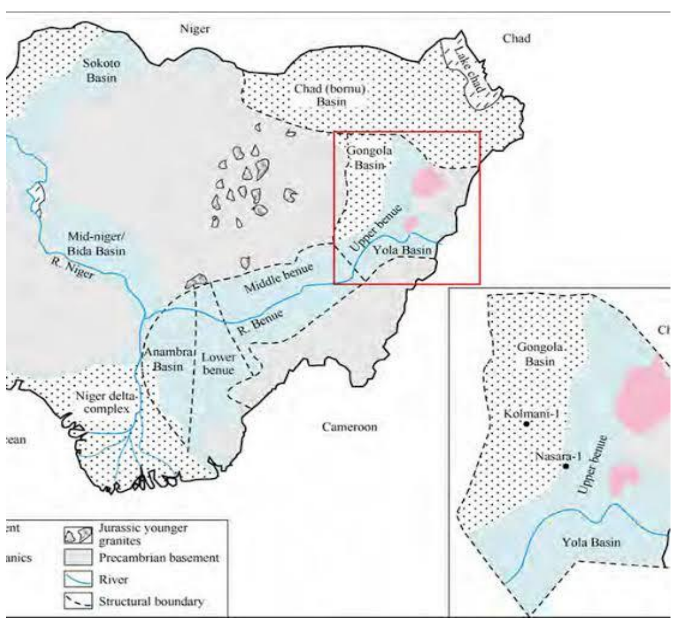


Figure 4.19: Geographical Subdivision of the Benue Trough (Dike 2002)

Obeying the law of Superimposition, the Gongola Basin have Bima Sandstone as the oldest, depositied during the Albian-Aptian time while Kerri Kerri is the youngest as outlined in table 4.17

Table 4.17: Stratigraphy of Gongola Basin (Modified from Zaborski et al, 1997)

Age	Formation	Lithology
Paleocene	Kerri Kerri	Coal, Claystone
Unconformity		
Maastrichtian	Gombe Sandstone	Sansdstone, Coal
Companian		
Unconformity		
Santonian	Pindiga Formation	Limestone, Sandstone, Claystone
Coniacian		
Turonian		
Cenomanian	Yolda	Shale/Sandstone
Albian – Aptian	Bima Sandstone	Claystone/Sandstone
Precambrian	Basement	Granite/Gneiss/schist

Plate 4.7: Interbedded sandstone and mudstone observed along Gombe – Potiskum road (10.457263N, 11.2599E)

6. Bornu Basin / Chad Basin

According to Okosun 1995, the Bornu basin is made up of six stratigraphic units ranges in age from Albian to recent as shown in the table below.

Table 4.18: Stratigraphic succession in the Bornu Basin (Modified, Okosun EA 1995)

Age	Formations	Lithology
Pliocene - Pleistocene	Chad Formation	Variegated clays with sand Interbeds
Paleocene	Kerri-Kerri	Iron rich sandstone and clay covered by plinth of lateritic
Unconformity		
Maastrichtian	Gombe Sandstone	siltstone, sandstone and clay with coal beds, fossils bivalve impressions.
Turonian - Santonian	Fika Shale	Shale, dark grey to black
Turonian	Gongila	Alternating sandstones and shale with limestone beds
Albian - Cenomanian	Bima	Sandstone, gravelly to medium grained, poorly sorted and highly feldspathic
Pre-Cambrian		Crystalline Basement

Deposition took place under varying conditions with each deposit representing one complete cycle of transgression and regression. From table 1.6, The oldest sediments are Albian to Cenomanian and comprise continental, sparsely fossiliferous, poorly sorted, thickly bedded, cross-stratified fine to coarse-grained feldspathic sandstones of the Bima formation, which rest unconformably on basement.

Next is the Gongila Formation which consists of thin to moderately thick bedded, grey to dark grey calcareous shales, silty sandstones and sandstones, conformably overlies the Bima formation. The Fika formation comprises of blue-black, ammonite-rich, and open marine shale with intercalations of thin limestone beds. The estuarine/deltaic Gombe formation rests unconformably on the Fika formation and occurs only in some parts of the study area. It comprises sandstone and siltstone with minor interbeds of claystone, ironstone and shale with thin coal beds.

The youngest stratigraphic unit in the basin is the continental (lacustrine and fluviatile) Chad formation, which is made-up of quaternary sedimentary sequence of fine to coarse-grained sand and clay.

4.6.4 Hydrogeology, Hydrology & Geomorphology

- **Geomorphology**

Plate 4.8: The highest point at Kuru railway Station, Jos

The major landforms typical of this study area are the **River Deltas** encountered at the Port Harcourt end of the project, **residual hills** and dry valleys encountered within Enugu axis and **plateaus** as observed in the Jos axis of the study area with the highest altitude of above 4000ft above sea level.

Thus, the study area has an undulating topography as shown in Figure 4.20. The three major geomorphic structures observed within the study area are the resultant effect of weathering, differential erosion accompanied with deposition of sediments and well defined extinct volcanic cones.

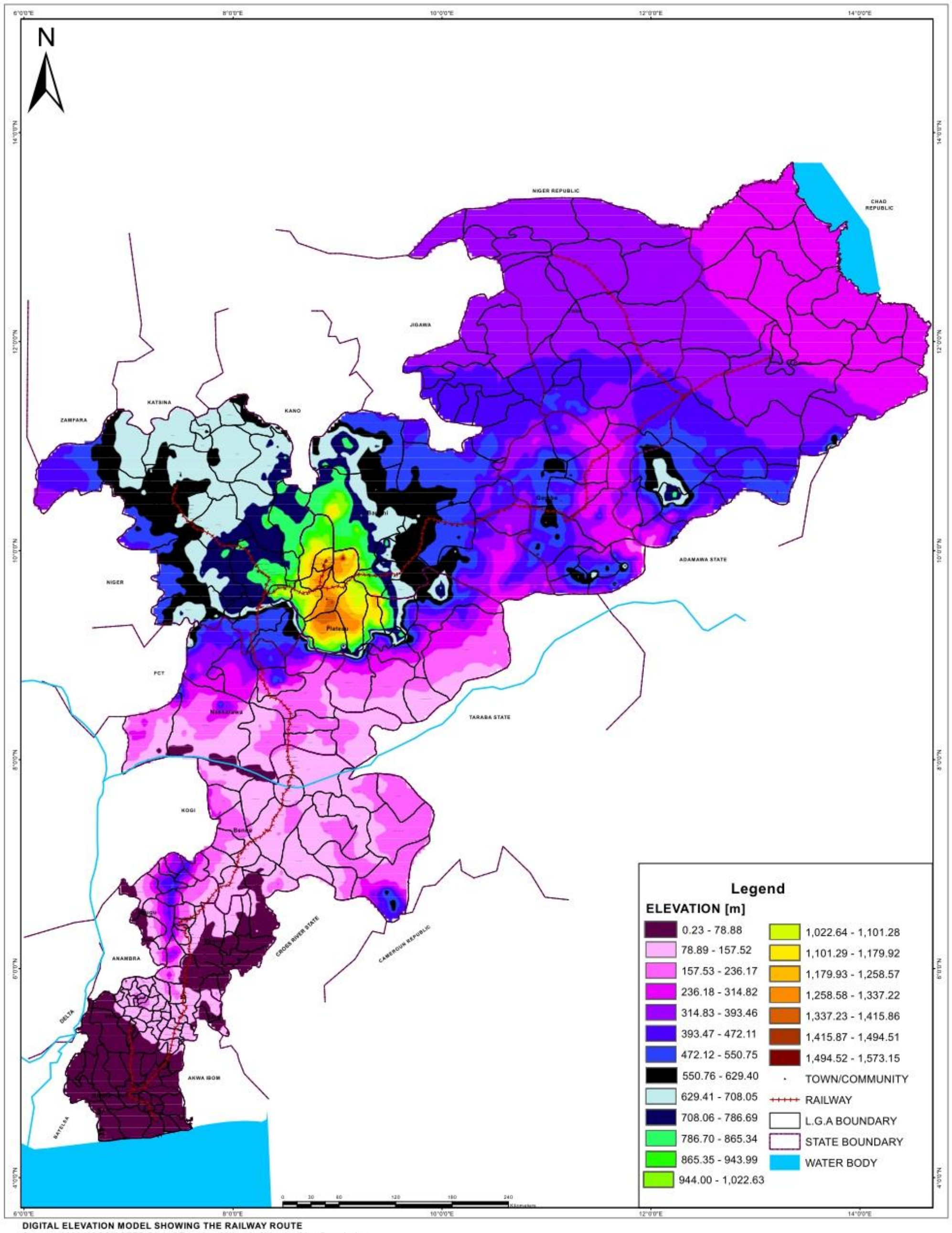


Figure 4.20: Digital Elevation Model of the study area

Hydrology

The study area falls within 7 drainage basins (Figure. 4.21). Its drainage pattern is semi-dendritic which together with the low drainage density indicates an underlying homogeneous lithology and a moderately well drained subsurface condition.

The rail line crossed six major rivers and /or their tributaries, as outlined in table 4.19

Table 4.19: Rivers along the RoW

Encountered rivers	Locations
Imo River	Rivers and Abia States (4.881975N, 7.171987E)
Ekulu River	Emene, Enugu State (6.47647N, 7.57889E)
River Benue	Benue State (7.741648N, 8.543448E)
Mada River	Nasarrawa State (8.758773N, 8.297698E)
Kaduna River	Kaduna State (10.49905N, 7.42235E)
Gongola River	Bauchi State (10.25249N, 10.148028E)
Unknown	Gashua, Yobe State (11.144919N, 11.876259E)

Source: PGM fieldwork 2020

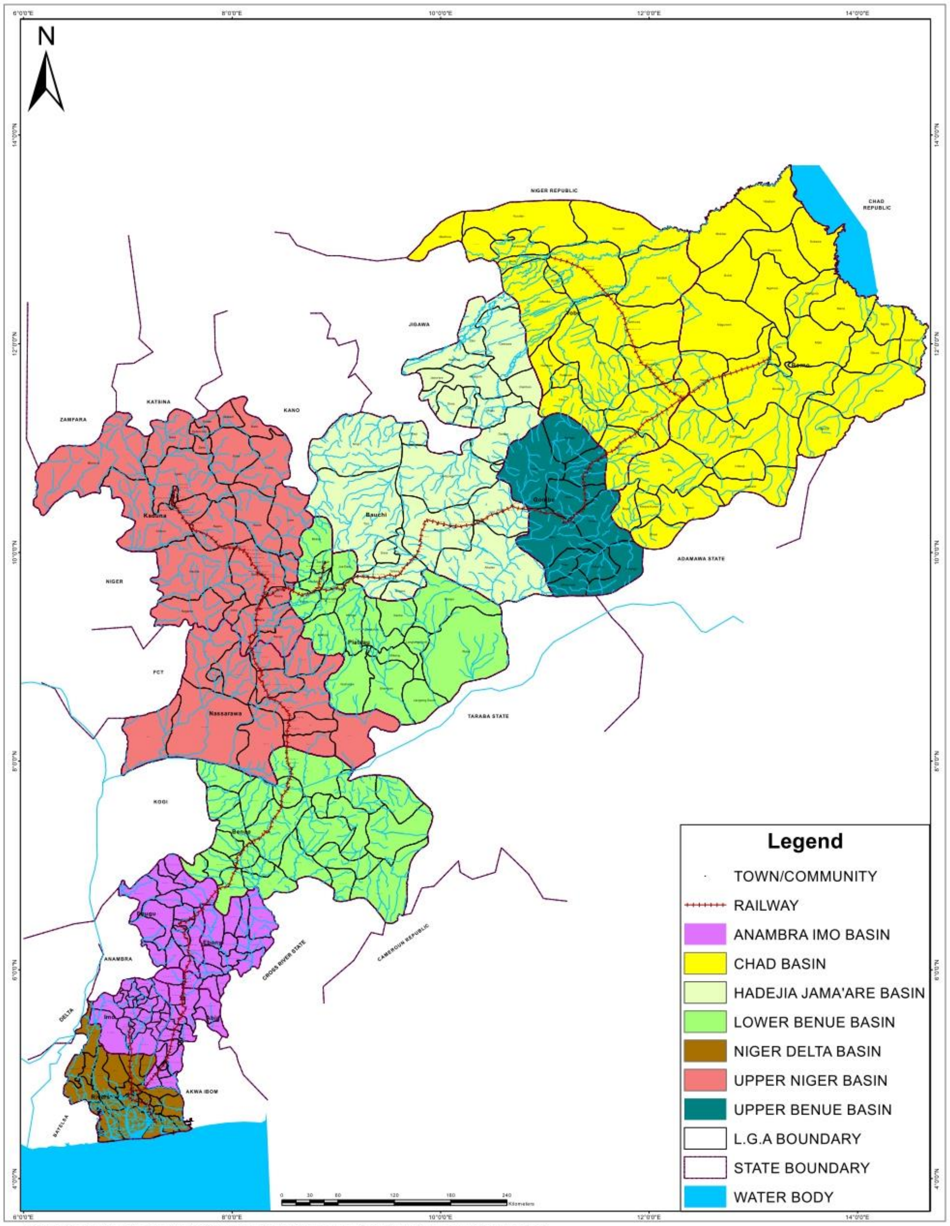


Figure 4.21: Hydrology map showing the drainage basins within the study area

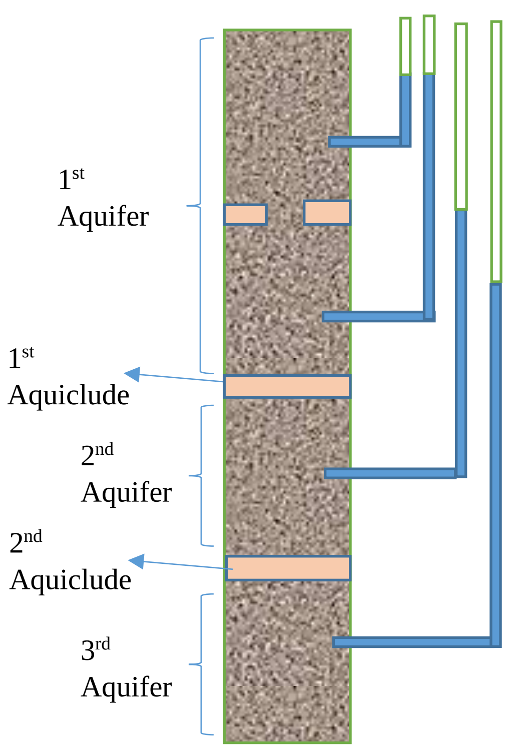
Hydrogeology

Sedimentary deposits dominate the study area and is evident from the local and Regional geological consideration. Sands (from medium to high) acts as excellent reservoir rock, the clayey intercalations, when present acts as aquitard or aquiclude, depending on the thickness, areal continuity and permeability of the layer.

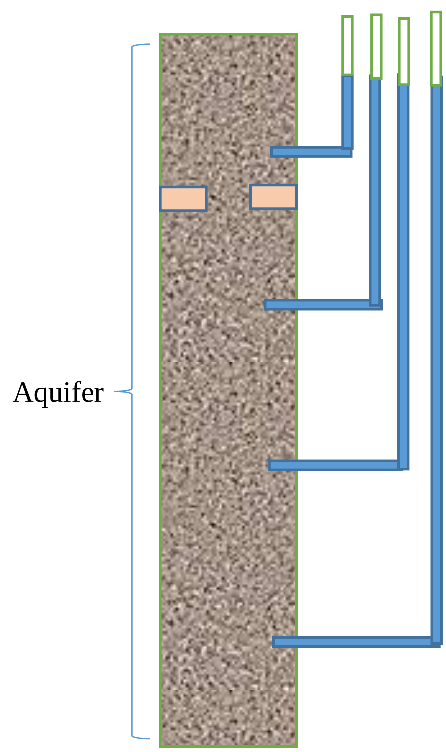
The litho-stratigraphic succession described above indicates the existence of a powerful alluvial aquifer hosted in sandy deposits. Given the variability of the sedimentary deposition and energy of the surface waterway flows, the existence of two types of aquifers (Multilayer and Monolayer aquifers) can be hypothesised.

A multi-layer aquifer is made up of several overlapping water bearing layers, hydraulically separated by less permeable clayey layers. Figure 5 gives an example of an alluvial aquifer of the multi-layer type, with continuous impermeable strata which defines a hydraulic separation. The sedimentary Formations hosts several strata hydraulically separated by impermeable strata as seen in the figure 4.22 by the various piezometric loads with hypothetical measuring pipes positioned at various depths.

Thus, a Monolayer aquifer is made up of one sedimentary body in which there is absence of less- permeable separation strata; the sedimentary body hosts a single water-bearing layer. In this case, the hydraulic loads measured at different levels are identical. In the case of multi-layer aquifer, the supply to the 1st aquifer is given by the direct recharge produced by rainfall in the area where the clayey cover is absent and by the exchange with surface waterways. The groundwater circulation of the 1st aquifer is strictly connected to the fluvial regime. Depending on the season, the Niger river may drain or be drained by the groundwater of the 1st aquifer. The mono-layer aquifer is fed by direct recharging due to rainfall and by the exchange with the surface waterways.



Multi-Layer Aquifer, encountered within Enugu, Benue, Damaturu and Yobe Axis



Mono-Layer Aquifer, encountered within Port harcourt axis

Figure 4.22: Examples of Multi-layer and Mono-layer Aquifer

Within the crystalline Formation, Groundwater occurs in the soft overburden aquifer and fractured bedrock aquifer. Hand dug wells within the study area are shallow therefore they tap water only from soft overburden aquifer. It is only some boreholes that tap water from fractured bedrock aquifer because they are drilled with mechanized equipment. The thickness of soft overburden aquifer in the study area is between 10 m observed within jos axis and 30 m in Lafia.

The two main types of aquifer in the study area are the weathered basement and the joint fractured basement aquifer with the latter sometimes occurring below the former. Thus, the occurrence of groundwater depends on the extent and depth of weathering and fracturing as shown in the figure 4.23

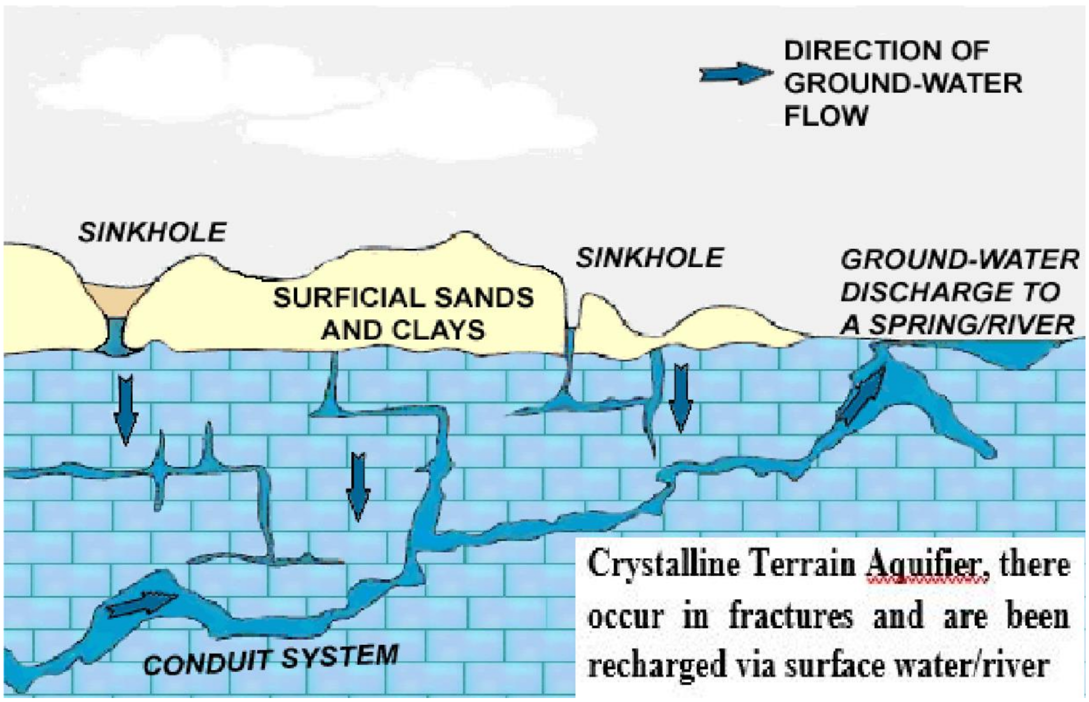


Fig 4.23: Examples of crystalline aquifier in fractured bedrock

Areas such as this hold more potential for ground water than areas with only weathered basement. As for the deep-seated weathered basement aquifer, the depth to the water table ranges from 10- 30m with water level of 20m in the wet season. In the shallow overburden aquifer, the water level during the wet season is between the surface in lowland areas and about 10- 15m in highland areas.

The depth of groundwater in the area is dependent on the topography, climate, thickness, and depth of aquifer at a certain point in time. The aquifers lack recharge during dry season due to lack of rain and capacity utilization of groundwater, which brings about fluctuation of depth in groundwater level

Water Table Configuration and Directions of Groundwater

Movement of water is strongly influenced by topography; recharge is mainly by percolating rainwater and in some places by seepages from adjacent surface water. Recharge areas consists of decomposed and fractured rocks in which pressure heads quickly spread through local water-bearing fissures and interconnected voids, thereby leading to abrupt rise in discharges in response to precipitation (Talkington RW 2004). Surface topography dictates groundwater flow directions. This may reflect varying degrees of weathering at different groundwater fronts and the occurrence of the fresh basement at different depths at different locations.

4.6.5 Geologic Structures

These are visible geologic structure encountered in the study area both within the Crystalline and Sedimentary Formations that are formed at the time of deposition of sediments and processes that operate within the depositional environment. Some of the sedimentary structures encounter within the study area includes:

7. Joints (8.757563N, 8.29582E)

8. Mudcrack (6.06464N, 7.50752E)

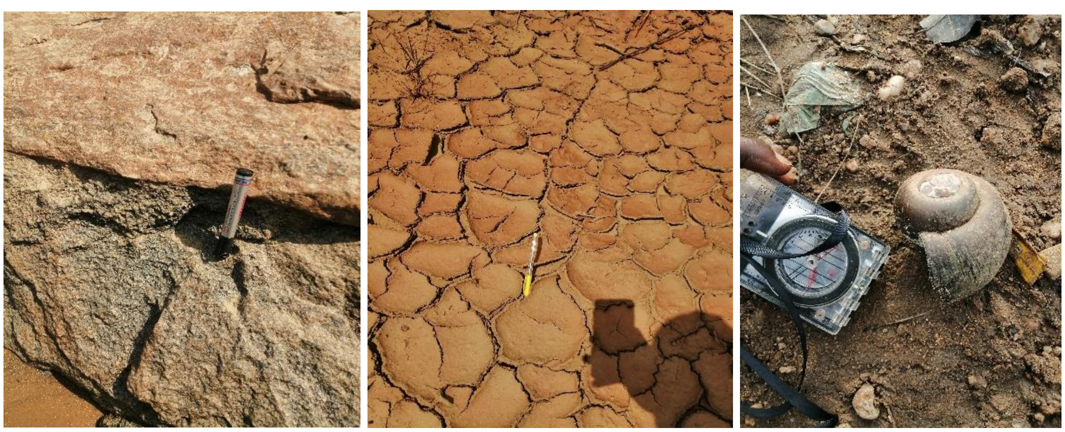
9. Body Fossil (7.733699N, 8.549581E)

10. Quartz Veins (8.757563N, 8.29582E)

11. Plane Bedding (6.543648N, 7.647536E)

12. Unconformity (6.233727N, 7.471254E)

13. Interbedded Mudstone (10.457263N, 11.2599E)



A B C

D **E**

F **G**

Plate 4.9: Geologic Structures observed within the study area (Source: PGM Fieldwork 2020)

4.7 Soil Resources

Soil is as important as water as a resource. It provides nutrients and an anchor to the roots of plants and is therefore essential to their healthy growth and yield of food and as such, vital for survival and welfare of the people. One of the most severe and widespread problems facing the agriculture industry is the degradation of soil quality due to changes and alteration to various physical and chemical parameters. Soil is a complex mixture of organic and mineral content which is constantly being formed by the weathering of rocks.

4.7.1 Soil Sampling

Soil samples were collected at thirty-five (35) stations. These include 28 sampling points and 7 control samples. At each station, soil samples were collected at two depths (0-15cm for top soil and 16-30cm for sub soil). This operation was carried out with hand auger as shown in plate 4.10. The soil sampling points and location map are provided in Table 4.19 and figure 4.24 below.

Table 4.19: Soil sampling points

Sampling Code	Coordinate	
	Longitude	Latitude
RWSS_1	7° 14' 43.880" E	4° 58' 48.009" N
RWSS_2	7° 14' 16.081" E	4° 57' 41.290" N
RWSS_3	7° 31' 24.455" E	5° 42' 7.795" N
RWSS_4	7° 58' 41.189" E	6° 50' 21.096" N
RWSS_5	7° 59' 13.043" E	6° 50' 43.149" N
RWSS_6	11° 16' 27.838" E	10° 20' 30.524" N
RWSS_7	11° 30' 19.177" E	10° 53' 7.321" N
RWSS_8	12° 20' 25.704" E	11° 29' 7.589" N
RWSS_9	12° 18' 15.764" E	11° 28' 3.606" N
RWSS_10	7° 13' 56.708" E	4° 35' 49.169" N
RWSS_11	7° 10' 3.033" E	4° 43' 38.720" N
RWSS_12	7° 10' 42.924" E	4° 42' 45.532" N
RWSS_13	7° 3' 55.300" E	4° 50' 40.065" N
RWSS_14	7° 1' 36.961" E	5° 26' 54.031" N
RWSS_15	7° 0' 46.803" E	5° 25' 26.255" N
RWSS_16	7° 1' 57.346" E	5° 9' 23.284" N
RWSS_17	7° 1' 21.619" E	5° 7' 50.814" N
RWSS_18	11° 46' 20.157" E	12° 12' 53.620" N
RWSS_19	11° 46' 14.734" E	12° 11' 55.778" N
RWSS_20	12° 52' 47.646" E	11° 45' 30.387" N
RWSS_21	7° 55' 6.614" E	10° 2' 54.942" N
RWSS_22	7° 57' 31.845" E	10° 2' 33.689" N
RWSS_23	7° 30' 6.458" E	10° 22' 30.416" N
RWSS_24	7° 27' 47.934" E	10° 37' 22.374" N
RWSS_25	7° 27' 51.313" E	10° 36' 30.005" N
RWSS_26	7° 22' 30.081" E	5° 8' 11.691" N
RWSS_27	7° 21' 35.762" E	5° 8' 49.152" N
RWSS_28	7° 30' 6.246" E	6° 26' 48.048" N
RWSS_ C1	7° 31' 27.393" E	5° 43' 3.618" N
RWSS_C2	11° 29' 14.540" E	10° 52' 49.692" N
RWSS_C3	7° 14' 58.163" E	4° 34' 44.099" N
RWSS_C4	7° 5' 41.088" E	4° 50' 38.726" N
RWSS_C5	12° 54' 48.604" E	11° 45' 21.315" N
RWSS_C6	7° 29' 49.565" E	10° 23' 17.717" N
RWSS_C7	7° 29' 6.825" E	6° 26' 8.434" N

Source: PGM fieldwork, 2020

Plate 4.10: Soil Sampling Exercise by PGM personnel.

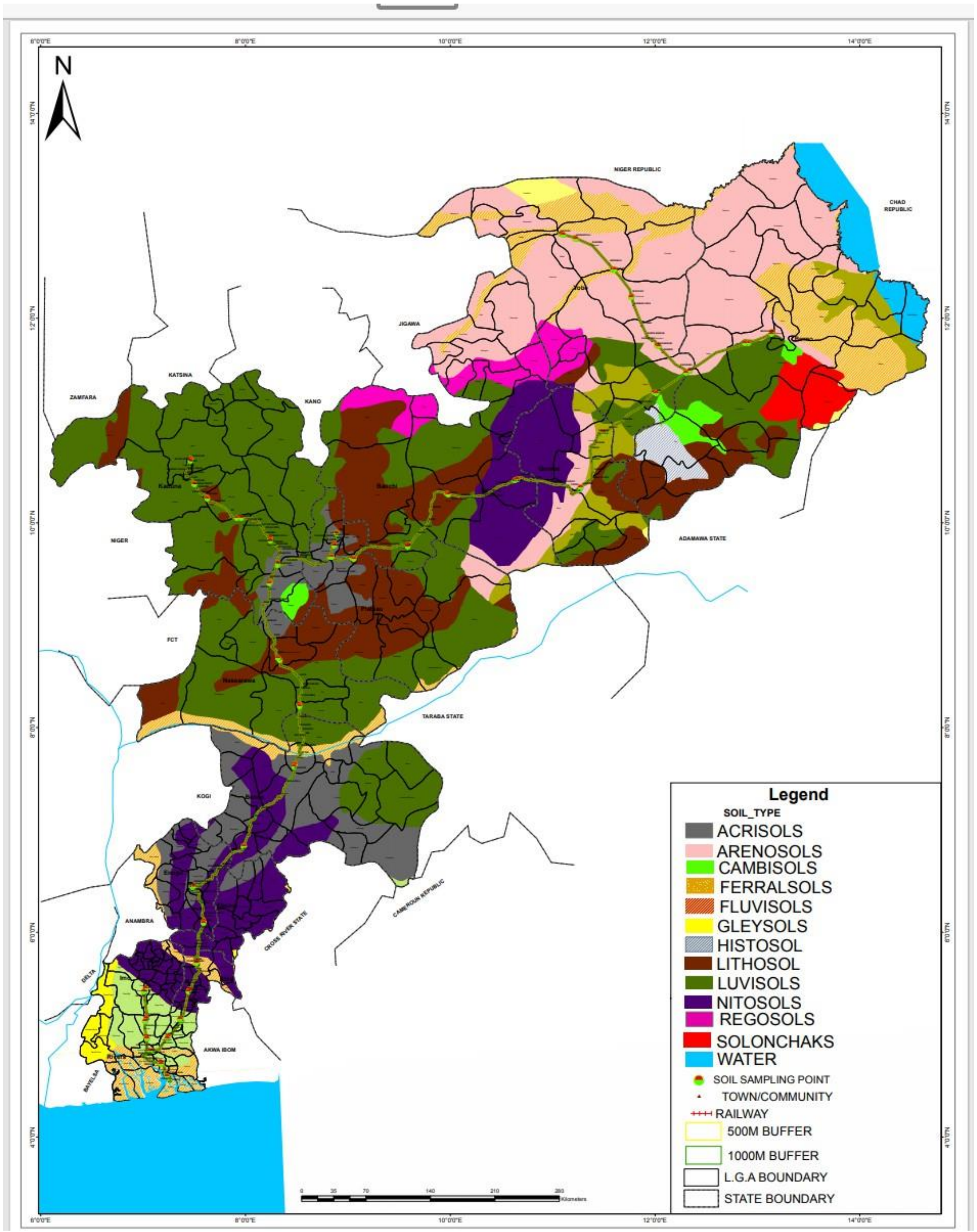


Figure 4.24: Soil Sampling location map

Each sample was collected in ziplock bags, labelled appropriately, and stored in a cooler ready for transportation to an approved Federal Ministry of Environment Laboratory. Table 4.20 is a summarized physico chemical results for soil sample (see appendix 1.2 for detailed result).

4.7.2 Physico Chemical Paramters of Soil samples

Table 4.20: Summarized of physico chemical parameters of soil samples

Parameter	Range	Mean	WHO/FMEnv Limits
Physical Characteristics			
Permeability (%)	38.6-42.3	40.433	-
Porosity (%)	38.7-49.2	44.392	-
Bulk Density (mg/kg)	1.1-1.8	1.417	-
Particle Size Distribution			
% Sand	65-82	73.167	-
% Clay	10.0-26.0	19.417	-
% Silt	6.0-9.0	7.417	-
Chemical Characteristics			
pH	6.73-7.23	6.989	6-8
Moisture Content (%)	38.5-42.3	40.508	-
Nitrate (mg/kg)	9.5-11.3	10.192	50
Phosphate (mg/kg)	2.54-5.02	3.722	5
Sulphate (mg/kg)	2.43-4.11	3.261	500
Calcium (mg/kg)	38.3-55.2	48.775	180
Magnesium (mg/kg)	5.9-8.5	7.383	-
Potassium (mg/kg)	0.27-0.52	0.413	-
Sodium (mg/kg)	0.23-3.25	1.737	-
THC(mg/kg)	<0.001	<0.001	-
Vanadium (mg/kg)	<0.001	<0.001	-
Nickel (mg/kg)	<0.001	<0.001	35
Iron (mg/kg)	9.58-12.50	10.836	45
Lead (mg/kg)	<0.001	<0.001	85
Copper (mg/kg)	0.55-1.31	0.991	36
Zinc (mg/kg)	4.68-6.28	5.558	140

Source: Laboratory Analysis 2020

All parameters analyzed were within WHO/FMEnv permissible limits.

Permeability

The permeability is a measurement of how easily liquid flows through a material (or soil). Both porosity and permeability are important to ground water. The permeability of the soil ranged from 38.6-42.3% with the mean of 40.433%. WHO/FMEnv permissible limit do not exist for soil permeability.

Porosity

The porosity of a material is a measurement of how much of its volume is open space (also called pore space). Porosity is usually expressed as a percentage of the material’s total volume. The porosity of the soil ranged from 38.7-49.2% with the mean of 44.392%. No WHO/FMEnv permissible limit available for the porosity of soil.

Bulk Density

Bulk density is the weight of soil for a given volume. It is used to measure compaction. Generally, the greater the density, the less pore space for water movement, root growth and penetration, and seedling germination. The bulk density of the soil ranged from 1.1-1.8 mg/kg with the mean of 1.417 mg/kg. WHO/FMEnv permissible limit no available.

Moisture Content

Moisture content is the ratio of the mass of water in a sample to the mass of solids in the sample, expressed as a percentage. Soils normally contains a finite amount of water, which can be expressed as the "soil moisture content." This moisture exists within the pore spaces in between soil aggregates (inter-aggregate pore space) and within soil aggregates (intra-aggregate pore space). Normally this pore space is occupied by air and/or water. If all the pores are occupied by air, the soil is completely dry. If all the pores are filled with water, the soil is said to be saturated.

The moisture content of the soil ranged from 38.5-42.3 % with the mean of 40.508 %. No recorded WHO/FMEnv permissible limit exist for moisture content.

pH

This is an indication of the acidity or alkalinity of the soil. A pH of 0 to 6.9 is increasingly more acidic while from (pH) 7.1 to 14 is increasingly more alkaline; pH 7 is a neutral point. A strongly acid soil shows intensive leaching, low exchangeable basic cation content and slow microbial activity. A strongly alkaline soil indicates non-leached soil with low nutrient content and may lead to reduced plant growth or even death to the plant (Brady and Weil, 2008).

The pH values of the soil of the project area ranged from 6.73-7.23 with the mean of 6.989 that is below WHO/FMEnv permissible limit of 6-8.

4.7.2.1 Soil Nutrients

The nitrate, phosphate and sulphate ions (NO_3^-, PO_4^{3-}, and SO_4^{2-}) are the ionic and utilizable forms of nitrogen, phosphorus and sulphur, which are essential plant nutrients present in the soil. Nitrogen is most often the limiting element in plant growth and is a constituent of chlorophyll, plant proteins, and nucleic acids. Also, phosphorus compounds form an essential part of nucleo-proteins in plant cells and these control cell division and growth. Soils usually have low total plant available phosphate supplies because mineral phosphate forms are readily not soluble. Sulphur on the other hand, occurs in proteins and is required for plant vitamin synthesis. In acidic soils, sulphur comes from mineralization of organic matter, particularly weathered soil.

The nitrates, phosphates, and sulphates levels in soils of the project area. The ranges for nitrate, phosphate and Sulphate were 9.5-11.3 mg/kg with the mean of 10.192 mg/kg; 2.54-5.02 mg/kg averaging 3.722 mg/kg; and 2.43-4.11 mg/kg with the mean of 3.261 mg/kg respectively.

In figure 4.25, nitrate accounted for 60 % of the soil nutrient followed by phosphate 22 % and the least sulphate 18 %.

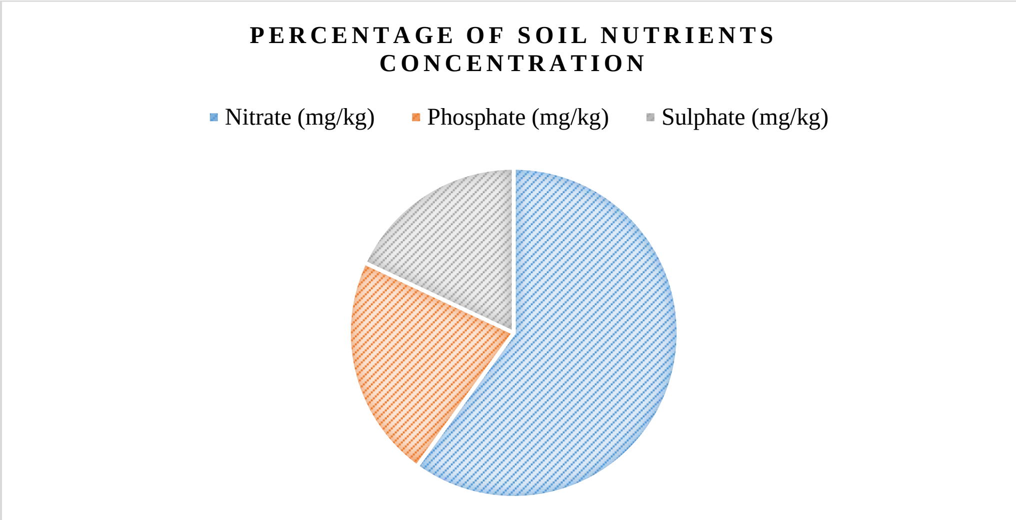


Figure 4.25: Soil nutrients concentration

Calcium

Calcium is important mineral for plants and essential for appropriate plants growth as well as helping the soil to overcome the effects associated with excess soluble salts of magnesium, sodium and potassium. The recorded concentration value ranged from 38.3-55.2 mg/kg with mean value of 48.775 mg/kg. The obtained value is within WHO/FMEnv permissible limit of 180 mg/kg.

Heavy Metals

The heavy metals analysed include vanadium, nickel, iron, lead, copper and zinc. Out of all the heavy metals analysed, vanadium, nickel and lead were below equipment detection limit of <0.001. The mean concentration value of iron (10.836 mg/kg), copper (0.991mg/kg), and zinc (5.558mg/kg) were all within WHO/FMEnv permissible limits of 45 mg/kg, 36mg/kg and 140mg/kg respectively.

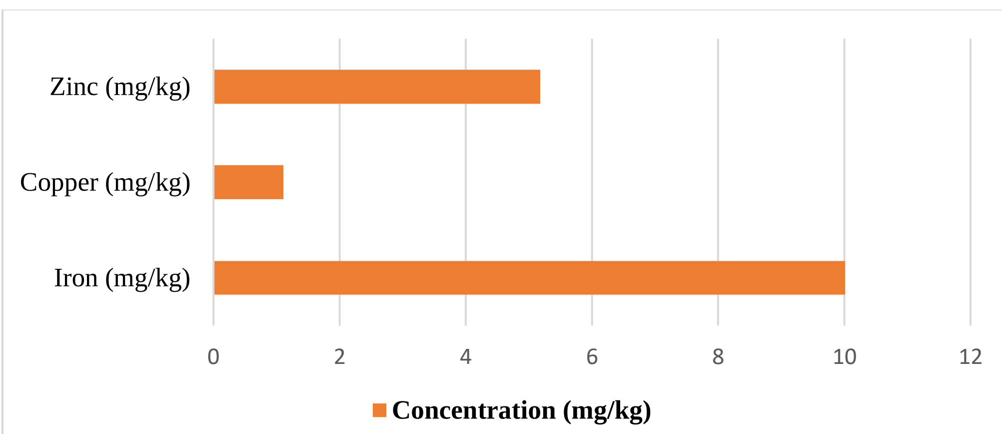


Figure 4.26: Mean concentration of heavy metals in soil sample

4.7.3 Soil Microbiology

Except for occasional insects or earthworms, once visible traces of plant biomass are removed, soil appears as a lifeless mass, which is composed of mineral particles and organic residues. However, even desert soils are abundant source of living microorganisms. This seemingly lifeless matter contains complex microbial community, including bacteria, fungi, protozoa and viruses. The integrity of the aboveground and belowground ecosystems depends on the stability, resilience and function of the soil microbial community (Tate, 2000). Soil is an interesting medium for growing microorganisms, as it contains various nutrients that the microbes need for their metabolism. Unfortunately, nutrients are not always readily available (McKinney, 2004). However, it is one of the richest reservoirs of microorganisms, i.e. 1 gram of agricultural soil may contain even several billion colony forming units (CFUs) of microorganisms belonging to thousands of different species (Rosello-Mora and Amann, 2001), and even though microorganisms constitute less than 0.5% of the soil mass, they have a major impact on soil properties and processes (Tate, 2000). Destruction of the soil microbiota through mismanagement or environmental pollution causes decline or even death of the aboveground plant and animal populations.

Numerous investigations emphasize the impact of soil structure and spatial isolation on microbial diversity and community structure (Torsvik and Ovreas, 2002). Some studies indicate that the soil particle size affects the diversity of microorganisms and community structure to a greater extent than other factors such as bulk pH and the type or amount of available organic compounds (Sessitsch *et al*., 2001). Other investigations show that the type and amount of available organic substrates strongly affect the abundance of microbial groups and their functional diversity in soils (Grayson et al., 2001). Fierer and Jackson (2006) claim that the structure of soil bacterial communities is not random also at continental scale and that the diversity and composition of soil bacterial communities at large spatial scales can be predicted to a large extent by a single variable, that is soil pH. The overall biodiversity of soil microflora comprises bacteria, fungi, actinomycetes and photosynthetic microorganisms (McKinney, 2004). Bacteria constitute the most numerous group of soil microbes – a teaspoon of productive soil contains between 100 million and 1 billion bacterial cells. As soil environment changes rather drastically, spore-forming bacteria tend to be the most common. When environmental conditions become too difficult for normal growth, the bacteria form spores and remain dormant until the environment returns to proper conditions (McKinney, 2004). They facilitate various processes in soils, e.g. those related to water dynamics, nutrient cycling or disease suppression (Hoorman, 2011).

Tate (2000) lists the most commonly encountered soil bacterial genera as: *Acinetobacter, Agrobacterium, Alcaligenes, Arthrobacter, Bacillus, Brevibacterium, Caulobacter, Cellulomonas, Clostridium, Corynebacterium, Flavobacterium, Hyphomicrobium, Metallogenium, Micrococcus, Mycobacterium, Pseudomonas, Sarcina, Streptococcus* and *Xanthomonas*. These are the heterotrophic bacteria that are augmented in soil by autotrophic and mixotrophic representatives, including nitrifiers, *Thiobacillus* species and iron bacteria. Bacteria facilitate a number of physical and biochemical alterations or reactions in soils and thereby directly or indirectly support the development of higher plants. Their performance is vital for a variety of processes that include: decomposition of cellulose or other carbohydrates (e.g. *Bacillus, Achromobacter, Cellulomonas, Clostridium, Methanococcus*), *ammonification (Bacillus, Pseudomonas),* *nitrification* (*Nitrosomonas, Nitrobacter*), *denitrification (Achromobacter, Pseudomonas, Bacillus, Micrococcus*) and nitrogen fixation (symbiotic *Rhizobium, Bradyrhizobium* etc., non-symbiotic *Azotobacter, Beijerinckia*) (Agriinfo, 2013).

On the other hand, soil fungi form three functional groups: decomposers, mutualists and pathogens. Fungi, along with bacteria, are important decomposers of hard to digest organic matter and they increase nutrient uptake of phosphorus. Mycorrhizal fungi support plants by promoting root branching and increasing nitrogen, phosphorus and water uptake. They improve plant resilience to pests, diseases or drought and improve soil structure, as fungal hyphae binds soil particles together to create water-stable aggregates. They in turn create the pore spaces in the soil that enhance water retention and drainage (Jenkins, 2005). The most common fungi found in soil belong to the *Penicillium* and *Aspergillus* genera together with the representatives of the Zygomycetes and the mycorrhizae-associated Ascomycetes and Basidiomycetes (Tate, 2000). Actinomycetes are a large group of microorganisms, systematically identified as bacteria, which grow as hyphae. They decompose a wide range of substances, but they are particularly important in degrading recalcitrant (difficult to degrade) compounds such as chitin, lignin, keratin and cellulose. Moreover, they produce a number of secondary metabolites such as antibiotics i.e. streptomycin (Schlegel, 1993) or geosmine which is responsible for "earthy" smell after soil plowing (Hoorman, 2011). Actinomycetes are important in forming stable humus, which enhances soil structure, improves soil nutrient storage and increases water retention in soils. According to Tate (2000), the most commonly encountered soil actinomycetes belong to *Nocardia* and *Streptomyces* genera.

Algae are the most common among photosynthetic microorganisms found in soil. They are found only near soil surface, where light is readily available (McKinney, 2004). The most common genera of green algae found in soil are: *Chlorella*, *Chlamydomonas*, *Chlorococcum*, *Protosiphon* etc. and that of diatoms are *Navicula*, *Pinnularia. Synedra, Frangilaria*. Their functions include the maintenance of soil fertility, increasing water retention capacity of soil, prevention of soil erosion due to the fact that they act as cementing agents in binding soil particles. They add organic matter to soil after the cell death and thus increase the amount of organic carbon, while their photo- synthetic activity release large quantity of oxygen that facilitate the aeration in submerged soils or oxygenate the soil environment. They also take part in weathering rocks, thus building up the soil structure (Agriinfo, 2013) Although biomass of all microorganisms living in soil constitutes only several percent of organic matter content, they play an important role in the functioning of entire ecosystems (Barabasz et al., 2002). They take part in soil formation, mineralize organic substances, provide plants with bio-available compounds, cooperate with plants or may be used as a source of insecticidal substances (Lynch, 1988).

Despite beneficial effects of numerous soil microbes on plant growth or development, soil structure and functioning, some soil-dwelling microorganisms may cause plant, animal and human diseases. Similarly to the beneficial soil microflora, soil pathogens include bacteria, fungi and viruses. One of the example of the most important or best known plant pathogens include *Agrobacterium tumefaciens* (whose updated scientific name is now *Rhizobium radiobacter*) (Young et al., 2001) which is the causal agent of crown gall disease of walnuts, grape vines, stone fruits and many others. These bacteria infect plant roots and induce cells to divide (due to overproduction of auxin and cytokinin), causing a tumor-like swellings that contain infected cells (Viss et al., 2003). *Erwinia carotovora* (or now called *Pectobacterium carotovorum*) and *Erwinia amylovora*, the Gram-negative plant pathogens with a diverse host range cause infections of numerous agriculturally and scientifically important plant species, such as potato, apple, pear and some members of the family Rosaceae (Toth *et al*., 2003). Soil is also an abundant source of fungal pathogens. Among them we may distinguish *Rhizoctonia solani*, a plant pathogenic fungus with a wide host range and worldwide distribution. It causes collar rot, crown rot, root rot, damping off and wire stem (Koike et al., 2003). It mainly attacks plant seeds below the soil surface, but may also infect leaves and stems. Due to a variety of hosts that this pathogen attacks, it is of great importance and is detrimental to a variety of crops. The *Armillaria* root rot, caused by several species of basidoimycete genus *Armillaria* – the honey fungus is, on the other hand, one of the greatest threat for woody plants (Williams et al., 1989).

Another example of soil-borne plant pathogens is an important genus of fungi – *Fusarium*, which contains a number of, worldwide distributed, phytopathogenic species (Moss and Smith, 1984). Moreover, *Fusarium* has also been more recently reported as an emerging human pathogen for immune-compromised patients (Vartivarian *et al*., 1993). *Clostridium tetani* is an example of one of the most dangerous soil borne human pathogens. It is a tetanus-causing Gram-positive bacterium, whose transmission occurs through the contamination of wounds with soil carrying its spores (Ryan, 2004). Generally, soil is a typical carrier of human bacterial and fungal pathogens. Another example of them is *Bacillus anthracis*, the causative agent of anthrax, which is found worldwide in a variety of soil environments. Inhalation of *B. anthracis* spores can be fatal. Nevertheless, the incidence of both of these fatal diseases has been largely controlled in developed countries due to the development of vaccines (Maier *et al*., 2009). Undoubtedly, soil is an inexhaustible reservoir of microorganisms, both beneficial and pathogenic ones. Causing the imbalance between groups of soil macro- and microorganisms may be irreversible and result in a variety of effects, sometimes unpredictable. Such imbalance may be caused by soil pollution resulting from developing industry; therefore, understanding the sources and effects of industrial soil pollution is an important element in preventing the environmental degradation.

Table 4.21: Microbial Characteristics of Sediment, Soil and Water Samples

Sample	Method	Reference
Sediment	Cultural	Frankland *et al*. (1995)
Soil	Cultural	Carter and Gregorich (2008)
Water	Cultural	Jayalakshmi and Lakshmi (2014)

4.7.3.1 Microbial Properties of soil

Table 4.22: Microbial Properties of Soil Samples

Parameter	SS_1	SS_2	SS_3	SS_4	SS_5	SS_6	SS_7	SS_8	SS_9	SS_{10}	SS_{11}	SS_{12}
Total Heterotrophic Bacteria (CFU/g)	4.7×10^5	3.3×10^5	3.1×10^5	2.7×10^5	2.5×10^5	3.8×10^5	4.1×10^5	5.0×10^5	3.9×10^5	3.8×10^5	4.3×10^5	5.3×10^5
Total Heterotrophic Fungi (CFU/g)	5.3×10^5	3.7×10^5	3.6×10^5	3.2×10^5	2.7×10^5	4.2×10^5	4.8×10^5	5.8×10^5	4.4×10^5	4.1×10^5	4.6×10^5	5.5×10^5
Hydrocarbon Utilizing Bacteria (CFU/g)	1.1×10^5	1.4×10^5	2.4×10^5	1.7×10^5	2.1×10^5	1.8×10^5	2.0×10^5	1.6×10^5	1.5×10^5	2.2×10^5	1.3×10^5	2.3×10^5
Hydrocarbon Utilizing Fungi (CFU/g)	1.3×10^5	1.7×10^5	1.5×10^5	1.3×10^5	1.7×10^5	1.4×10^5	1.9×10^5	1.8×10^5	1.3×10^5	1.8×10^5	2.1×10^5	1.7×10^5

Parameter	SS_{13}	SS_{14}	SS_{15}	SS_{16}	SS_{17}	SS_{18}	SS_{19}	SS_{20}	SS_{21}	SS_{22}	SS_{23}	SS_{24}
Total Heterotrophic Bacteria (CFU/g)	6.5×10^5	5.3×10^5	5.5×10^5	5.8×10^5	4.9×10^5	4.7×10^5	3.8×10^5	3.2×10^5	2.8×10^5	3.7×10^5	4.2×10^5	5.4×10^5
Total Heterotrophic Fungi (CFU/g)	6.7×10^5	4.8×10^5	4.8×10^5	4.9×10^5	3.5×10^5	5.3×10^5	4.1×10^5	3.3×10^5	3.5×10^5	4.5×10^5	4.8×10^5	5.7×10^5
Hydrocarbon Utilizing Bacteria (CFU/g)	1.8×10^5	2.5×10^5	1.1×10^5	1.5×10^5	2.4×10^5	1.7×10^5	1.6×10^5	1.9×10^5	2.0×10^5	1.2×10^5	1.4×10^5	2.6×10^5
Hydrocarbon Utilizing Fungi (CFU/g)	1.5×10^5	1.9×10^5	1.7×10^5	1.6×10^5	1.8×10^5	1.3×10^5	1.5×10^5	1.3×10^5	2.2×10^5	1.4×10^5	1.8×10^5	1.8×10^5

Source: Laboratory Analysis (2020)

Table 4.23: Microbial Properties of Soil Samples contd

Parameter	SS_{25}	SS_{26}	SS_{27}	SS_{28}	SS_{29}	SS_{30}	SS_{31}	SS_{32}	SS_{33}	SS_{34}	SS_{35}
Total Heterotrophic Bacteria (CFU/g)	4.3×10^5	4.5×10^5	3.5×10^5	3.5×10^5	3.2×10^5	3.4×10^5	4.4×10^5	4.8×10^5	3.5×10^5	3.2×10^5	4.5×10^5
Total Heterotrophic Fungi (CFU/g)	3.6×10^5	4.2×10^5	3.7×10^5	3.7×10^5	2.9×10^5	4.5×10^5	4.4×10^5	5.3×10^5	4.3×10^5	3.7×10^5	4.0×10^5
Hydrocarbon Utilizing Bacteria (CFU/g)	1.3×10^5	1.5×10^5	1.6×10^5	1.8×10^5	1.7×10^5	1.4×10^5	1.1×10^5	1.4×10^5	1.3×10^5	1.8×10^5	1.5×10^5
Hydrocarbon Utilizing Fungi (CFU/g)	1.4×10^5	1.7×10^5	1.7×10^5	1.5×10^5	1.5×10^5	1.2×10^5	1.3×10^5	1.6×10^5	1.5×10^5	1.5×10^5	1.1×10^5

Source: Laboratory Analysis (2020)

Table 4.24: Microorganisms Identified in Soil Samples

Sample Code	Bacteria	Fungi
SS_1	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_2	*Bacillus brevis, Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Enterobacter faecium*.	*Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida* albicans, Chrysogenum sp, *Alternaria* sp.
SS_3	*Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Escherichia coli*, *Enterobacter faecium*.	*Saccharomyces* sp, *Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*, **Candida tropicalis*
SS_4	*Staphylococcus aureus*, *Micrococcus* sp, *Actinomyces* sp, *Pseudomonas aeruginosa*,	*Penicillium* sp, *Aspergillus fumigatus*, *Pichia* sp, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_5	*Achromobacter* sp, *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* sp.	*Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_6	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_7	*Proteus* sp, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Clostridium* sp.	*Fusarium* sp, *Aspergillus niger*, **Candida tropicalis*.
SS_8	*Klebsiella* sp, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus brevis*, *Enterobacter faecium*.	**Penicillium* sp, **Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*.
SS_9	**Bacillus* sp, *Achromobacter* sp, *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* subtilis, *Streptococcus faecalis*,	*Alternaria* sp, *Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_{10}	*Staphylococcus aureus*, *Enterococcus* sp, *Pseudomonas aeruginosa*, *Acetobacter* sp.	*Fusarium* sp, *Aspergillus niger*, **Candida tropicalis*, *Chrysogenum* sp.
SS_{11}	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Nitrosomonas* sp., *Nitrobacter* sp.	*Aspergillus fumigatus*, *Rhizopus stolonifer*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_{12}	*Bacillus brevis, Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Enterobacter faecium*.	*Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida* albicans, Chrysogenum sp, *Alternaria* sp.
SS_{13}	*Chondrococcus* sp., *Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Escherichia coli*, *Enterobacter faecium*, , *Lyngbya* sp., *Oscillatoria* sp., *Phormidium* sp., *Microcoleus* sp., *Cylindrospermum* sp., *Anabaena* sp., *Nostoc* sp., *Scytonema* sp. *Fischerella* sp.	*Saccharomyces* sp, *Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*, **Candida tropicalis*, *Rhizopus stolonifer*
SS_{14}	*Staphylococcus aureus*, *Micrococcus* sp, *Actinomyces* sp, *Pseudomonas aeruginosa*,	*Penicillium* sp, *Aspergillus fumigatus*, *Agaricus campestris* , *Pichia* sp, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_{15}	*Achromobacter* sp, *Chrococcus* sp., *Aphanocapsa* sp., *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* sp. *Thiobacillus* sp.	*Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_{16}	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Myxococcus* sp., *Chondrococcus* sp., *Archangium* sp., *Polyangium* sp, *Cytophaga* sp. *and Sporocytophaga* sp.	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.

Sample Code	Bacteria	Fungi
SS_{17}	*Proteus* sp, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Clostridium* sp. *Archangium* sp.	*Fusarium* sp, *Neurospora* sp., *Saccharomyces cerevisiae* , *Aspergillus niger*, **Candida tropicalis*.
SS_{18}	*Klebsiella* sp, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus brevis*, *Enterobacter faecium*, *Ferrobacillus* sp.,	**Penicillium* sp, **Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*.
SS_{19}	**Bacillus* sp, *Achromobacter* sp, *Thermoactinomyces* sp., *Streptomyces* sp. *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* subtilis, *Streptococcus faecalis*,	*Alternaria* sp, *Rhizopus stolonifer*, *Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_{20}	*Staphylococcus aureus*, *Enterococcus* sp, *Pseudomonas aeruginosa*, *Acetobacter* sp. *Polyangium* sp, *Cytophaga* sp.	*Fusarium* sp, *Agaricus campestris* , *Aspergillus niger*, **Candida tropicalis*, *Chrysogenum* sp.
SS_{21}	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Nitrosomonas* sp., *Nitrobacter* sp.	*Aspergillus fumigatus*, *Rhizopus stolonifer*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_{22}	*Bacillus brevis*, *Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Enterobacter faecium*.	*Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida* albicans, Chrysogenum sp, *Alternaria* sp.
SS_{23}	*Chondrococcus* sp., *Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Escherichia coli*, *Enterobacter faecium*, , *Lyngbya* sp., *Oscillatoria* sp., *Phormidium* sp., *Microcoleus* sp., *Cylindrospermum* sp., *Anabaena* sp., *Nostoc* sp., *Scytonema* sp. *Fischerella* sp.	*Saccharomyces* sp, *Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*, **Candida tropicalis*, *Rhizopus stolonifer*
SS_{24}	*Staphylococcus aureus*, *Micrococcus* sp, *Actinomyces* sp, *Pseudomonas aeruginosa*,	*Penicillium* sp, *Aspergillus fumigatus*, *Agaricus campestris* , *Pichia* sp, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.

Table 4.25: Microorganisms Identified in Soil Samples contd

Sample Code	Bacteria	Fungi
SS_{25}	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_{26}	*Bacillus brevis*, *Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Enterobacter faecium*.	*Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida* albicans, Chrysogenum sp, *Alternaria* sp.
SS_{27}	*Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Escherichia coli*, *Enterobacter faecium*.	*Saccharomyces* sp, *Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*, **Candida tropicalis*
SS_{28}	*Staphylococcus aureus*, *Micrococcus* sp, *Actinomyces* sp, *Pseudomonas aeruginosa*,	*Penicillium* sp, *Aspergillus fumigatus*, *Pichia* sp, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_{29}	*Achromobacter* sp, *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* sp.	*Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_{30}	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.

Sample Code	Bacteria	Fungi
SS_{31}	*Proteus* sp, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Clostridium* sp.	*Fusarium* sp, *Aspergillus niger*, *Candida tropicalis*.
SS_{32}	*Klebsiella* sp, *Micrococcus* sp, *Pseudomonas* sp, *Bacillus brevis*, *Enterobacter faecium*.	*Penicillium* sp, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, *Candida albicans*.
SS_{33}	*Bacillus* sp, *Achromobacter* sp, *Bacteroids* sp, *Acinetobacter* sp, *Bacillus* subtilis, *Streptococcus faecalis*,	*Alternaria* sp, *Geotricum* sp, *Penicillium* sp, *Aspergillus niger*, *Candida* sp,
SS_{34}	*Staphylococcus aureus*, *Enterococcus* sp, *Pseudomonas aeruginosa*, *Acetobacter* sp.	*Fusarium* sp, *Aspergillus niger*, *Candida tropicalis*, *Chrysogenum* sp.
SS_{35}	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Nitrosomonas* sp., *Nitrobacter* sp.	*Aspergillus fumigatus*, *Rhizopus stolonifer*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.

*Hydrocarbon degrader

4.7.3.2 Soil Microbiology Discussion

The abundance and distribution of soil microorganisms are presented in Table 4.22. The densities of bacteria and fungi in the study area varied between sample locations. The heterotrophic bacterial densities obtained ranged from 2.5 x 10^5cfu/g to 6.5 x 10^5cfu/g while 2.7 x 10^5cfu/g to 6.7 x 10^5 cfu/g was recorded for fungi.

The present status of heterotrophic microbial densities indicates a fertile soil environment. Oil degrading microbes were also detected in the soil samples. The low counts of oil degrading bacteria (1.1 x 10^5 cfu/g to 1.8 x 10^5 cfu/g) and fungi (1.1 x 10^5 cfu/g to 1.9 x 10^5 cfu/g) indicates a remarkable low hydrocarbon load of the soil (Essien and Antai, 2005, Odu 1972).

Their presence implies that the rail project environment may undergo natural remediation process (depending on the extent of pollution) in event of contamination with hydrocarbons during construction. The diverse species of microorganisms encountered in the project environment are listed on Table 4.24.

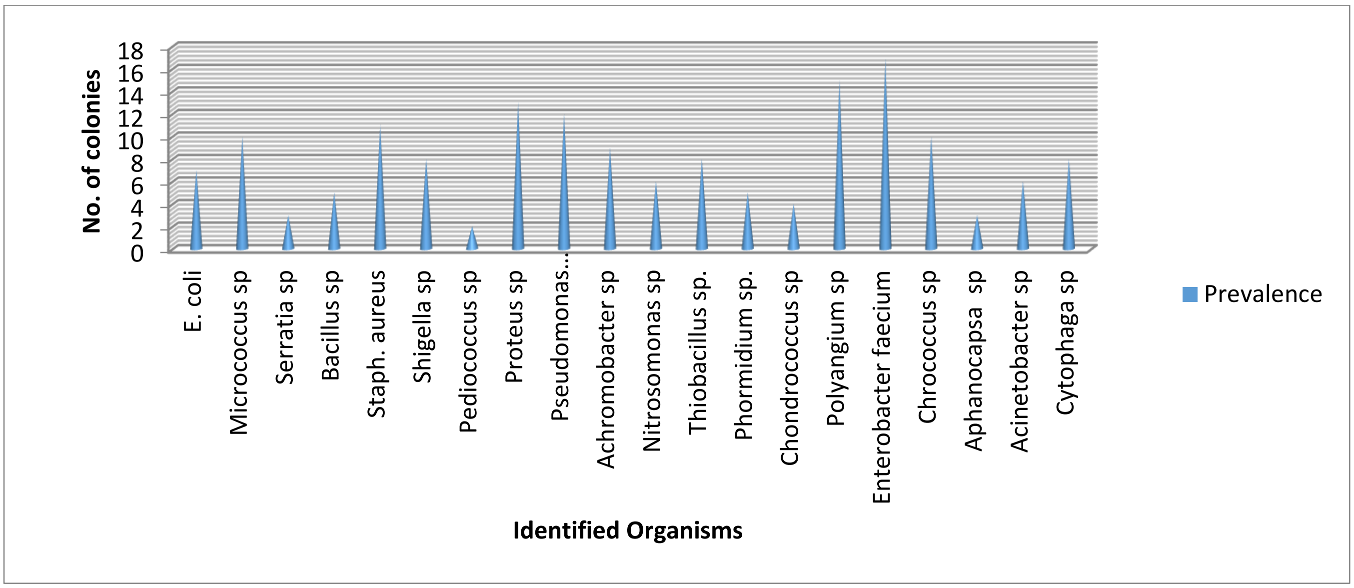


Figure 4.27: Prevalence of Bacterial Isolates in Soil Samples

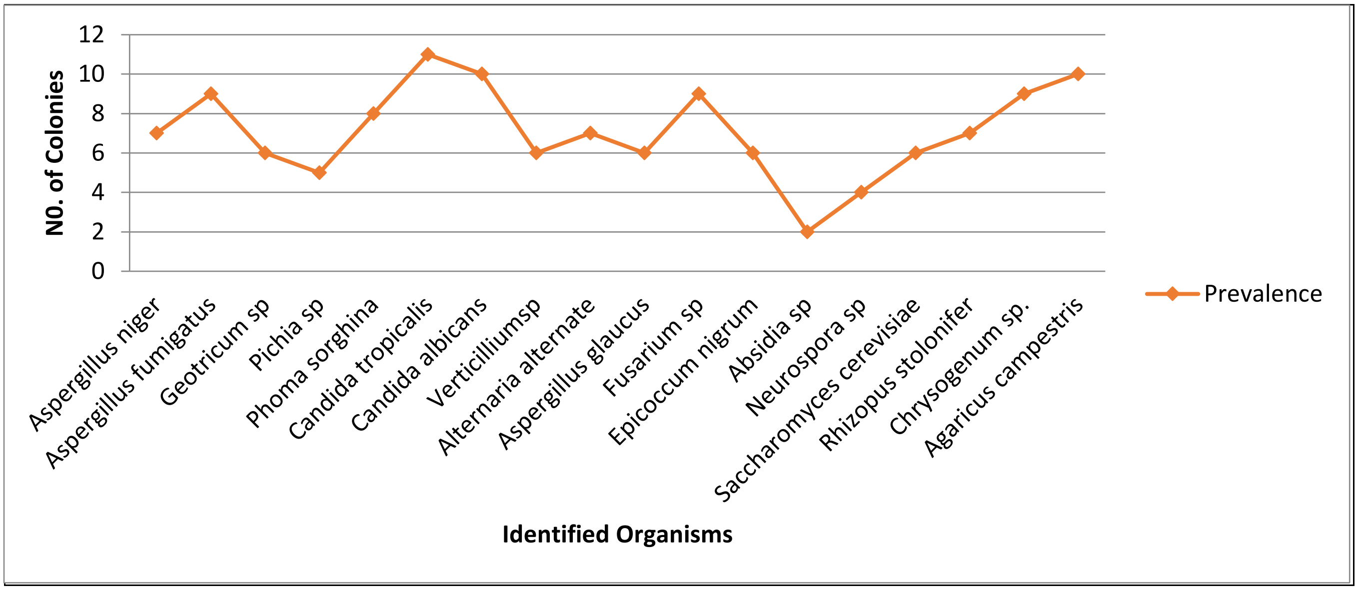


Figure 4.28: Prevalence of Fungal Isolates in Soil Samples

4.8 Surface Water and Sediments

Sixteen (16) water samples were collected for surface water in close proximity to the proposed project area. These include 12 stations as sampling point and 4 stations as control point as shown in Table 4.26 and these were analysed for physico-chemical and microbiological properties and were subsequently sampled.

Table 4.26: Surface water sampling locations.

Sample Code	Coordinate	
	Northing	Easting
ERWSW 1	7° 10' 30.330" E	4° 52' 37.977" N
ERWSW 2	7° 10' 11.229" E	4° 52' 40.787" N
ERWSW 3	8° 32' 19.776" E	7° 44' 38.082" N
ERWSW 4	9° 45' 57.173" E	9° 58' 42.135" N
ERWSW 5	9° 46' 16.682" E	9° 58' 38.121" N
ERWSW 6	9° 48' 44.693" E	10° 6' 1.459" N
ERWSW 7	9° 49' 3.473" E	10° 5' 55.967" N
ERWSW 8	10° 8' 46.708" E	10° 14' 54.572" N
ERWSW 9	11° 16' 52.697" E	10° 21' 32.384" N
ERWSW 10	11° 17' 10.364" E	10° 21' 34.886" N
ERWSW 11	11° 23' 3.379" E	10° 30' 5.779" N
ERWSW 12	11° 23' 15.063" E	10° 30' 14.748" N
ERWSW-C1	8° 32' 35.877" E	7° 44' 26.530" N
ERWSW-C2	10° 8' 54.081" E	10° 15' 13.088" N
ERWSW-C3	7° 32' 26.395" E	6° 21' 35.383" N
ERWSW-C4	11° 52' 32.419" E	11° 8' 43.727" N

Source: PGM fieldwork, 2020

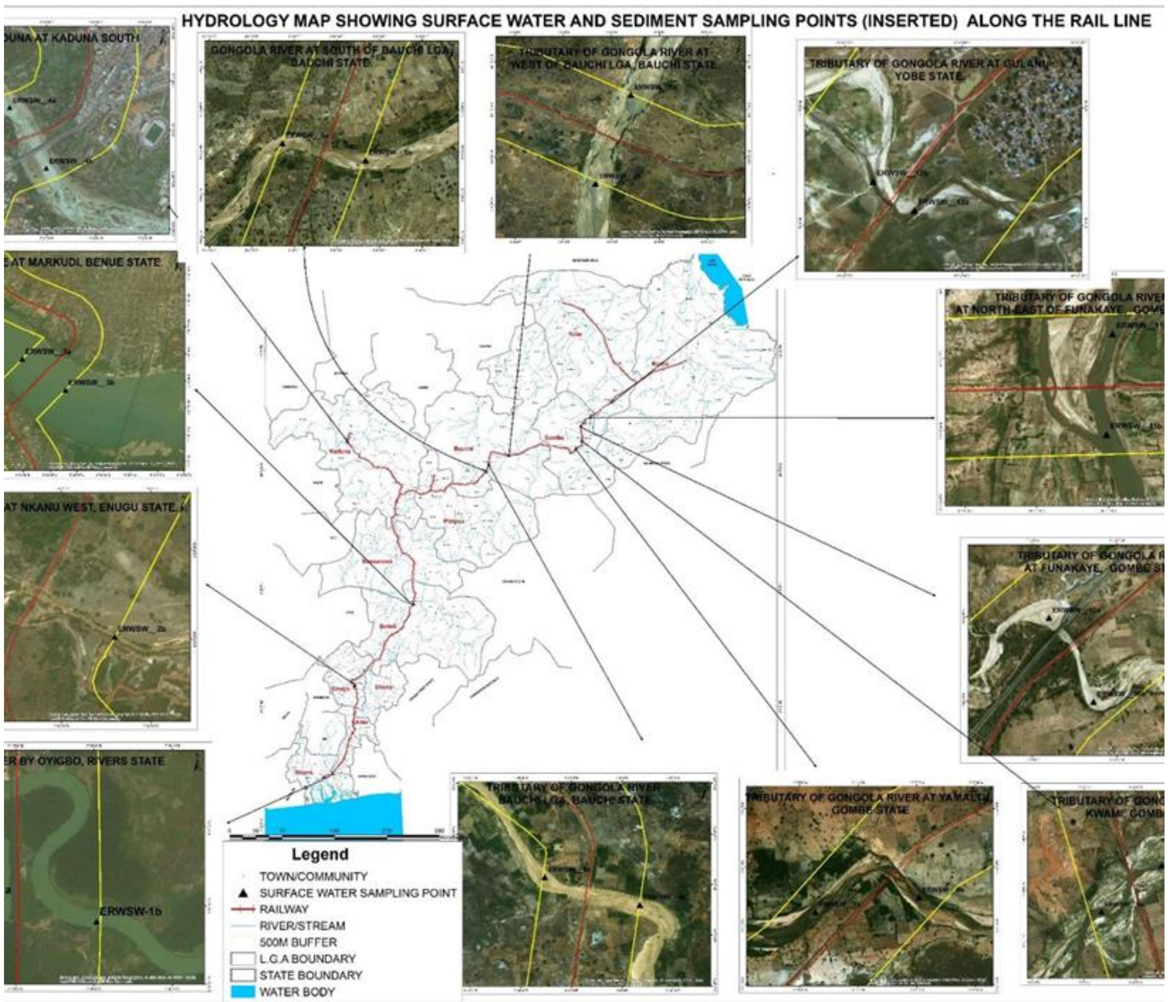


Figure 4.29: Water sampling location map

4.8.1 Sampling Methodology

Bottle sampler for water quality determinant was lowered into the river to collect surface water samples. Water samples were collected directly into various ampoules. These were stored and preserved as appropriate for each analysis.

Plate 4.11: Surface water sampling

The exercise involved *in situ* measurement of salinity, temperature, turbidity, pH, dissolved oxygen and conductivity. These are parameters with short holding time. Water samples for heavy metal analysis were collected in 2ml plastic bottles and acidified with 10% HNO_3

4.8.2 Physico chemical Result

The physico-chemical characteristics of the surface water bodies within the proposed project areas are summarized in Table4.27 (see appendix 1.2 for detailed result)

Table 4.27: Summary of Results of Physio-chemical Analyses of Surface water

Parameter	Range	Mean	WHO Limit	FMEnv Limit
Color (Pt Co Units NCASI)	13.27-15.34	14.638	5-15	-
pH	5.58-7.23	6.354	6.5-8.5	6.5-9.0
Temperature (oC)	32.4-36.2	34.663	-	-
Turbidity (NTU)	1.23-4.25	3.68	5	5
Salinity (ppt)	0.065-0.084	0.076	-	-
Hardness (mg/l)	225.4-626.3	379.044	250	250
Conductivity (µS/cm)	92.7-120.7	108.756	1000	400
DO (mg/l)	6.45-7.55	6.998	5	>4.0
BOD (mg/l)	1.03-1.36	1.214	10	-
COD (mg/l)	<0.01	<0.01	-	150
THC (mg/l)	<0.01	<0.01	-	-
Phosphate (mg/l)	0.33-0.67	0.468	-	-
Sulphate (mg/l)	3.22-4.21	3.764	250	250
Nitrate (mg/l)	2.12-3.23	2.661	10	10
TDS (mg/l)	12.81-28.68	18.129	1000	1000
TSS (mg/l)	11.01-21.35	16.31	-	-
Copper (mg/l)	0.211-0.337	0.272	1	0.01
Iron (mg/l)	1.03-2.44	1.725	0.36	0.36
Lead (mg/l)	<0.001	<0.001	0.05	<1.0

Parameter	Range	Mean	WHO Limit	FMEnv Limit
Zinc (mg/l)	0.33-0.59	0.453	3	<1.0
Cadmium (mg/l)	<0.01	<0.01	0.003	<1.0
Chromium (mg/l)	<0.01	<0.01	0.05	0.05
Potassium (mg/l)	0.18-0.36	0.273	-	-
Faecal Coliform (cfu/100ml)	3.0-14.0	8.188	0	0
Total Coliform (cfu/100ml)	7.0-15.0	11.25	0	0
THB(cfu/ml)	$1.1\text{-}2.8 \times 10^5$	2.1×10^5	100	100

Source: Laboratory Analysis, 2020

Colour

The apparent colour of river water results from light scattered upwards after it has passed through the water to various depths and undergone selective attenuation en-route. The mean value of 14.638 recorded is found to be within WHO permissible limit of 5-15.

pH

pH The pH is a measure of the hydrogen ion concentration and it is also used to indicate the degree of acidity or alkalinity. Its value is a good indicator of the state of the water**.** Recorded pH values for surface water ranged from 5.58-7.23 with the mean of 6.354. This value is within WHO/FMEnv permissible limits of 6.5-8.5 and 6.5-9.0 for drinking water and aquatic lives respectively.

Temperature

Most aquatic organisms including fishes are cold-blooded. Consequently, their metabolism increases as the water warms and decreases as it cools. Temperature values obtained for surface water ranged from 32.4-36.2^{o}C with the mean value of 34.663^{o}C. This value is within WHO/FMEnv permissible limit of 35 and 40 for drinking water and aquatic lives respectively

Salinity

Salinity is the total of all non-carbonate salts dissolved in water, usually expressed in parts per thousand (1 ppt = 1000 mg/L). Unlike chloride (Cl^-) concentration, you can think of salinity as a measure of the total salt concentration, comprised mostly of Na^+ and Cl^- ions.

Salinity values ranged from 0.065-0.084 ppt with the mean of 0.076 ppt. Neither WHO nor FMEnv has assigned permissible limit for salinity in drinking water.

Turbidity and TDS

Turbidity varies fairly proportional to the total suspended solids in the various analysed samples. Although the suspended particles that reduce clarity can include organic particles, turbidity in the water bodies in the study area is a measure of the inorganic particles that account for most of the TSS. Regulatory limits of 10 and 25 NTU are the upper intervention values for safe drinking water and sustenance of aquatic lives respectively. From the result, the turbidity level range from 1.23-4.25 NTU with mean value of 3.68 NTU. This recorded value is within WHO/FMEnv permissible limit of 10NTU.

Possible sources of TDS could be through runoff from industrial wastewater and chemicals used in the water treatment process. Thus, the TDS test is an indicator test to determine the general quality of the water. The concentration values TDS range from 12.81-28.68 mg/l with mean value of 18.129 mg/l. This value is below 1000 mg/l assigned WHO/FMEnv permissible limit for drinking water.

Total Hardness

Hardness is a measure of polyvalent cations in water. Calcium and magnesium are the most common polyvalent ions (ions with a charge greater than +1). Hardness mitigates metals toxicity, because Ca^{2+} and Mg^{2+} helps keep fish from absorbing metals such as lead, arsenic, and cadmium into their bloodstream through their gills. The greater the hardness, the harder it is for toxic material to be absorbed through the gills (Eze, 2008). Total hardness values ranged from 225.4-626.3 mg/l with the mean of 379.044 mg/l. The recorded value is within WHO/FMEnv permissible limit of 250 mg/l.

Conductivity (EC)

Solids can be found in nature in a dissolved form. Salts that dissolve in water break into positively and negatively charged ions. Conductivity is the ability of water to conduct an electrical current, and dissolved ions are conductors. Electrical conductivity values ranged from 92.7-120.7 µS/cm with the mean of 108.756 µS/cm. The recorded value is below WHO and FMEnv permissible limit of 1000 µS/cm and 400 µS/cm for drinking water respectively.

Total Hydrocarbon Content (THC)

The concentration of dispersed THC is an important parameter for water quality and safety. THC in water can cause surface films and shoreline deposits leading to environmental degradation, and can induce human health risks when discharged in surface or ground waters. Additionally, THC may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency. The concentrations of the THC in the water samples of the study area were below equipment detect limit of <0.01. There is no recommended WHO/FMEnv permissible limit for THC in drinking water.

Biochemical-Oxygen Demand (BOD)

The measured value of BOD level ranged from 1.03-1.36 mg/l with mean concentration value of 1.214 mg/l. The obtained value is below WHO/FMEnv permissible limit of 10mg/l for BOD in drinking water.

Chemical Oxygen Demand (COD)

The Chemical Oxygen Demand (COD) is an expression of the reducing capacity that measures the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. COD concentrations in the water samples of the study area were below equipment detect limit of <0.01. There is no recommended WHO/FMEnv permissible limit for COD in drinking water.

Dissolved Oxygen

Dissolved Oxygen is a very important indicator of a water body's ability to support life. Oxygen is essential for the survival and propagation of aquatic organisms. If the amount of oxygen dissolved in waterfalls below 3.0mg/l, aquatic organisms or their eggs and larvae may die. It is therefore, imperative to know the amount of dissolved oxygen (DO) in surface water of the project area. Water with high dissolved nutrients leading to DO above 6 mg/l is not good for the human health (UNICEF, 2004). DO values ranged from 6.45-7.55 mg/l with the mean of 6.998 mg/l. This value exceeds WHO/FMEnv permissible limit of 5mg/l and >4 mg/l respectively for drinking water.

Heavy Metals

Heavy metals analysed include copper, iron, lead, zinc, cadmium, and chromium. Among these, lead, cadmium and chromium were below equipment detection limit of 0.001mg/l. The mean concentration value recorded for copper (0.272 mg/l) and zinc (0.453 mg/l) were observed to be below WHO permissible limit of 1 mg/l and 3 mg/l respectively. However, iron with mean concentration value of 1.725 mg/l exceeded WHO/FMEnv permissible limit of 0.36mg/l. This could be attributed to waste water discharges from domestic sources and storm water.

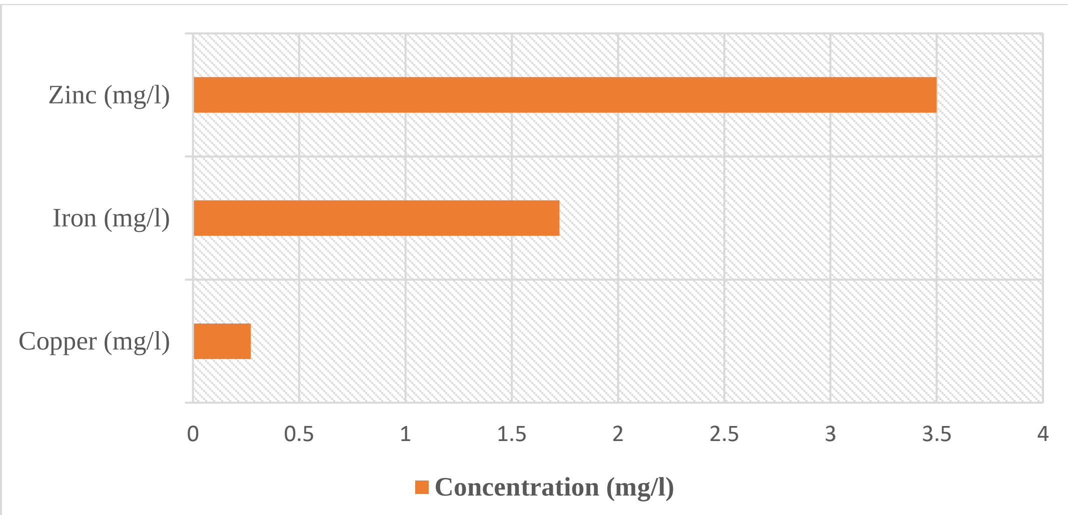


Figure 4.29: Mean concentrations of heavy metals in surface water sample

4.8.3 Sediment Study

- **Overview**

The productivity of water body is related with soil conditions. Soil serves as a more reliable index for productivity than water qualities. The productivity of any river or spring depends largely on the quality of bottom soil that is a "store house of nutrients." The chemical and biological changes continuously take place resulting in releases of different nutrients in to the over lying water and their absorption by the soil mass and microbial population. The growth and abundance of different aquatic flora and fauna are greatly dependent upon the presence of essential nutrients in water body in adequate and balanced quantities. Therefore, bottom soil could best be described as the "chemical laboratory of pond."

4.8.3.1 Sediment collection methodology:

Sediment samples from riverbed were collected using an Eckman grab. The grab used was of a stainless-steel plate with two jaws that close automatically when it reaches the riverbed. On reaching the bottom of the river, sediments are trapped in the jaws and are gradually pulled back to the surface. For shallow streams, samples were collected without grabs. The sampling points was same as that of the surface water.

4.8.3.2 Sediment Physico-chemistry

The physico-chemical properties and microbiological charactersistics of the sediments were analysed to ascertain the pollution status of the water since sediments serve as sinks. The detailed physico-chemical characteristic of the sediment of the project area is presented in Appendix 1.2. The summarized physico-chemical parameters of the sediment of the project area is presented in Table 4.28.

Table 4.28: Summarized Physico chemical Results for Sediment

Parameter	Range	Mean	WHO/FMEnv for aquatic lives	ISQGV for aquatic lives
pH	6.89-7.44	7.208	6.5-9.0	6.0-9.0
EC (µS/cm)	275.4-325.3	299.106	-	-
TOC (%)	21.3-31.2	25.963		
Av. P (mg/kg)	4.68-6.27	5.566	-	-
NO_3^- (mg/kg)	7.23-12.14	9.008	-	-
SO_4^{2-} (mg/kg)	0.36-2.17	0.825	-	-
Na (meq/100g)	2.06-7.21	5.541	-	-
K (meq/100g)	7.88-10.27	9.053	-	-
Ca (meq/100g)	18.05-25.12	21.67	-	-
Mg (meq/100g)	1.78-3.23	2.509	-	-
Fe (mg/kg)	2.38-3.47	2.848	-	-
Mn (mg/kg)	3.08-4.55	4.002	7	460
Zn (mg/kg)	2.56-3.35	3.061	88	120-540
Cu (mg/kg)	0.57-1.28	0.934	25	-
Pb (mg/kg)	<0.001	<0.001	50	-
Cd (mg/kg)	<0.001	<0.001	-	0.6-3.5
V (mg/kg)	<0.001	<0.001	-	-
Cr (mg/kg)	<0.001	<0.001	50	-

Source: Laboratory Analysis, 2020

pH: The pH of sediment samples can affect the immediate water system and aquatic lives positively or negatively depending on the chemical composition of the sediment. The measured pH ranged from 6.89-7.44 with a mean value of 7.208. The value is within WHO/FMEnv and ISQG permissible limit of 6.5-9.0 and 6.0-9.0 respectively for aquatic lives.

Conductivity

The sediment electrical conductivity ranged from 275.4-325.3 μS cm^{-1} with a mean value of 299.106 μS cm^{-1}. No assigned WHO/FMEnv and ISQGV permissible limit for aquatic lives.

Total Organic Carbon (TOC)

Total Organic Carbon is the amount of carbon found in an organic compound and is often used as a non-specific indicator of water quality. The TOC value ranged from 21.3-31.2 % with mean concentration value of 25.963 %. There is no recommended WHO/FMEnv and ISQGV limit for TOC in sediments.

Nitrate

Nitrates are essential for the growth of micro-organisms in sediment. Samples analysed had value ranged from 7.23-12.14 mg/kg with mean value of 9.008 mg/kg.

Sulphate

Sulphate concentration is known not to pose problems generally for structures except when treated with calcium-based stabilizers and subjected to moistures (Tack *et al.*, 1997). High level of sulphate in sediment could be attributed to failing septic systems, excessive use of agriculture fertilizers, leachable from refuse dumps and industrial discharges. The concentration sulphate in the analysed samples ranged 0.36-2.17 mg/kg with mean value of 0.825 mg/kg.

Phosphate

The recorded concentration value of phosphate ranged from 4.68-6.27 mg/kg with mean concentration value of 5.566 mg/kg. There is no recommended WHO/FMEnv and ISQGV limit for phosphate in sediments

Potassium (K)

Potassium occurs widely in the environment, including all natural waters. Possible ways of potassium chloride exposure could be its use in treatment devices such as water softeners. Result of this study had concentration level ranged from 7.88-10.27 mg/kg with mean value of 9.053 mg/kg.

Heavy Metals and metalloids

The heavy metals investigated in the sediment samples include iron, manganese, zinc, copper, lead, cadmium, vanadium, and chromium. The concentrations of lead, cadmium, vanadium and chromium in streambed sediment collected within the proposed project area were below their respective limit of detection. However, the mean concentration of manganese (4.002 mg/kg), zinc (3.061 mg/kg) and copper (0.934 mg/kg) in the sediment samples were all within WHO permissible limit of 7 mg/kg, 88 mg/kg and 25 mg/kg for aquatic lives respectively. Only iron with mean concentration value of 2.848 mg/kg do not have any stipulated guideline limits.

The result indicated that the streambed sediments from the proposed project areas were not contaminated with heavy metals and metalloids.

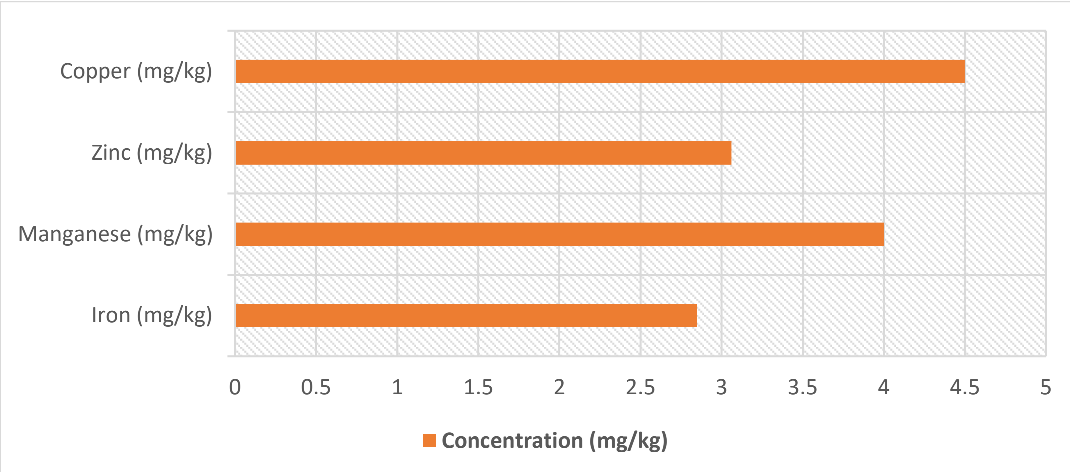


Figure 4.30: Mean concentration of heavy metals in sediment sample

4.8.3.3 Water Microbial

According to Jayalakshmi and Lakshmi (2014), water is one of the prime elements responsible for life on earth as two thirds of earth's surface is covered by water. Water is the essential resource for living system, industrial process, agricultural production and domestic use. The use of water increases with growing population, putting increasing strain on these water resources. An adequate supply of safe drinking water is one of the major prerequisites for a healthy life. Pollution occurs when a product added to our natural environment adversely affects nature's ability to dispose it off.

A pollutant is something which adversely interferes with health, comfort, property or environment of the people. Onyango *et al*. (2018) reported that increase in population has exerted more pressure on the available water sources. Consequently, more than 1.2 billion people worldwide do not have access to safe water. Millions of people die yearly from diarrheal disease and a larger proportion are children aged below5 years. Besides causing death, water-related diseases also prevent people from working and living active lives. Water is susceptible to contamination with microorganisms and organic matter among other pollutants regardless of the source. Significantly, microbial contaminants such as coliforms, *E.coli*, *Cryptosporidium parvum*, and *Giardia lamblia* compromise the safety of the water. Presence of *Escherichia coli, Klebsiella*, and *Enterobacter* species in water is a likely indicator of the presence of pathogenic organisms such as *Clostridium pafringens*, *Salmonella*, and Protozoa. These pathogens cause diarrhea, giardiasis, dysentery, and gastroenteritis, which is common among the rural dwellers of developing nations (Onyango *et al*., 2018).

Table 4.29: Microbiological Profile of Surface Water Samples

Parameter	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	WHO Limit	FME Limit
Total Coliform (CFU/100ml)	11	13	16	18	22	26	15	22	14	27	17	22	17	23	10	17	0	0
Faecal Coliform (CFU/100m)	16	18	13	15	16	19	10	12	18	20	15	17	13	16	12	13	0	0
Faecal Streptococci (CFU/100m)	20	22	18	23	17	22	13	16	21	24	16	21	14	19	15	18	0	0
E. coli (CFU/100ml)	6	3	7	4	5	8	2	4	6	7	9	9	3	2	4	5	0	0
Total Heterotrophic Bacteria (cfu/ml)	17	25	14	17	18	22	13	27	23	28	15	21	17	30	23	34	100	0

Table 4.30: Microbiological Profile of Surface Water Samples contd

Parameter	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	WHO Limit	FME Limit
Total Coliform (CFU/100ml)	18	21	11	13	10	15	14	20	14	17	15	17	12	16	13	18	0	0
Faecal Coliform (CFU/100m)	11	16	12	13	16	20	12	12	20	17	9	7	17	13	15	11	0	0
Faecal Streptococci (CFU/100m)	14	18	13	17	19	21	16	16	22	21	11	9	13	14	16	19	0	0
E. coli (CFU/100ml)	8	5	8	9	3	2	7	6	8	3	5	5	7	8	5	7	0	0
Total Heterotrophic Bacteria (cfu/ml)	22	30	25	32	15	19	14	23	16	27	18	25	21	27	21	26	100	0

Source: Laboratory Analysis (2020)

Table 4.31: Microbiological Properties of Sediment Samples

Parameter	Sed$_1$	Sed$_2$	Sed$_3$	Sed$_4$	Sed$_5$	Sed$_6$	Sed$_7$	Sed$_8$	Organism Identified	
									Bacteria	**Fungi**
Total Heterotrophic Bacteria (CFU/g)	4.4×10^5	3.5×10^5	2.8×10^5	3.2×10^5	2.4×10^5	2.6×10^5	4.1×10^5	4.2×10^5	*Staphylococcus aureus*, *Micrococcus* sp, *Bacillus subtilis*, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
Total Heterotrophic Fungi (CFU/g)	4.5×10^5	3.7×10^5	3.1×10^5	3.5×10^5	2.7×10^5	2.8×10^5	4.3×10^5	4.6×10^5	*Bacillus brevis*, *Clostridium* sp, *Staphylococcus aureus*, **Pseudomonas* sp, *Enterobacter faecium*.	*Aspergillus fumigatus*, *Aspergillus niger*, *Fusarium* sp, **Candida* albicans, Chrysogenum sp, *Alternaria* sp.
Hydrocarbon Utilizing Bacteria (CFU/g)	1.4×10^5	1.1×10^5	1.0×10^5	1.3×10^5	1.2×10^5	1.0×10^5	1.2×10^5	1.0×10^5	*Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Escherichia coli*, *Enterobacter faecium*.	*Saccharomyces* sp, *Aspergillus fumigatus*, **Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp,
Hydrocarbon Utilizing Fungi (CFU/g)	1.5×10^5	1.2×10^5	1.4×10^5	1.1×10^5	1.3×10^5	1.2×10^5	1.0×10^5	1.2×10^5	*Staphylococcus aureus*, *Micrococcus* sp, *Actinomyces* sp, *Pseudomonas aeruginosa*,	*Penicillium* sp, *Aspergillus fumigatus*, *Pichia* sp, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.

* = Hydrocarbon degrader

Table 4.32: Microbiological properties of sediments Samples contd

Parameter	Sed$_9$	Sed$_{10}$	Sed$_{11}$	Sed$_{12}$	Sed$_{13}$	Sed$_{14}$	Sed$_{15}$	Sed$_{16}$	Organism Identified	
									Bacteria	**Fungi**
Total Heterotrophic Bacteria (CFU/g)	2.7×10^5	3.7×10^5	3.2×10^5	2.8×10^5	2.7×10^5	3.1×10^5	2.1×10^5	2.9×10^5	*Achromobacter* sp, *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* sp.	*Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
Total Heterotrophic Fungi (CFU/g)	2.9×10^5	4.0×10^5	3.3×10^5	2.7×10^5	2.4×10^5	3.4×10^5	2.7×10^5	3.1×10^5	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.

Parameter	Sed_{9}	Sed_{10}	Sed_{11}	Sed_{12}	Sed_{13}	Sed_{14}	Sed_{15}	Sed_{16}	Organism Identified	
									Bacteria	**Fungi**
Hydrocarbon Utilizing Bacteria (CFU/g)	1.0×10^5	1.3×10^5	1.5×10^5	1.1×10^5	1.1×10^5	1.4×10^5	1.5×10^5	1.3×10^5	*Proteus* sp, *Micrococcus* sp, *Pseudomonas aeruginosa, Enterobacter aerogenes, Clostridium* sp.	*Fusarium* sp, *Aspergillus niger*, **Candida tropicalis*.
Hydrocarbon Utilizing Fungi (CFU/g)	1.3×10^5	1.4×10^5	1.6×10^5	1.3×10^5	1.5×10^5	1.5×10^5	1.7×10^5	1.4×10^5	*Klebsiella* sp, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus brevis*, *Enterobacter faecium*.	**Penicillium* sp, **Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans.*

Source: Laboratory Analysis (2020) * = Hydrocarbon degrader

4.8.3.4 Microbiological Characteristics of Surfacewater

Total coliform, faecal coliform, faecal streptococci and heterotrophic bacteria were detected in the samples. Isolation of *E. coli* provides conclusive evidence that the water was polluted by faecal matter within the period of sampling. Presence of heterotrophic bacteria in water poses no health risks to humans but a high heterotrophic plate count is an indicator for ideal conditions for the growth of bacteria. This can be a breeding ground for more pathogenic bacteria.

4.8.3.5 Microbiological Characteristics of Sediment Samples

Sediment microorganisms are crucial for the biodegradation of organic matter and the recycling of nutrients while these microorganisms are susceptible to toxic pollutants. The degradation of organic pollutants in aquatic ecosystems is mainly performed by bacteria.

The result of studies on densities of heterotrophic bacteria and fungi counts in sediment samples show that the heterotrophic bacteria counts ranged from $2.1 \times 10^5 – 4.4 \times 10^5$ cfu/g. Fungi population ranged from $2.4 \times 10^5 – 4.6 \times 10^5$ cfu/g. The hydrocarbon utilizing bacteria counts ranged from $1.0 \times 10^5 – 1.5 \times 10^5$ cfu/g, whereas the fungi population ranged from $1.1 \times 10^5 – 1.6 \times 10^5$ cfu/g. Bacterial isolates of the sediment were *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Bacillus brevis*, *Clostridium* sp, **Pseudomonas* sp, *Enterobacter faecium*, **Micrococcus* sp, **Pseudomonas* sp, *Escherichia coli*, *Enterobacter faecium*, *Actinomyces* sp., while fungal genera include: *Geotricum* sp, *Candida tropicalis*, *Pichia* sp, *Aspergillus fumigatus*, *Penicillium* sp, *Alternaria* sp, *Fusarium* sp, *Aspergillus niger*, **Candida* albicans, Chrysogenum sp, *Saccharomyces* sp, *Candida albicans*.

4.9 Groundwater Quality and Contamination

Twenty (20) Groundwater samples within the zone of hydrological influence to the study area were obtained. These include 15 stations as sampling point and 5 stations as control point and these were analysed for physico-chemical and microbiological properties.

4.9.1 Sampling Methodology

The boreholes were sampled using Niskin bottle. The Niskin bottle was flushed with distilled water before used at every station. Plate 4.12 shows PGM team performing underground water sampling.

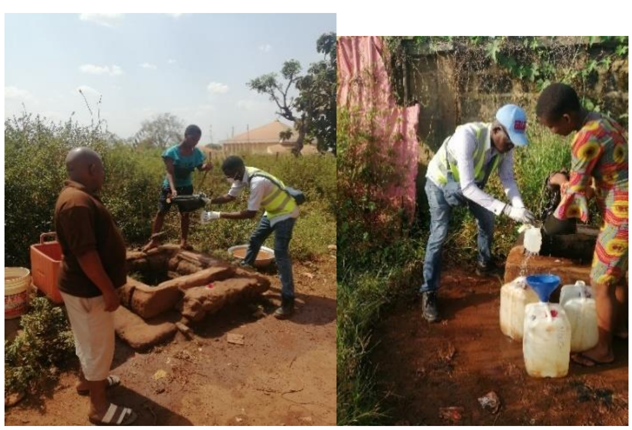


Plate 4.12: PGM team performing underground water sampling.

4.9.2 Hydro-geochemistry

The results of the physical and chemical characteristics of groundwater sample obtained from the boreholes within the spatial influence of the project area are summarized in Table 4.34 (see appendix 1.2 for detailed result).

Table 4.34: Summarized Groundwater Physico-chemical parameters

Parameter	**Range**	**Mean**	**WHO Limit**	**FMEnv Limit**
Color (Pt Co Units NCASI)	2.12-3.24	2.738	5-15	-
pH	5.75-6.43	6.152	6.5-8.5	6.5-9.0
Temperature (°C)	29.7-31.4	30.87	-	-
Turbidity (NTU)	0.22-0.42	0.31	5	5
Salinity (ppt)	0.0076-0.0094	0.009	-	-
Hardness (mg/l)	17.7-24.1	21.49	250	250
Conductivity (µS/cm)	15.2-18.7	17.35	1000	400
DO (mg/l)	0.08-0.21	0.145	5	>4.0
BOD (mg/l)	<0.01	<0.01	-	-
COD (mg/l)	<0.01	<0.01	-	150
THC (mg/l)	<0.01	<0.01	-	-
Phosphate (mg/l)	0.04-0.12	0.076	-	-
Sulphate (mg/l)	1.56-2.44	2.069	250	250
Nitrate (mg/l)	0.12-0.32	0.208	10	10
TDS (mg/l)	7.6-9.35	8.675	1000	1000
TSS (mg/l)	0.09-0.18	0.13	-	-
Copper (mg/l)	0.001-0.013	0.006	1	0.01
Iron (mg/l)	0.22-0.37	0.292	0.36	0.36
Lead (mg/l)	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.22-0.33	0.284	3	<1.0
Cadmium (mg/l)	<0.001	<0.001	0.003	<1.0
Chromium (mg/l)	<0.001	<0.001	0.05	0.05
Potassium (mg/l)	0.02-0.06	0.036	-	-
Faecal Coliform (cfu/100ml)	0	0	0	0
Total Coliform (cfu/100ml)	0	0	0	0
THB(cfu/ml)	$1.1 – 1.7 \times 10^4$	1.3×10^4	100	100

Source: Laboratory Analysis, 2020

Color

Color refers to the appearance of water that is free of suspended matter. The mean concentration of color in the analysed groundwater samples had concentration within WHO 15 Pt/Co permissible limit for groundwater.

pH

pH is an important variable in water quality assessment as it influences many biological and chemical processes and all processes associated with water supply and treatment. In unpolluted waters, pH is principally controlled by the balance between the carbon dioxide, carbonate, and bicarbonate ions.

The recorded pH values in groundwater samples from the study area ranged from 5.75-6.43 with a mean of 6.152. The pH values for the groundwater in the study area was slightly acidic to slightly alkaline. The pH of most natural groundwater is between 6.0 and 8.5, although lower concentrations can occur in dilute water high in organic content, and high values in eutrophic waters, groundwater brines and salt lakes (Todd and Mays, 2005). The observed pH values are within the WHO/FMEnv permissible limits of 6.5-8.5 and 6.5-9.0 respectively for drinking water in Nigeria.

Temperature

Temperature refers to degree of hotness or coldness and it can be measured in degree Celsius. The rate of chemical reactions generally increases at higher temperature. Water, particularly groundwater, with higher temperatures can dissolve more minerals from the rocks it is in and will therefore have a higher electrical conductivity. Temperature values for groundwater ranged from 29.7-31.4^{o}C with the mean value of 30.87^{o}C. The recorded value is within WHO permissible limit of 40^{o}C for groundwater temperature.

Turbidity (NTU)

Turbidity in water is caused by suspended particles or colloidal matter that obstructs light transmission through the water. It may be caused by inorganic or organic matter or a combination of both (WHO 2007). Turbidity in some groundwater sources is a consequence of inert clay or chalk particles or of the precipitation of non-soluble reduced iron and other oxides when water is pumped from anaerobic waters.

The groundwater turbidity values ranged from 0.22-0.42 NTU with an average of 0.31 NTU. This is relatively low and within WHO/FMEnv permissible limit of 5 NTU. This suggest non-polluted groundwater in the area.

Total Dissolved Solids (TDS)

Total dissolved solid in the groundwater samples ranged between 7.6-9.35 mg/l with mean value of 8.675 mg/l. This value is well within the recommended limit of the World Health organisation (WHO) limit of 1000 mg/l for drinking water.

Electrical Conductivity (µS/cm)

Conductivity is a measure of the ability of water to conduct an electric current. It is sensitive to variations in dissolved solids, mostly mineral salts. The degrees to which these dissociate into ions, the amount of electrical charge on each ion, ion mobility and temperature of the solution all have an influence on conductivity.

The conductivity of groundwater samples from the study area ranged from 15.2-18.7 µS/cm with a recorded mean of 17.35 µS/cm. This recorded value is below WHO and FMEnv permissible limits of 1000 µS/cm and 400µS/cm.

Total Hardness, mg/l

Water hardness values in groundwater samples ranged from 17.7-24.1 mg/l with a mean of 21.49 mg/l. Values below 200 mg/l do not have any associated adverse health related effects on humans but is an indication of deposits of Ca and/or Mg ions (WHO 2007). These values were within WHO/FMEnv permissible limit of 250 mg/l.

Total Hydrocarbon Content (THC)

The concentrations of the THC in the water samples of the study area were below the detection limit of the equipment and hence assume to be zero and therefore within the WHO regulatory limit of ≤ 0.01.

Biological Oxygen Demand (BOD) (mg/l)

BOD is an indirect measure of the amount of biologically degradable organic materials in water and is an indicator of the amount of dissolved oxygen that will be depleted from water during natural biological assimilation of organic pollutants (USEPA 2002). Excess BOD in water therefore could adversely affect aquatic organisms and by extension humans. BOD level in groundwater samples from the study area were below limit of equipment detection.

Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) was used as a measure of the oxygen equivalent of the organic matter content of the sample which was susceptible to oxidation by a strong chemical oxidant (WHO 2007). COD level in groundwater samples were below detection limit of the equipment. The low COD values also signify low level of organic matter in the groundwater.

Dissolved Oxygen (DO), mg/l

Dissolved oxygen (DO) measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Dissolved oxygen range between 0.08-0.21 mg/l with a mean of 0.145 mg/l. These values compared well with natural limits expected for groundwater water and within WHO/FMEnv permissible limits of 5 mg/l and <4 mg/l respectively.

4.9.2.1 Nutrients

Nitrates, phosphate and sulphate are important plant nutrients; however, they are undesirable in drinking water. Sources of nutrients in groundwater are domestic/industrial effluents, agricultural (fertilizer use) and leachates from industrial and domestic refuse dumps.

- **Nitrate (NO_3^-) mg/l**

Nitrate, the most oxidized form of nitrogen compounds is commonly present in groundwater because it is the end-product of the aerobic decomposition of organic nitrogenous matter. Unpolluted natural waters usually contain only minimal quantities of nitrate. Natural sources of nitrate to groundwater include igneous rocks, land drainage as well as plant and animal debris.

The mean concentrations of nitrates recorded was 0.208 mg/l. This value is within 10mg/l permissible limit allowed by WHO/FMEnv for groundwater.

- **Phosphate (PO^-_4) mg/l**

High phosphate concentrations in ground water could be related to perennial locked up inputs from terrestrial environments. The concentration across the ground water samples suggest low phosphate presence of mean concentration value of 0.076 mg/l. At this concentration, eutrophication potential in the groundwater is low.

- **Sulphate ($SO^{2-}{}_4$) mg/l**

Sulphate is naturally present in groundwater as SO_4^{2-}. It rises from the leaching of sulphur compounds, either sulphate minerals such as gypsum or sulphide mineral such as pyrite from sedimentary rocks. It is a stable, oxidized form of sulphur and is readily soluble in water (except for lead, barium and strontium that precipitate sulphates). The recorded mean concentration value of 2.069 mg/l revealed the concentration is below 250 mg/l WHO/FMEnv permissible limits.

4.9.2.2 Heavy Metals

The availability of metals in water depends on the interplay between several factors including pH, redox potentials, and CO_2 levels. Metal are of environmental health concerns because it has the potential to accumulate or concentrate in biotas. They enter the food chain in the process and can affect man. Besides, metal exhibits a wide range of toxicity effects including cancer, impairment of reproductive and nervous system, cardiovascular and renal system disorder, lung damage, skin problem etc (Iwegbue *et al.*, 2016). The heavy metals investigated in the groundwater samples include copper, iron, lead, zinc, cadmium, and chromium. Lead, cadmium, and chromium concentration level in the analyzed samples were below equipment detection limit of <0.001. The mean concentration value of copper (0.006 mg/l), iron (0.284 mg/l) and zinc (0.284 mg/l) were within WHO permissible limits of 1 mg/l, 0.36 mg/l, and 3 mg/l respectively.

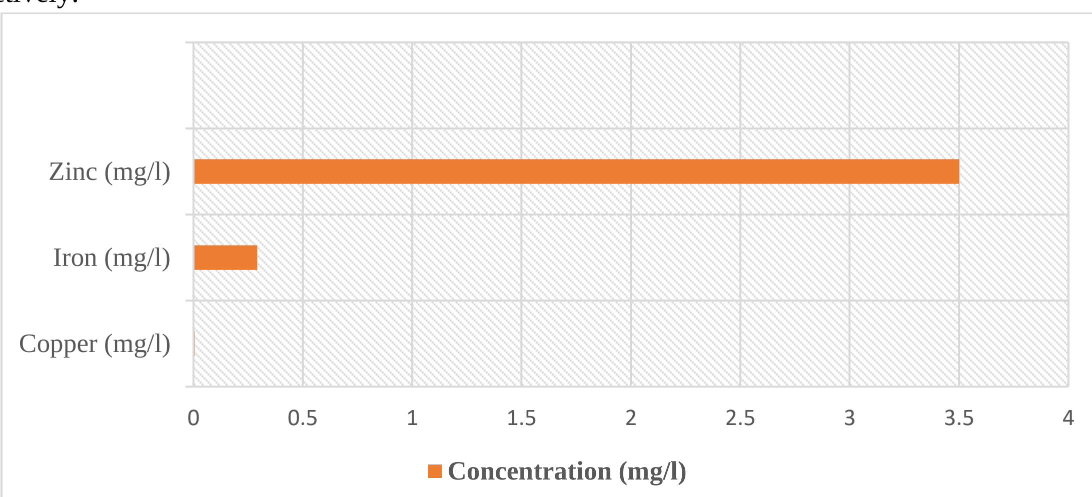


Figure 4.31: Mean concentrations of heavy metals in ground water sample

4.9.3 Groundwater Microbiology

Both total coliform and fecal coliform bacteria (*Escherichia coli*) were not detected in the samples. Viable cells of bacteria were detected, and are harmless to human beings but a high heterotrophic plate count is an indicator for ideal conditions for the growth of pathogenic bacteria

Table 4.35: Microbiological Profile of Groundwater Samples

Parameter	GW_1	GW_2	GW_3	GW_4	GW_5	GW_6	GW_7	GW_8	GW_9	GW_{10}	GW_{11}	GW_{12}	GW_{13}	GW_{14}	GW_{15}	GW_{16}	WHO Limit	FME Limit
Total Coliform (CFU/100ml)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Faecal Coliform (CFU/100m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Faecal Streptococci (CFU/100m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. coli (CFU/100ml)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Heterotrophic Bacteria (cfu/ml)	7	8	10	12	15	8	5	5	10	17	6	12	6	4	5	7	100	-

Source: Laboratory Analysis (2020)

4.10 Terrestrial Biodiversity

International Finance Corporation's (IFC's) Performance Standard 6 (PS6) recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems." Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types:

- Provisioning services, which are the products people obtain from ecosystems
- Regulating services, which are the benefits people obtain from the regulation of ecosystem processes
- Cultural services, which are the nonmaterial benefits people obtain from ecosystems; and
- Supporting services, which are the natural processes that maintain the other services.

4.10.1 Flora Wildlife

4.10.1.1 Vegetation Sampling

Vegetation studies were carried out to determine the baseline status of the study area vis-à-vis the species composition, diversity, and population of the plant species as well as their medicinal and economical uses. The density and percentage of the key tree species and the herbaceous layers were determined while rare and endangered plant species and all those of special significance to the ecosystem and the local economy were categorized. The species diversity of the plants was calculated as the ratio between the number of species and importance value which for the purpose of this study was taken as numbers of individual per quadrat. Both the generic and specific characteristics of the vegetation were assessed by determining their floristic composition, life form and biological spectra.

Twenty-four (24) stations point of the study area was established (1200m x 2400m). Each sampling station was further divided into sampling points. A sampling point was established as a fine line transect of 200m apart over a 300m length.

An average of 2 hectares was adopted as sampling size per sampling point. This resulted in a total sampled area of 24 hectares.

Methodology (wildlife)

The wildlife study cuts across the entire ecosystem. Methodologies of sample collection and identification include;

- Visual observations and documentation of droppings.
- Oral discussion with natives of the study area.

- Tree beating, shaking, purpose mark, feathers, shells, sounds, foot prints, information on the available species and relative abundance was obtained through oral interviews and discussions with artisanal hunters and indigenes.

4.10.2 Description of study area

The existing vegetation consist of forest (Rainforest and Freshwater swamp), Savannah (guinea, sahel and sudan savannah), plateau and montane, some of the states in the project site consist of more than one vegetation types. The rainforest in the study area is built of high-mountainous multi-tiered tropical forests, which contain trees of 40-45 meters namely: mahoganies, walnuts, irokos, oil palms, rubber trees, and obeche trees.

Savannahs (insignificant tree cover, with grasses and flowers located between trees) The savannah zones are categorized into three namely: Guinean savanna, made up of plains of tall grass which are interrupted by trees, the most common across the study area; Sudan savannah, similar but with shorter grasses and shorter trees; and Sahel savannah patches of grass and sand, found in the northeast, the belt is represented by various vegetation formations according to changes in rainfall and soils and is dominated with *Acacia toritllis* and *Maerua crassifolia* in the eastern clay plains, *Acacia mellifera* and *Commiphora africana* in the sandy soil of the west.

The Montane zone is situated in high-mountain areas of the project area. Montane vegetation in the study area (mountain and plateaus vegetation) is not very developed due to the reason of low average temperatures and the significant impact of animals and man. The Jos plateau is one of the highest points in the study area. This is grassland zone but the slopes are covered by forests. This zone is used for growing of rich crops of different vegetables and small grain crops, and provides a good place for pastures for the herbivores.

The distribution of these vegetation types in the study area is presented in Figure 4.32

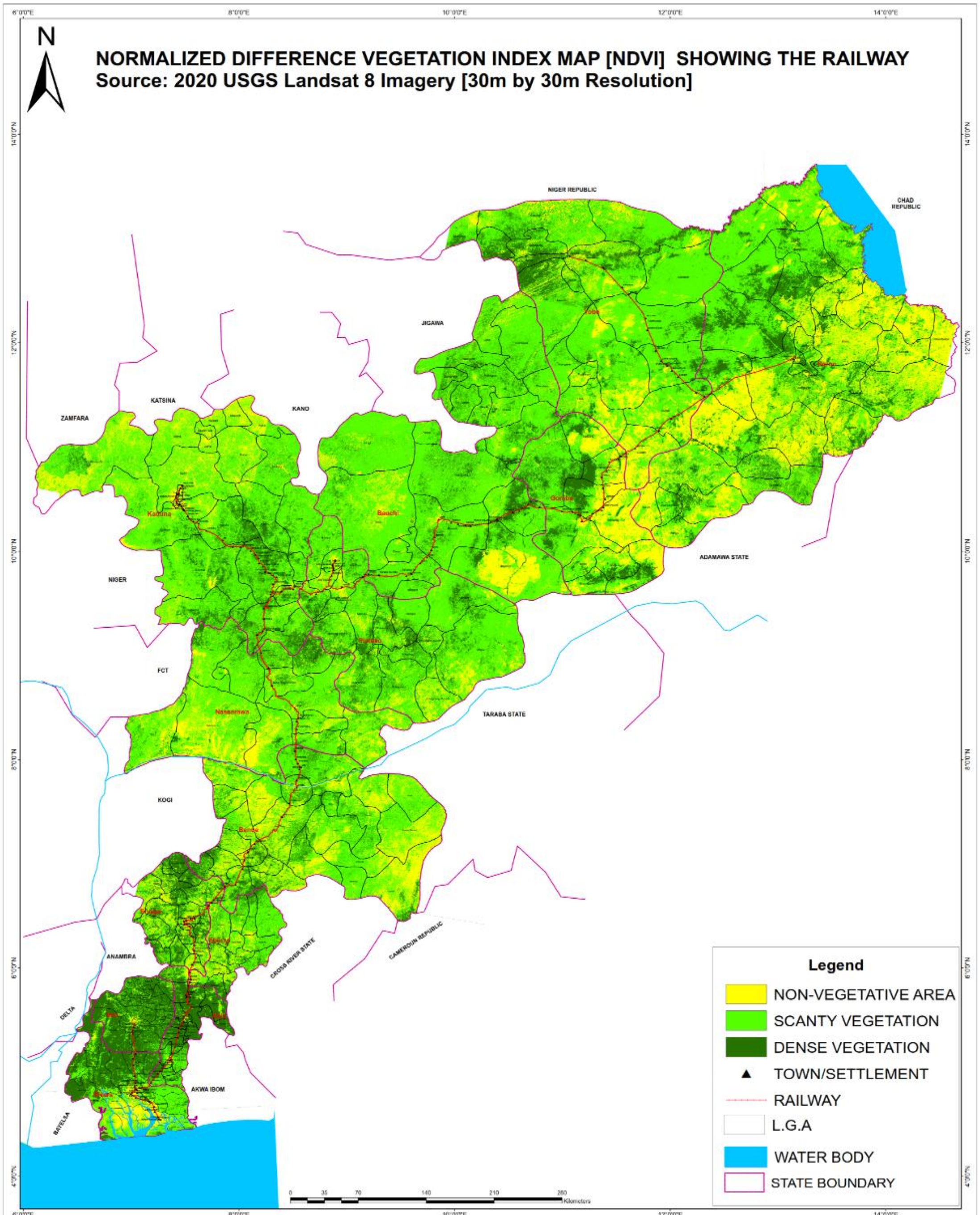


Figure 4.32: Showing a generalized vegetations map of the study area (PGM Fieldwork 2020)

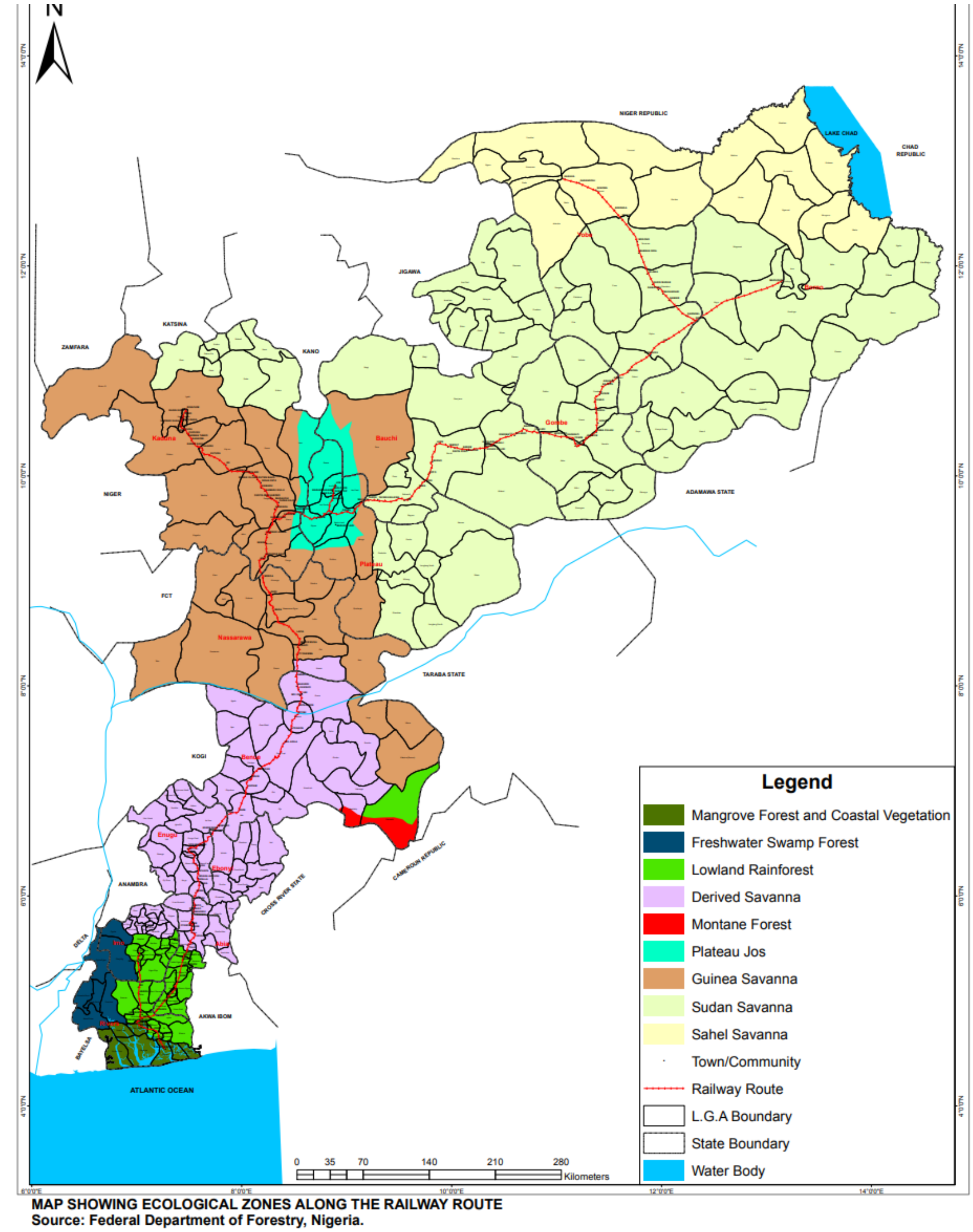


Figure 4.33: Showing a generalized vegetations map of the study area (PGM Fieldwork 2020)

The existing vegetation is composed of mix of habitats namely:

- Rain Forest
- Freshwater Swamp Forest
- Guinea Savanna
- Plateau
- Montane
- Sudan Savanna
- Sahel Savanna
- Cultivated Areas
- Plantations

4.10.2.1 Rainforest (Vegetation around the project axes in Rivers, Abia, Enugu and Ebonyi states)

Plates 4.13 showing Rainforest vegetation (Port Harcourt, PGM Fieldwork, 2020)

This is the most dominant forest formation of the study area as it extends from Rivers to Ebonyi states. However, this forest type is not continuous. In most areas, they are seen as remnants of its own self or rainforest of several years. The stages of re growth and maturity of the rainforest differ at different locations. To some extent human activities have greatly transformed the structure as well as the species richness of this vegetation type. This is seen in the number oil palm plantations and farmlands.

Trees of the uppermost layer include; *Klainedosa gabonensis, Hevea brasilensis, Triplochiton scleroxylon, Symphonia globufera, Alstoria booneii, Terminalia superba, Invingia gabonensis, chlorophora excelsa, Ceiba. Pentandra, Piptademiastrum africanum, Cynometra megalophylla, Cola spp, Lophire alata*. These trees are very tall and range between 40-45m.Trees in the second layer of canopy have the highest range of 10 to 27m. Their crown merges to form a continuous canopy. They are associated with various shrub-like species especially climbers and epiphytic species. They include *Chloromolaena odorata, Clappertonic ficifolia, Psychortinia Vogelina, Anthoratha macrophylla, Xylopia ethiopica, Alchanea cordifolia. Tetrapleura tetraptera, ficus veogeliana, Baphia* spp.

The forest is reasonably penetrable and the canopies formed by the crown of the trees species makes the forest floor gloomy with isolated sunlight rays penetrating through gaps in the canopy. Species occurring here includes*; Diplarium sammanti, Acanthus monotamus, Maranthocloa congensis, Costus afer, sellogenella* spp. The density distribution of trees in this forest type shows that *Elaeis guineensis* is the most dominant tree species. Figure 4.34 -4.37 below shows maps of the concern state within the rainforest vegetation.

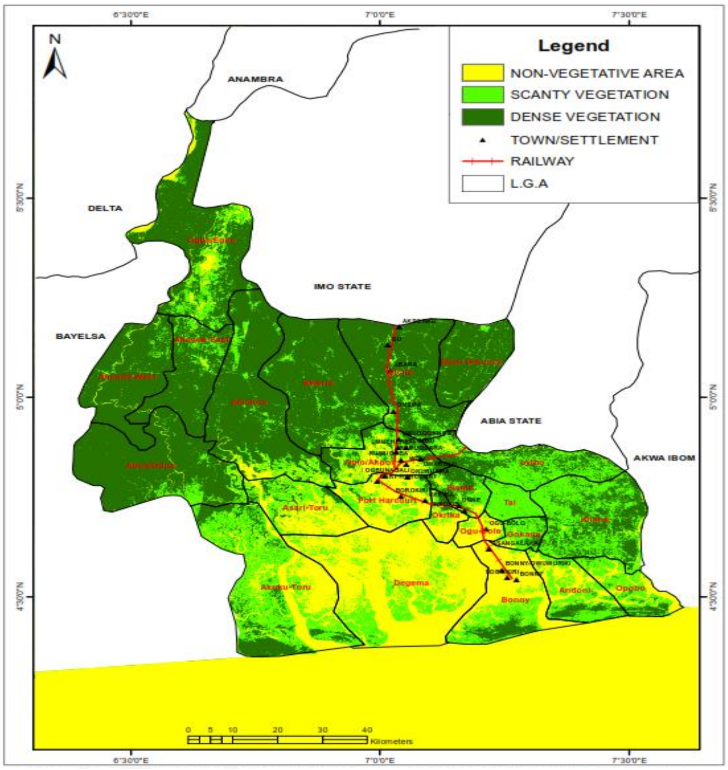


Figure 4.34: Map Showing vegetation of Rivers State

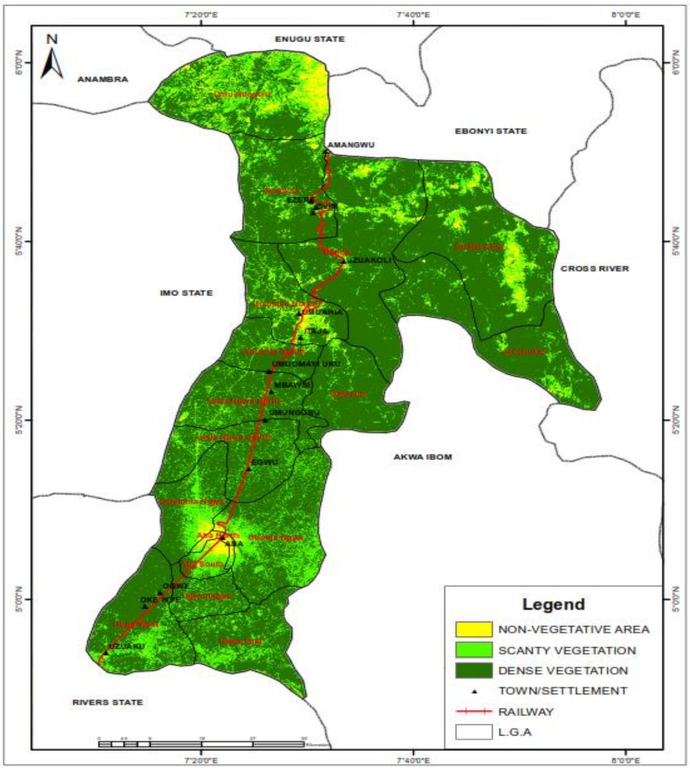


Figure 4.35: Map showing vegetation map of Abia state

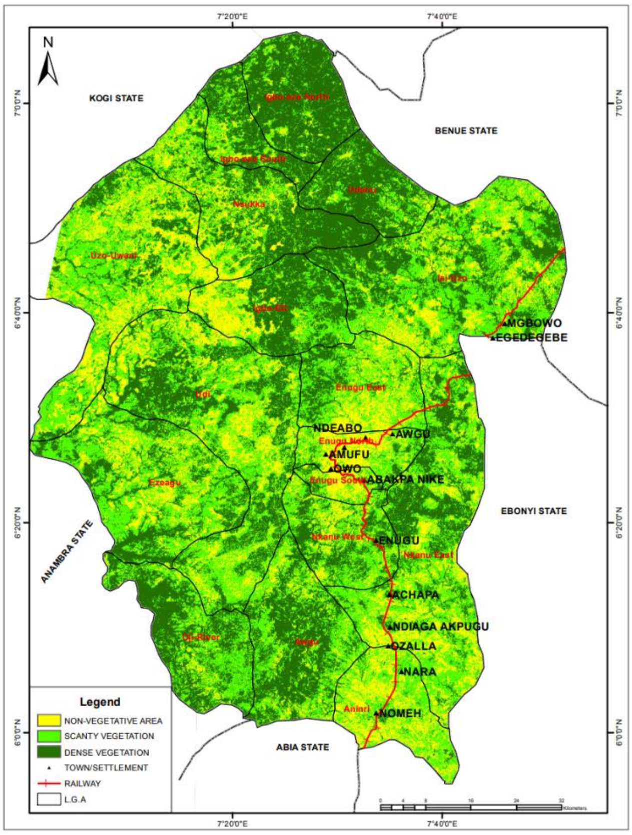


Figure 4.36: Map Showing vegetation of Enugu State

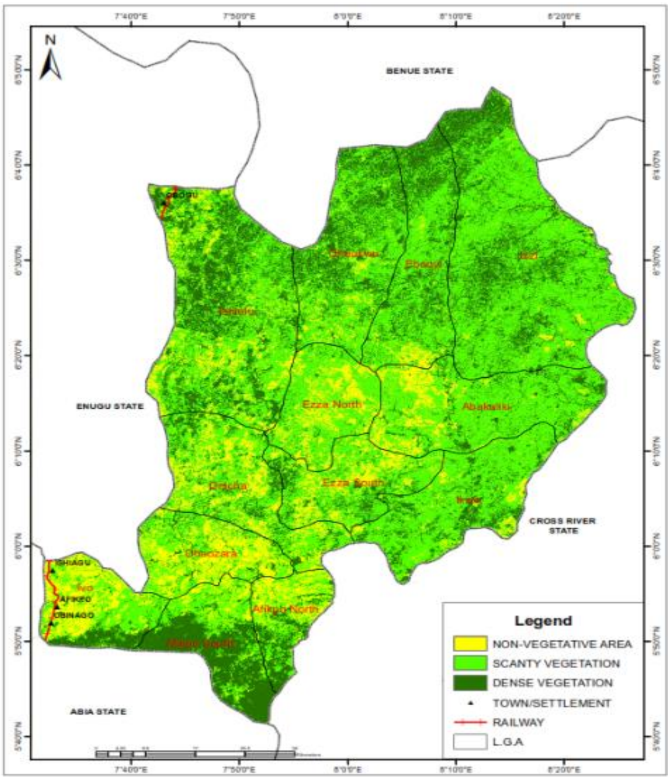


Figure 4.37: Map Showing vegetation of Ebonyi State

4.10.2.2 Freshwater Swamp Forest (Vegetation around the project axes in Rivers and Abia States)

The Freshwater swamp forest forms a wide belt inland after the mangrove and coastal vegetation. The zone has more open canopy, which may reach 45 m in height, densely tangled, and almost impenetrable undergrowth. It is usually flooded during the wet season and dries out during the dry season leaving portions of dry forest floor interspersed with permanent pools of water. Much of this vegetation type has been converted to agricultural and urban lands, and the original swamp forest remains mostly on alluvial sites along the major rivers.

Climbing palms with hooked spines are particularly characteristic as are clumps of large aroids such as *Cyrtospernia senegalense.* Large trees such as *Mitragyna ciliata*, *Spondianthus preussii*, *Lophira alata*, *Anthostema aubryanum* and *Alstonia congensis* occur with smaller trees such as *Nauclea gilletii*, *Berlinia spp.*, *Grewia coriacea*, and *Uapaca spp.* A number of tree species in this ecological zone have stilted roots. The *Raphia* palm (*Raphia hookerii*) and *Lonchocarpus griffonianus* are usually abundant in the outer fringe vegetation which seldomly exceeds 14 m in height. Behind the fringe, the trees of the freshwater swamp may reach 30 m in height.

Plates 4.14 showing freshwater/swamp forest vegetation (Imo river at Oyibo, PGM Fieldwork, 2020)

4.10.2.3 Guinea Savannah (Vegetation around the project axes in Ebonyi, Enugu, Benue, Nasarawa and Kaduna)

The Guinea savannah belt of Nigeria. The vegetation, which apparently was of the rainforest type several years ago, is presently advancing in transformation to a typical savannah. The Guinea savanna (or savanna woodland/wooded savanna) is the most extensive vegetation in the middle belt of Nigeria, and consist of a mixture of trees and grass. It receives annual rainfalls between 1000 – 1500 mm with about 6-8 months of rainfall. The predominant features in the forested areas within the project area are grasses and moderately tall trees 1 to 3m high) in open areas and trees (up to 15m high) usually with short boles and broad leaves.

This vegetation is burnt almost annually by fierce fires in the dry season, therefore fire-resistant species predominate. The major reserve is cashew-dominated forests which serve such purposes as cash crop estates as well as agro-forestry centres meant for preservation of the environment against desertification and soil erosion. Another prominent feature of the vegetation is oil palm estates and orchards which are apparently also sites of agro-forestry in which mixed cropping is practiced. A third feature of the vegetation of the area is secondary forests in which the most prominent tree species is oil bean. There are also farm lands.

Species in the Southern areas of the Guinea Savanna zone include, *Magnifera Indica, Citrus sinensis, Carica papaya, Anacardium occidentale, Psidium guajava, Azadirachta indica, Gmelina arborea, Butyrospermum parkii and Parkia bioglobosa*, the most dominant tree in this zone is *Magnifera Indica.*

Figure 4.38 – 4.41 below shows maps of the affected states (i.e Benue, Nasarawa and Kaduna state)

Plates 4.15 Showing Guinea Vegetation (around Esagu station Ebonyi State, PGM Fieldwork 2020)

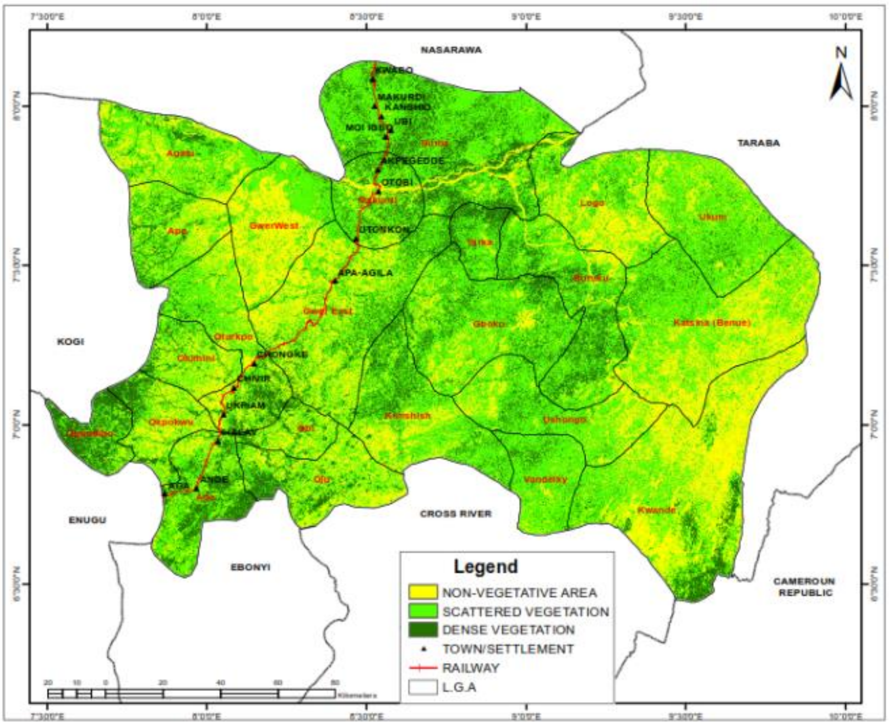


Figure 4.38 Map Showing vegetation of Benue State

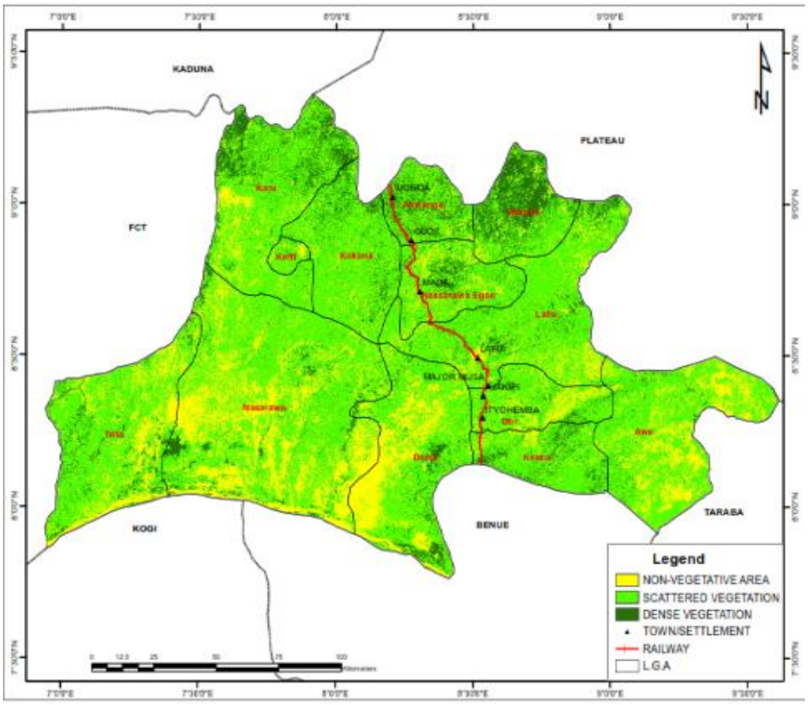


Figure 4.39: Map Showing vegetation of Nasarawa State

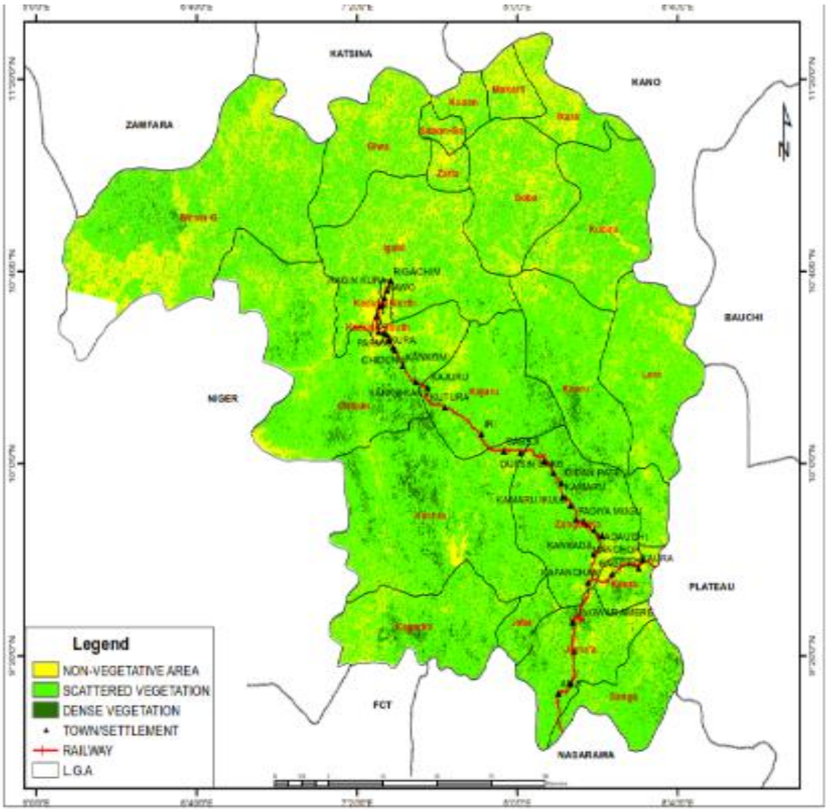


Figure 4.40: Map Showing vegetation of Kaduna State

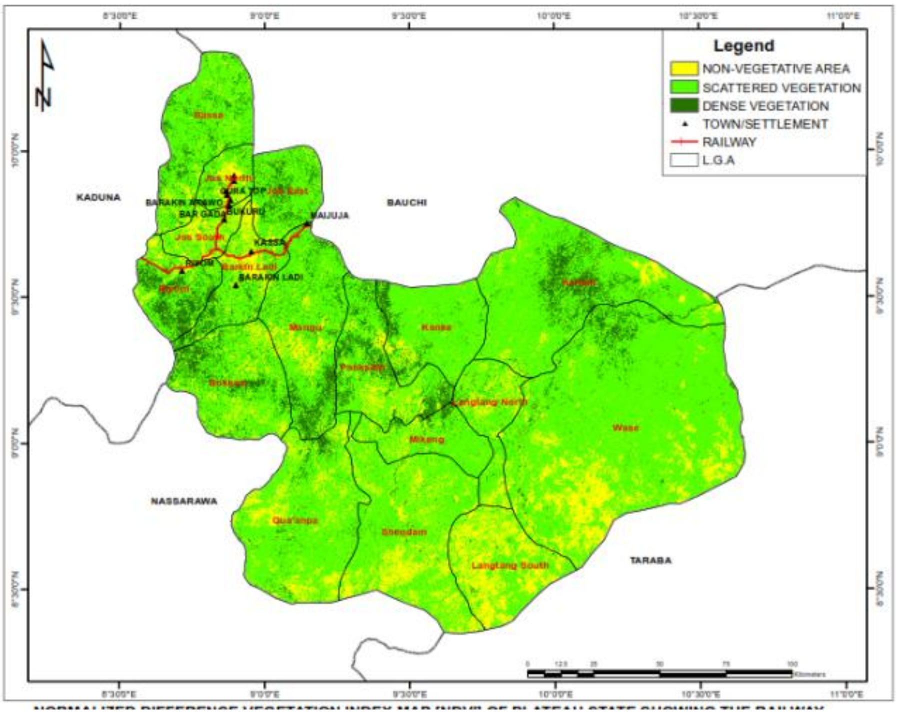


Figure 4.41: Map Showing vegetation of Plateau state

4.10.2.4 Montane Vegetation (Vegetation around the project axis in Plateau State)

Plates 4.16: Showing mountainous vegetation in the study area (Karu, Plateau state, PGM Fieldwork, 2020)

The montane vegetation zone is situated in high mountain areas of Plateau state and Kafanchan in Kaduna State. It is a combination of mountainous and plateau vegetation. These ecosystems are strongly affected by climate, which gets colder as elevation increases, Jos Plateau Ecological Zone is based on the distinctness of the vegetation of the plateau (altitude about 1200 m) for two reasons. First, the high plateau has suffered widespread degradation by man so that only relics of Guinea woodland remain.

Presently, the plateau is almost devoid of trees. Second, the flora on the Plateau is peculiar with many species of woody and herbaceous plants not found elsewhere in West Africa, alongside many typical Guinea Savanna species. The endemic species peculiar to the Jos Plateau include *Terminalia brozenii, Morea zambesiaca* and the orchids *Disperis johnstoni* Disa *hircicornis and abundant Mamillaria spp.*

4.10.2.5 Sudan savannah: Vegetation around the project axes in Bauchi, Gombe Yobe and Borno states

Plates 4.17 showing Sudan savannah (Mogono, Yobe state. PGM Fieldwork, 2020)

The Sudan vegetation zone is situated in the northern areas of the project areas in Bauchi, Gombe, Damaturu (Yobe state) and Borno (Maiduguri) State. This vegetation is found to the Northern parts of the railway and stretches from the Sokoto Plains through the Northern section of the High Plains of Nigeria to the Chad Basin. It is actually a mixture of vegetation types; composed of grasslands and woodlands thriving under annual rainfall between 600-1000 mm and the relative humidity is generally below 40%, except for the few rainy months when this can rise to 60% and above.

The zone experiences a dry season of about 4-6 months. The zone has the largest population density in Northern Nigeria, produces important economic crops such as groundnuts, cotton, millet, and maize and has the highest concentration of cattle in the country. Sudan savanna has consequently suffered great impact from man and livestock. The landscape has less vegetation than the Guinea savanna. Existing vegetation consist mainly of short grasses, about 1-2 m high, and some stunted tree species, such as Acacia species, the silk cotton *Ceiba pentandra* (silk cotton) and the *Adansonia digitata* (baobab), *Azadirachta indica*.

Figure 4.42 – 4.45 below Shows map of the affected vegetations

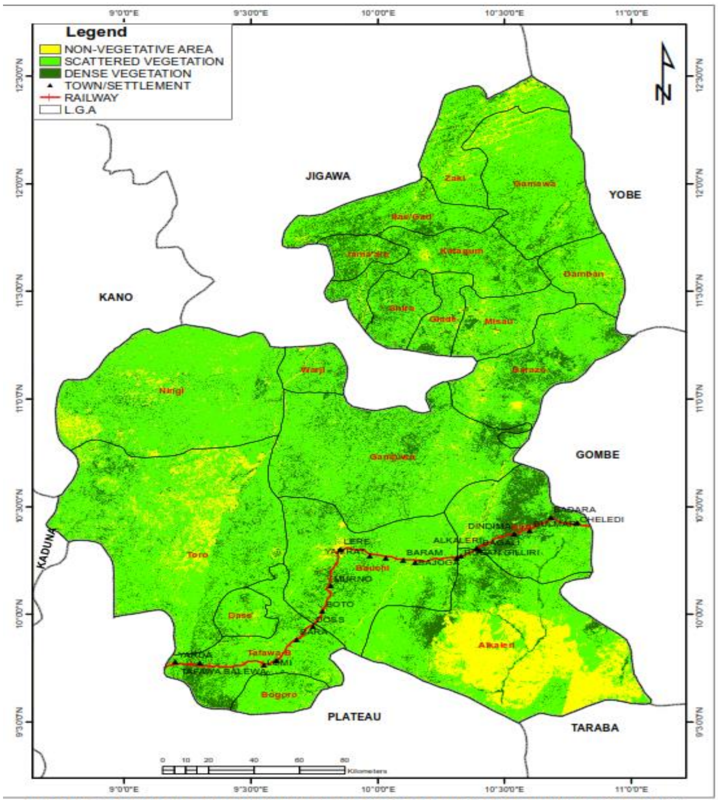


Figure 4.42: Map Showing vegetation of Bauchi state

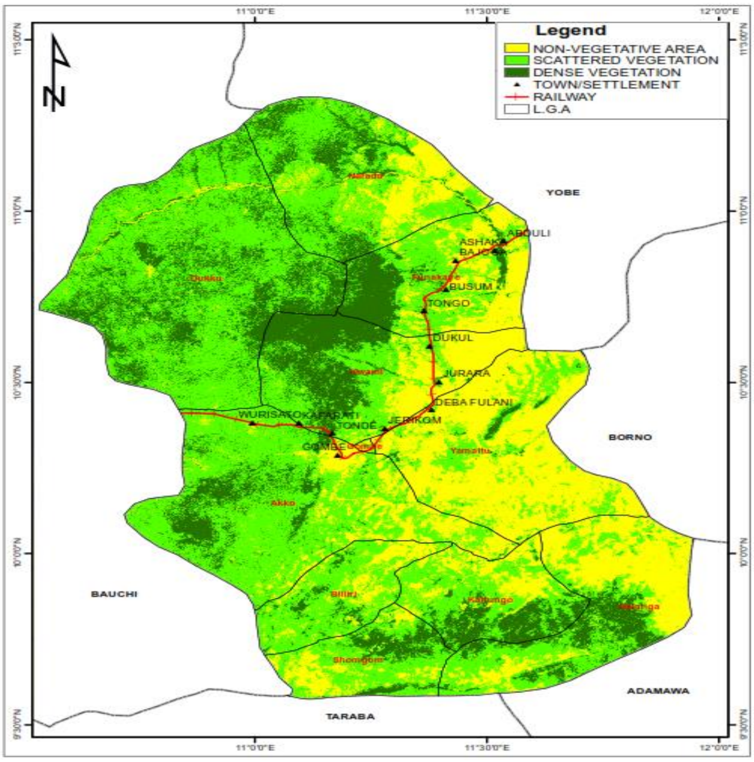


Figure 4.43: Map Showing vegetation of Gombe State

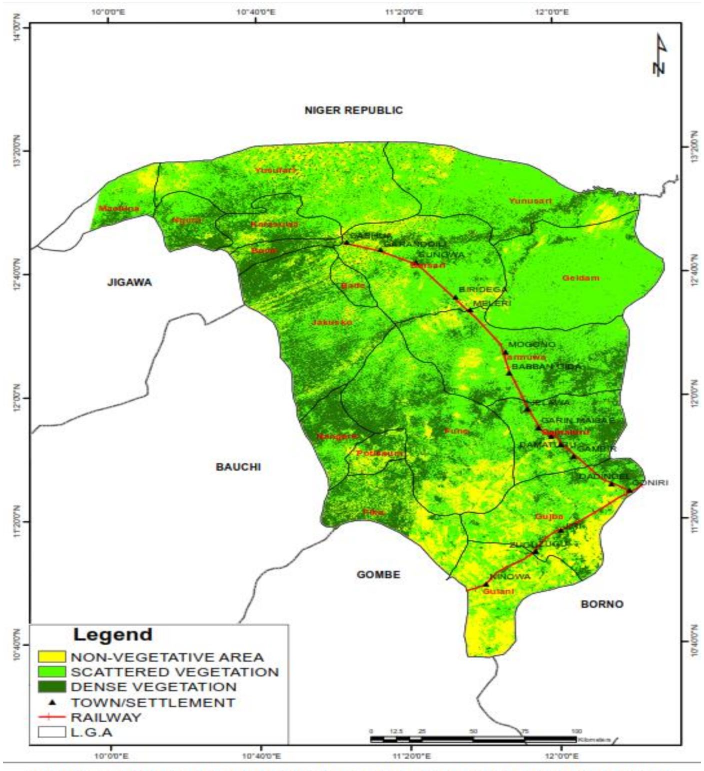


Figure 4.44 Map Showing vegetation of Yobe State

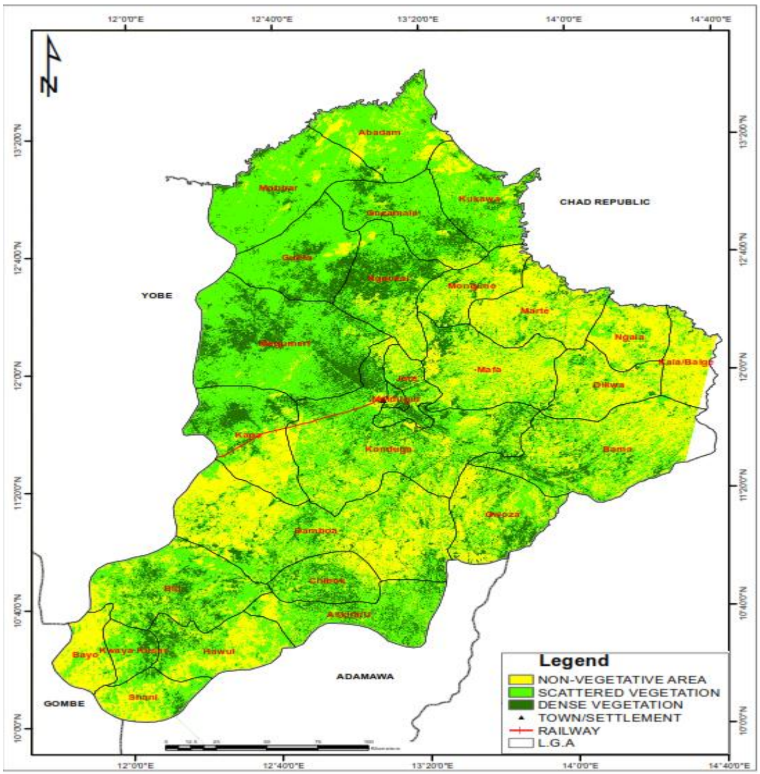


Figure 4.45: Map Showing vegetation of Borno State

4.10.2.6 Sahel savannah: Vegetation around the project axes in Bauchi, Gombe Yobe and Borno states

The Sahel vegetation zone is situated in the northern areas of the study area in Bauchi, Gombe, Damaturu, Maiduguri. This belt spreads in the northern parts of the study area. annual rainfall is less than 600 mm and with dry seasons exceeding 8 months, very variable and unreliable. The vegetation is a variable mixture of grasses and herbs with a variable scatter of low shrubs and bushes interspersed with bare areas. The belt is represented by various vegetation formations according to changes in rainfall and soils and is dominated with *Acacia raddianna, A. Senegal, A. laeta* and *Commiphora africana;* the shrubs are *Salvadora persica, Leptadenia pyrotechnica*; while the grasses include *Aristida stipoides, Schoenefeldia gracilis* and *Chloris priean*. The pockets of bushes are the main source of feed for livestock especially in the dry season. Accordingly, the type of vegetation is a grazing climax where the palatable browse species are reduced or eliminated.

Plates 4.18: showing Sahel savannah (Biridega, Yobe State. PGM Fieldwork, 2020)

4.10.2.7 Vegetation around the cultivated areas

Areas that have been used for agricultural purpose are also found within the study area, these are areas used for agriculture but are devoid of" natural trees" which have been felled either for fuel or other purposes, as well as shrubs, due to continuous clearing of the land, filling and cultivation of agricultural crops. Species diversity in this area is quite low. Plants occurring here are mainly foods crop such Cassava (*Manihot esculenta),* Maize (*zea mays),* Cocoyam (*Coloccosia esculenta),* Yam (*Discorea rotundata*), Sugar cane (*Saccharum officinale*), rice (*Oriza sativa*) and Millet *(Pennisetum glaucum).*

Plate 4.19: Cultivation of cassava around Ndeaboh station in Enugu state

4.10.2.8Vegetation around the Plantations

The vegetation in the plantation is largely dominated with stands of *Elaeis guineensis* which is predominantly the major tree of the rainforest in the study area. The stands provide a definite canopy for the area, other plantation found in the project site includes Banana *(Musa sapientum*), Plantain (*Musa paradisica)* and Oranges.

Plate 4.20 Oil palm Plantation in the study area (Adara, Rivers state. PGM fieldwork, 2020)

4.10.3 Flora

A total of 48 species were censored yielding 1,880 individuals (Abundance). About 55.6% were trees, 5% shrubs, 22.4% were herbs and about 17% were grasses.

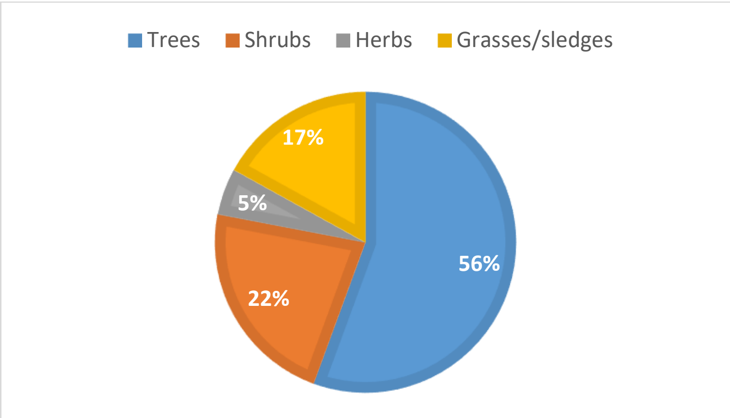


Figure 4.46 Showing percentage abundance of flora

Some of the tree species censored in the study areas include; *Elaeis guineensis, Hevea brasilensis, Triplochiton scleroxylon, Magnifera Indica, Citrus sinensis, Carica papaya, Anacardium occidentale, Psidium guajava, Azadirachta indica, Gmelina arborea, Butyrospermum parkii and Parkia bioglobosa, Klainedosa gabonensis, Symphonia globufera, Alstoria booneii,Terminalia superba ,Invingia gabonensis, chlorophora excelsa, Ceiba Pentandra, Piptademiastrum africanum , Cynometra megalophylla,Cola spp, Lophire alata, Raphia hookerii, Adansonia digitata and Terminalia glaucescens,.*

The Shannon index for the study area was 2.15. Of the twenty-four (24) species listed in the IUCN database as alien and invasive to Nigeria, only *Panicum lax and Mimosa pudica*were the invasive species captured in this study while *Etandrophragma angolense* was the only alien species.

(as shown in Table 4.36). With respect to the ecosystem services provided by the plant species, some of the species were reviewed to provide food/energy and medicinal services, while some species were used as raw materials. The indigenous uses of each plant inventoried were assessed. Some of the indigenous uses include fuel wood, medicinal purposes, as fruits and seeds, as sundry products, as beverages and drinks, as fodder, as wattles, as nuts, as spice, as flavours and thickeners as chewing stick, as gum and adhesives, and some for prevention of soil erosion. Some species with numerous indigenous uses include *Elaeis guineensis, Magnifera indica, Carica papaya, Raffia hookeri, Azadirachta indica, Acacia senegalensis and Khaya ivorensis*. The IUCN version of 2016 criteria were used to evaluate the conservation status of the species. The result indicated that some of the species were threatened or vulnerable.

Table 4.36: List of alien plant species in Nigeria

Alien Species	Invasive Species
Acalypha indica	*Bidens Pilosa*
Adeniacissampeloides	*Chromolaena odorata*
Ageratum conyzoides	*Cyperan rotundas*
Alternetherabrasicus	*Dalbergia sissoo*
Alternetherasessils	*Elchhhornia crasipies*
Antigoniumleptolus	*Imperata cylindrical*
Chromolaena odorata	*Leucaena leucocephala*
Cissus argute	*Mimosa diplotrichia*
Commenlina benghalensis	*Momomorium destractor*
Dissotis rotundifolia	*Momomorium floricola*
Euphorbia grammea	*Nypa fruticans*
Euphorbia heterophylla	*Psidum guajava*
Lantana camara	*Prosopis sp*
Leucaena leucocephala	*Adenanthera pavonine*
Merremia kentrocaulos	*Althermanthera sessilus*
Mucuna pruriens	*Mimosa pudica*
Passoflora foetida	*Oxycaryam cabense*
Plastosoma africanum	*Bacopa momieri*
Ruthalaciae glandulosa	*Cardiospermun grandiflorum*
Schriankia leptocarpa	*Cenchrus ciliaris*
Setaria barbata	*Commelina bengualensis*
Tithonia diversifolia	*Discorea bulbifera*
Truimfetta rhombusa	*Lygodium microphyllum*
Typha australis	*Panicum repens*
	Paspalum scrobiculatum
	Rhizophora mangle
	Rottbiellia cocchinchnesis
	Ricinus cumunis
	Ziziphus Mauritania

Source: Borokini (2011)

4.10.3.1 Data Analysis

Species Richness/Composition

The number of species present in each plot was evaluated using several multivariate data analysis packages that treated multivariate data summarizing the data and revealing the structure. It further gave detailed information about each plot and made it possible for plots to be weighed against each other. Plots were compared for the number of species in relation to the number of individuals.

Species Abundance

Abundance of species was evaluated by counting the number of individuals of a species in the area census.

Relative abundance (Pi) of species was evaluated using the following formula:

$$Pi = \frac{Ni \times 100}{\text{Sum of all individuals recorded.}}$$

Where Ni is the sum or proportion of each individual species in the sample

Species Diversity

In order not to miss an important aspect of the numerical structure of the community, diversity index was calculated for the different plot. Despite the several diversity indices available, Shannon's index was preferred as it is independent of area hence result can be compared with other sites. It was calculated by determining for each species the proportion of individuals that it contributed to the total in the sample. The following formula was used:

$H = -\Sigma Pi \ln Pi$,

Where H = Shannon's index, ln = log.

Equitability or evenness, which is the maximum possible value diversity, assumed that since individuals were completely evenly distributed (Begon, et al 1986) was also calculated using the following formula;

$= EQ = -\Sigma Pi \ln Pi / \ln S$

Where EQ = equitability, S = total number of species.

Family Abundance

Family abundance was evaluated by counting the number of individuals of species belonging to a family. Relative abundance of family was evaluated by:

$$\frac{\text{The number of individuals in a family} \times 100}{\text{Sum of all individuals recorded.}}$$

Species Frequency

Frequency is a simple measure calculated as the percentage of the plots set up, in which the species is present (Sutherland et al 1996).

$$\frac{\text{Number of plots in which species is recorded} \times 100}{\text{Total number of plots census}}$$

Relative frequency of species was evaluated by dividing the frequency of individual species by the sum of all frequencies.

$$\frac{\text{Frequency of a species x 100}}{\text{Sum of all frequencies}}$$

Frequency analysis of families followed the same procedure.

Species Dominance

For each plant species recorded, diameter at breast height (DBH) was also recorded. DBH was also used to calculate the basal area of each species and also for the total study area. Species dominance was then evaluated by summing for each species, the basal area. Relative dominance of each species was evaluated by dividing the sum of basal area of a species by the total basal area of all species, expressed in percentage.

$$\frac{\text{Combined basal area of a single species} \quad \text{X 100}}{\text{Total basal area of all species.}}$$

Family Dominance

For each plant family that was recorded, dominance was evaluated by summing the basal area of all species belonging to the family. Relative dominance of each family was evaluated by dividing the sum of basal area of all species in a family by the total basal area of all species, expressed in percentage

$$\frac{\text{Combined basal area of species in a family} \quad \text{X 100}}{\text{Total basal area of all species.}}$$

Forest Structure

Forest structure was evaluated in terms of stem densities, tree diameter and size class distribution and basal area.

Density

Tree density was evaluated by dividing the total number of trees recorded by the total area sampled. Relative densities were also evaluated where the following formula was used:

$$\frac{\text{Number of individuals of a species} \quad \text{X 100}}{\text{Total area sampled}}$$

Size class Distribution

Tree diameter recorded was arranged in diameter classes. The range of tree diameter found in the area was represented in a graphic way by displaying tree diameter in an orderly manner of 10m interval difference. Tree diameter recorded was arranged in diameter classes. The range of tree diameter found in the area was represented in a graphic way by displaying tree diameter in an orderly manner of 10 interval difference.

Basal Area

The basal area was calculated using Edward method, where tree diameter was divided by 2 to get the radius, secondly the radius was squared and thirdly, the number was multiplied by π, where π = 3.14.

Table 4.37: Showing Plant Diversity Index and Occurrence

Species	n_1	p_1	Lnpi	$-(P_1.\ln p_1)$	Distribution %
Elaeis guineensis	280	0.1489	1.9045	0.2084	14.9
Klainedosa gabonensis	58	0.0309	3.4770	0.1074	3.1
Azadiractha indica	152	0.0809	2.5145	0.2034	8.1
Magnifera Indica	400	0.2128	1.5474	0.0329	21.3
Citrus sinensis	108	0.0574	2.8577	0.1640	5.7
Carica papaya	87	0.0462	3.0748	0.1421	4.6
Anacardium occidentale	68	0.0361	3.3215	0.1199	3.6
Psidium guajava	50	0.0266	3.6268	0.0965	2.6
Gmelina arborea	175	0.0931	2.3740	0.2210	9.3
Butyrospermum parkii	135	0.0718	2.6339	0.18911	7.2
Parkia bioglobosa	40	0.0213	3.8490	0.0473	2.1
Acanthus monotamus	24	0.0128	4.3583	0.0558	1.3
Raffia hookeri	38	0.0202	3.9020	0.0788	2.02
Mamillaria spp	35	0.0186	3.9846	0.07411	1.9
Adansonia digitata	55	0.0292	3.5336	0.1031	2.9
Acacia raddianna	70	0.0372	3.2914	0.1224	1.9
Lonchocarpus griffonianus	35	0.0186	3.9845	0.0741	1.9
Isoberlinia doka	64	0.0340	3.3814	0.1150	3.4
Total	**1880**			**2.15**	**100**

Source: PGM Fieldwork, 2020

Table 4.38 Flora species occurrence in the study area

Serial No.	Species	Life Form	IUCN STATUS (2016)
1.	*Elaeis guineensis*	Tree	D
2.	*Klainedosa gabonensis*	Tree	Th
3.	*Azadiractha indica*	Tree	D
4.	*Raffia hookeri*	Tree	Th
5.	*Symphonia globufera*	Tree	Th
6.	*Alstoria booneii*	Tree	Th
7.	*Terminalia superba*	Tree	Th
8.	*Adansonia digitata*	Tree	Th
9.	*Acacia raddianna*	Tree	Th
10.	*Lonchocarpus griffonianus*	Tree	Th
11.	*Isoberlinia doka*	Tree	Th
12.	*Lophire alata*	Tree	Th
13.	*Acanthus monotamus*	Tree	Th
14.	*Diplarium sammanti*	Tree	Th
15.	*Salvadora persica*	Shrubs	R
16.	*Leptadenia pyrotechnica*	Shrubs	Th
17.	*Chloromolaena dorata*	Shrubs	Th
18.	*Clappertonic ficifolia*	Shrubs	Th

Serial No.	Species	Life Form	IUCN STATUS (2016)
19.	*Psychortinia Vogelina,*	Shrubs	Th
20.	*Anthoratha macrophylla*	Shrubs	Th
21.	*Xylopia ethiopica,*	Shrubs	Th
22.	*Alchanea cordifolia*	Shrubs	Th
23.	*ficus veogeliana*	Shrubs	Th
24.	*Baphia* spp	Shrubs	Th
25.	*Tetrapleura tetraptera*	Shrubs	Th
26.	*Opilia celtidifolia*	Climbers	Th
27.	*Uvaria chamae*	Climbers	Th
28.	*Alchomea cordifolia*	Shrub	Th
29.	*A. laxiflora*	Shrub	Th
30.	*Allophyllus africanus*	Herb	Th
31.	*Commelina benghalensis*	Herb	Th
32.	*Cosnis afer*	Herb	R
33.	*Digitaria debilis*	Herb	Th
34.	*Dimorphochlamys mannii*	Herb	Th
35.	*Dossotis rotundifolia*	Herb	Th
36.	*Calamus derratus*	Shrub	Th
37.	*Carpolobia lutea*	Shrub	Th
38.	*Chromolacna odorata*	Herb	Th
39.	*Cissus polyantha*	Shrub	Th
40.	*Cleistopholis pattens*	Tree	Th
41	*Mamillaria spp*	Tree	D
42	*Magnifera indica*	Tree	D
43	*Citrus sinensis*	Tree	D
44	*Carica papaya*	Tree	D
45	*Anacardium occidentale*	Tree	D
46	*Psidium guajava*	Tree	D
47	*Gmelina arborea*	Tree	D
48	*Butyrospermum parkii*	Tree	D
49	*Parkia bioglobosa*	Tree	D

Source: PGM fieldwork, 2020

Keys

Th – Threatened

R - Rare

D- Dominant

Table 4.39: Plant species and their provisional services

Provisional services	Species	Common names
Food and energy	*Elaeis guineensis*	Oil palm
	Rafia hookeri	Raffia palm
	Anarchadium occidentele	Cashew
	Vachelliafortiila	Umbrella thorned acacia
	Cocos nucifera	Coconut
	Hageniaabyssinica	African redwood
	Magnifera indica	Mango
	Sacchariumofficinale	Sugarcane
	Lophiraalata	Ironwood
Medicine	*Azadiracthaindica*	Neem (dogoyaro)
	Acrocerus macrum	Nile grass
	Acaciaciasenegalensis	Gum Arabic tree
	Afzelia Africana	Afican mahogany
	Lovoatrichiliodes	African walnut
	Magnifera indica	Mango
	Phoenix dactilfera	Date palm
Raw material	*Elaeis guineensis*	Oil palm
	Raphia hoookeri	Raffia palm
	Parkia clappertononia	Locust bean
	Lophira alata	Iron wood
	Hageniaabyssinica	African redwood
	Milletiaconraui	Baobab tree
	Gmelina gmelina	Gmelina

Source: PGM Fieldwork, 2020

4.10.3.2 Protected Areas

Generally, there are no protected areas to be affected by the project in all the states.

Protected Area Nigeria's protected area management system falls into 3 categories. Game Reserves and Forest Reserves are by statute managed by State Governments. The Federal Government of Nigeria oversees the management of the National Parks. Protected areas such as Forest Reserves were mostly creation of the colonial government in Nigeria.

Most protected areas were thus established between the 1930s and 1960. For a variety of reasons mostly related to inadequate resources such as funding, skilled manpower and conflicting government policies, most protected areas at both state and federal level exist only on paper. A review of existing literature did indicate that in times past, the areas adjoining the proposed project area were reported to have harbored species of conservation importance. The following are Protected Areas in the affected Stated, although none is traversed by the existing railway line ofr any of the proposed branch lines:

- ❖ The Finima Nature Park or upper Orashi Forest Reserves in Rivers State
- ❖ Kalunta Forest Reserves in Abia State
- ❖ Ebonyi Forest Reserves

- Enugu Forest Reserves
- Yaaiwa and Ipinu – Igede Forest in Benue state
- Doma Forest Reserves in Nasarawa state
- Kamuku National Park in Kaduna state
- Ngel Nyaki Forest Reserves in Plateau State
- Yankari Game Reserves in Bauchi State
- Chad Basin National Park in Borno state

4.10.4 Fauna Wildlife

4.10.4.1 Sampling Method

A combination of sampling techniques was used which included identifications of major ecosystem types to identify associated fauna, collecting, preserving and representing fauna species such as foot prints analysis, faecal samples, nest type, feeding site, sounds, shell types and interviews with the indigenes.

Two main methods of fauna sampling were adopted: Direct evidence (sighting) and indirect evidences.

Direct observations: Visual encounter survey during nocturnal and diurnal expeditions and recognizing evidence of wildlife species presence through vocalization was undertaken. The Capture-recapture method was used for small mammals and some invertebrate fauna.

Indirect Observations: Indirect signs such as footprints, scats/faeces, feeding activity, nests, tracks, holes/diggings or scratching, carcass. The recorded evidence was represented both by direct (collections and observations) and indirect (tracks, footprints, scats/faeces, feeding activity, nests, tracks, holes/diggings or scratching, carcass and identification by local residents).

Examination of road kills and meat markets*:* Interview of hunters, fishermen, farmers, etc to gain better insight into the habitat history, faunal distribution pattern, seasonal migration, local names, conservation status, economic importance and threats to biodiversity.

The fauna diversity in the study area is very rich. A total of 17 species of birds, 34 of mammals and 8 species of reptiles were encountered. Some predominant invertebrate species recorded around the study area include termites, snails, worms and ants. The termites and ants dominate especially the grasslands of the study area. Of all these, mammals found in the study area include deer, antelope, grasscutter. The fauna species play an important role in traditional worship of gods and deities in some part of the study areas, as they are sacrificed for appeasements during festivals and occasions such as; commencement of new farming season, harvest season, marriages, burials and coronations.

Hunting of these animals is done in local and crude methods. Sometimes the animals are trapped or directly clubbed or macheted to death. Hunting is mostly done at night especially during the hunting seasons mostly by ensnarement at water holes. Also found in the northern region of the study areas are cattle herded by the Fulani herdsmen. These cattle are reared and fed in the grasslands which hold a definite seasonal cattle route. They cattle herds are made up of the Muturu, Zebu and N'dama breeds.

Further in the lower food chain are the Isopteran termites which dominate the soil fauna forming heaps occasionally. The Lady Beetle and the Spiders are part of the invertebrate fauna. There is a wide range of species habitats as some live on tree tops such as the Eagle (which is seen maybe once in a year), Kites, Hawks and vultures which are mostly scavengers feeding on dead and decomposing carcasses. The lower canopies of the trees are habitats for monkeys, bats (a delicacy in the study area), snakes and squirrels.

The soil fauna also recorded black ants *(Monosium minium)* which are the major invertebrate fauna in the study area forming huge colonies found in most quadrats in the study area.

The avian species recorded are of high economic importance as they feed on grains and seeds of crop plants in the fields.

Like flora, the study was also conducted on the fauna resources of the study area. The habitats were also classified based on the vegetation habitats - forests habitat, savannah habitat and muntane habitat. Appendix 1 shows fauna species in the study areas

4.10.4.2 Mammalia fauna

The mammalian fauna existing in the natural forest habitat of the project area was studied. The result as shown in table 4.40 indicated that a total of thirty-four (34) mammalian species cutting across nine (9) families were recorded. The breakdown of this number comprises sixteen (16) species of Rodentia, nine (9) species of Artiodactyla, six (6) species each of Primata and Viverridae, two (2) species each of Manidae and Molossidae and one (1) species each of Pongidae, Canidae and Bovidae**.**

Table 4.40: Mammalian Fauna Species Recorded in the Study Area

S/N	Family/ Order	Common Names	Zoological Names	Abundance	2016 IUCN Status
1	Rodentia	Red-legged sun squirrel	*Helioscius rufobrachium*	1	LC
2		Pygmy striped squirrel	*Myosciurus pumilio*	*	LC
3		Crested porcupine	*Hystrix cristata*	*	LC
4		Grass-cutter	Thryonomys swinderianus	1	LC
5		Giant rat	*Cricetomys gambiannus*	2	DD
6		Bush tailed porcupine	*Atherurus africanus*	*	LC
7		Marsh cane-rat	*Thryonomis spp*	*	LC
8		Green squirrel	*Paraxerus poensis*	*	LC
9		Bush rat	*Rattu rattus*	3	LC
10		common rat	*Rattus norvegicus*	6	LC
11		Bush rat	*Rattus fuscipes*	3	LC
12	Pongidae	Robust chimpanzee	*Pan troglodytes*	*	
13	Manidae	Giant pangolin	*Manis gigantea*	*	VU
14		Ground pangolin	*Smutsia gigantea*	*	VU
15	Canidae	Pale fox	*Vulpes pallid*	*	LC
16	Bovidae	Congo forest buffalo	*Syncerus caffer nanus*	*	NE
17	Molossidae	*Nigerian free-tailed bat*	*Chaerephon nigeriae*	3	LC
18		Little Free-tailed Bat	*Chaerephon pumilus*	1	LC
19	Primata	white throated monkey	Cercopithecus erythrogaster	*	Vu
20		black throated colored monkey	Cercopithecus roloway	*	EN
21		Blue Monkey	*Cercopithecus mitis*	*	LC
22		Old world monkey	*Mandrillus leucophaeus*	*	**EN**

S/N	Family/ Order	Common Names	Zoological Names	Abundance	2016 IUCN Status
23		Mona monkey	*Cercopithecus mona*	*	LC
24	Viverridae	Blotched genet	*Genetta tigrine*	*	LC
25		African civet	*Civettictis civetta*	*	LC
26		African palm civet	*Nandinia binotata*	*	LC
27		Cape clawless otter	*Aonyx capensis*	*	NT
28		Small Indian *Mongoose*	Herpestes auropunctatus	*	NA
29	Artiodactyla	Bush pig	*Potamochoerus porcus*	*	LC
30		Sitatunga or marshbuck	*Tragelaphus spekii*	*	LC
31		Water chevrotain	*Hyemoschus aquaticus*	-	LC
32		Blue duiker	*Cephalophus monticola*	2	LC
33		Red-flanked duiker	*Cephalophus rufilatus*	*	LC
34		Deer	Odocoilus virgianus	3	LC

Source: PGM Survey, 2020

Asterisk (*) indicate species recorded indirectly, **LC**=Least Concern, **Vu**=Vulnerable, **CE**=Critically Endangered, **EN**= Endangered**, NT**=Near Threatened, **DD**=Data deficient, NA=Not Assessed, NE= Not Evaluated

4.10.4.3 Species Abundance

A total of thirty-four (34) individuals of the ten (10) mammalian species were censored directly in this habitat. *Rattus norvegicus* (common rat) represented by six (6) individuals was the most abundant mammalian species sighted. This was followed by *Rattu rattus* (Bush rat) and *Chaerephon nigeriae (Nigerian free-tailed bat)* with three (3) individuals each. *Cricetomys gambiannus* (Giant rat), and *Rattus fuscipes* (Bush rat) were represented by two (2) individuals each while *Helioscius rufobrachium* (Red-legged sun squirrel), Thryonomys swinderianus (Grass-cutter), *Chaerephon pumilus* (Little Free-tailed Bat), *Cephalophus monticola* (Blue duiker) and *Tragelaphus scriptus* (Bush buck) were each represented by an individual.

Twenty three (23) species including *Myosciurus pumilio*, *Hystrix cristata*, *Atherurus africanus*, *Thryonomis spp*, *Paraxerus poensis*, *Pan troglodytes*, *Manis gigantean*, *Smutsia gigantean*, *Vulpes pallid*, *Syncerus caffer nanus*, Cercopithecus erythrogaster, Cercopithecus roloway, *Cercopithecus mitis*, *Mandrillus leucophaeus*, *Cercopithecus mona*,*Genetta tigrina*, *Civettictis civetta*, *Nandinia binotata*, *Aonyx capensis*, Herpestes auropunctatus, *Potamochoerus porcus*, *Tragelaphus spekii* and *Cephalophus rufilatus* were censored by indirect indicators.

2016 IUCN Status

A total of 5 species censored in this habitat were classified in any one of the three threatened categories. *Pan troglodytes*, Cercopithecus roloway and *Mandrillus leucophaeus*were classed as Endangered (EN) while *Manis gigantean* and *Smutsia gigantean* were classed as Vulnerable.*Aonyx capensis* was categorized as Near Threatened (NT). All others were either classed as Data Deficient, Not Evaluated or Least Concern.

4.10.4.4 Avi fauna Species

The Avi fauna existing in the Natural Forest Habitat of the project area was studied. The result as shown in table 4.41 indicated that a total of seventeen (17) Avi fauna species cutting across nine (9) taxonomic families were recorded. The breakdown comprises three (3) species each of Accipitridae and

Columbidae, two (2) species each of Anatidae, Apodidae, Muscicapidae and Tytonidae and one (1) species of Rallidae, *Phasianidae* and Numididae.

Table 4.41: Avi Fauna species Recorded in the study area

S/N	Family/ Order	Common Names	Zoological Names	Abundance	2016 IUCN Status
1	Accipitridae	Back kite	*Milvus migrans*	2	LC
2		Hooded vulture	*Necrosyrtes monachus*	1	CR
3		African harrier hawk	*Polyboroides typus*	2	LC
4	Rallidae	African rail	*Rallus caerulescens*	*	LC
5	*Phasianidae*	Double-spurred Francolin	*Francolinus Bicalcaratus*	1	LC
6	Apodidae	African palm swift	*Cypsiurus parvus*	1	LC
7		Little swift	*Apus affinis*	2	LC
8	Tytonidae	**Barn owl**	*Tyto alba*	3	LC
9		Owl	*Strix alba*	2	LC
10	Muscicapidae	Cassins flycatcher	*Muscicapa cassini*	*	LC
11		Rusty-tailed Flycatcher	*Muscicapa*ruficauda	1	LC
12	Columbidae:	Red eyed dove	*Streptopelia semitorquata*	*	LC
13		Blue headed wood dove	*Turtur brehmeri*	2	LC
14		African green fruit pigeon	Treron calvus	1	LC
15	Numididae	Guinea fowl	*Numida meleagris*	3	LC
16	Anatidae	Bush duck fowl	*Nettapus auratus*	1	LC
17		*Nigerian free-tailed bat*	*Chaerephon nigeriae*	3	LC

Source: PGM Survey, 2020

Asterisk (*) indicate species sighted indirectly, **LC**=Least Concern, **Vu**=Vulnerable, **CR**= Critically Endangered

4.10.4.5 Species Diversity

A total of seventeen (17) Avi fauna species were censored in this habitat. Of this, fourteen (14) species which include [*Milvus migrans* (Back kite), *Necrosyrtes monachus* (Hooded vulture), *Polyboroides typus*(African harrier hawk), *Francolinus bicalcaratus*(Double-spurred Francolin) *Cypsiurus parvus* (African palm swift), *Apus affinis* (Little swift), *Tyto alba*(**Barn owl),** *Strix alba*(owl), *Muscicapa* ruficauda (Rusty-tailed Flycatcher), *Turtur brehmeri(*Blue headed wood dove), Treron calvus(African green fruit pigeon), *Numida meleagris*(Guinea fowl), *Nettapus auritus*(Bush duck fowl) and *Anas sparsa* (African black duck)] were censored directly while three (3) species including *Rallus caerulescens* (African rail), *Muscicapa cassini* (Cassins flycatcher), and *Streptopelia semitorquata (*Red eyed dove) were censored by indirect evidences.

Family Diversity

Accipitridae, Rallidae, *Phasianidae*, Apodidae, **Tytonidae,** Muscicapidae, Columbidae, Numididae, and Anatidae were the nine (9) fauna families for which the seventeen (17) censored avi fauna species are grouped. Breakdown showed that Accipitridae and Columbidae which accounted for three (3) species each were the most abundant families in terms of species richness, this was followed by Apodidae, **Tytonidae,** Muscicapidae and Anatidae accounting for by two (2) species each while Rallidae, *Phasianidae* and Numididae were represented by a species each.

Species Abundance

A total of seventeen (17) individuals from fourteen species were censored directly in this habitat. The Breakdown showed that *Tyto alba* and *Numida meleagris* has the highest abundance of three (3) individuals each, followed by *Milvus migrans, Polyboroides typus, Apus affinis, Strix alba,* and *Turtur brehmeri with two (2) individuals each. Necrosyrtes monachus, Francolinus bicalcaratus, Cypsiurus parvus, Muscicapa*ruficauda, Treron calvus, *Nettapus auratus* and *Anas sparsa* had one individual each. On the other hand, *Rallus caerulescens, Muscicapa cassini* and *Streptopelia semitorquata* were the three (3) avi fauna species censored indirectly.

2016 IUCN status

One species, *Necrosyrtes monachus* censored in this habitat was categorized as **Critically Endangered in the 2016 Red List.** All others were classified as **Least Concern** (LC).

4.10.4.6 Reptilian Fauna species

The reptilian fauna in the Natural Forest Habitat was studied. The result as shown in table 1.8 indicated that a total of nine (9) reptilian fauna species cutting across three (3) taxonomic families were recorded. The breakdown comprises seven (7) scinidae species, One (1) Agamidae species, and one (1) Bovidae species. This finding is shown in table 4.42

Table 4.42: Reptilian Fauna Species Recorded in the Natural Forest

S/N	Family/ Order	Common Names	Zoological Names	Abundance	2016 IUCN Status
1	Agamidae	Common rainbow lizard	*Agama agama*	*	LC
2	Bovidae	Boa	*Boa constrictor*	*	LC
3	Scinidae	Skink	*Mabuya cochonaev*	4	LC
4		West African dwarf crocodile	*Osteolaemus tetraspis*	*	Vu
5		Rock python	*Python bivittatus*	*	LC
6		Spitting cobra	*Naja nigricollis*	1	LC
7		Nile monitor	*Varanus niloticus*	1	LC
8		Alligator	*Alligator sinensis*	*	CR

Source: PGM Fieldwork 2020

Asterisk (*) indicate species sighted indirectly, **LC** = Least Concern, **Vu** = Vulnerable, CR= Critically Endangered, (-) = Indicate species absent in the study area

Species Diversity

A total of nine (9) reptilian fauna species were censored in this habitat. Of this number, three (3) species which include *Mabuya cochonaev* (Skink), *Naja nigricollis* (Spitting cobra) and *Varanus niloticus*(Nile monitor) were censored directly while four (4) species including *Agama agama*(Common rainbow lizard), *Osteolaemus tetraspis* (West African dwarf crocodile), *Python bivittatus* (Rock python), and *Alligator sinensis* (alligator)were censored by indirect evidences

Family Diversity

Agamidae, Bovidae and Scinidaeare the three (3) fauna families for which the nine (9) ReptilianFaunaspecies are grouped. Breakdown showed that Scinidae had seven (7) species while Bovidae and Agamidae were represented by a species each.

Species Abundance

A total of three (3) individuals from two (2) species were recorded in this habitat. *Mabuya cochonaev* was represented by four (4) individuals while *Naja nigricollis* and *Varanus niloticus*were represented by one individual each.

Soil Fauna Diversity

Five species of termites were found in the grasslands. Their estimated total abundance and biomass were 485m^2 and 1.0gm^{-2} respectively. The dominant trophic group was the soil feeders (460m^2 and 0.4gm^{-2}) although the wood feeders (8m^2 and 0.01gm^2) were underestimated due to exclusions of their arboreal nesting. Only two of the five species of the soil feeders constructed epigeal nests (mounds).

The presence of Tsetse fly in the grasslands indicates the reason for the neglect of the derived savannah area in livestock rearing and development. These biting flies are vectors of the disease *Trypanosomiasis* which is fatal to both man and grazing herds. The Tsetse flies live in trees and shrubs covers. Also abound in the study area are soldier ants which help in disposing of ground litter and debris and in soil aeration by their burrowing activities.

4.10.5 Land Use

The study area is a typical dominated majorly by Forest, fallow land and or agricultural land, followed by Rivers and clusters of settlements scattered along the project area

Table 4.43 shows the percentage distribution of the major land uses in the study area and its immediate environs and Figure 4.47 shows the relative land coverage/size of the major land uses.

Table 4.43: Major Land Use Distribution in the Study Area

S/N	Major Land Use	Coverage Area (%)
1.	Forest	67
4.	Agriculture	10
5.	Rivers/streams	3
6.	Buildings (Residential, Commercial, Industrial, Worship, Education, Infrastructure)	5
8.	Others	10

S/N	Major Land Use	Coverage Area (%)
	Total	**100**

Source: PGM Survey, 2020

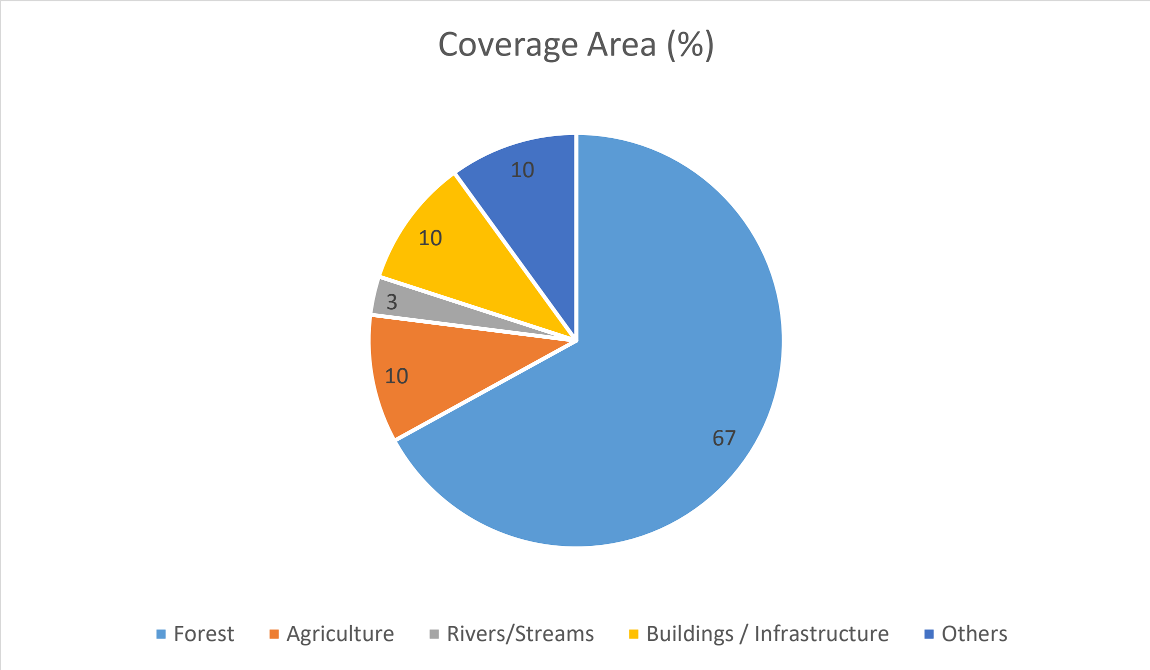


Figure 4.47: Relative Coverage Area/size of the Major Land Uses in the Project Area

4.11 Hydrobiology

4.11.1 Overview

The productivity of any aquatic water body depends on the amount of plankton present in the said water body (Davies *et al* 2009). Four groups of hydrobiology parameters were evaluated. They are phytoplankton, zooplankton benthos and Fishes.

Ecosystem stability is a critical factor for aquatic lives. Since preconstruction and construction activities are likely to impact negatively on the water bodies, expected change in water quality would result in growth and count of opportunistic species. Therefore, a baseline study of the plankton population is imperative. Also, sediment deposition is also predicted to affect benthonic lives.

4.11.2 Sampling Methods

Methodology

Plankton Sampling

Sample for plankton analyses were collected by means of a 55 µm mesh tow net with diameter of 30 cm. The net was used to filter water scooped in a bucket (the content of the tube attached to the end of the plankton net was emptied into plastic bottles and made up to 100 ml mark) and preserved in buffered 10 % formalin.

Sediment

Plate 4.21: Sediment sampling with grab in River Benue

Sediment samples were collected from sampling stations where surface water samples were taken. Bottom sediments were sampled using the Eckman Grab. Samples for macrobenthic fauna were sieved through a 0.5 mm mesh and transferred into 500 ml wide-mouthed plastic containers. Benthic organisms were preserved in 500 ml plastic containers using 40 ml of 10 % formalin. The organisms were identified and enumerated in the laboratory using identification tools and keys.

4.11.3 Zooplankton

A checklist of the zooplankton in the aquatic systems around the proposed life camp is present in Table 4.44. A total of 16 species of zooplankton were recorded and. The total zooplankton counts ranged from 137-328 organisms per litre within under study. The chart showing the contributions of the major families of zooplankton were recorded namely: Rotifera, Cladocera, Crustaceans (Copepoda) and Euphausiacea. Cladocera were the dominant family and constituted 41 % of the total number of zooplankton followed by crustacean (Copepoda) in the rivers (Rivers Imo, Benue and Gongola).

Table 4.44: Diversity and Relative Abundance of Zooplankton

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Rotifera							
Brachiomus caliciflorus	10	2	5	8	12	0	**37**
Collotheca pelagic	3	1	6	4	0	0	**14**
Lecame bulla	8	4	0	0	2	1	**15**
Euchlanis sp.	7	5	10	0	0	0	**22**
Asplanchia prodonta	15	8	5	3	0	5	**36**
Sub-total	**43**	**20**	**26**	**15**	**14**	**6**	**124**
Cladocera							
Alona affinis	5	3	6	1	2	0	**17**
Bosmina sp.	21	17	0	0	14	19	**71**
Daphnia carinata	3	41	26	13	40	32	**155**

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Chydorus sp.	0	0	0	0	3	15	**18**
Plolyphemus pediculus	4	0	23	0	0	40	**67**
Sub-total	**33**	**61**	**55**	**14**	**59**	**106**	**328**
Crustaceans (Copepoda)							
Acartia longirenis	22	8	15	28	3	0	**76**
Anomaalocera patersoni	4	10	9	0	0	11	**34**
Calamus finmarchicus	3	8	1	2	14	1	**29**
Candacia speciosis	12	4	2	3	26	22	**69**
Sub-total	**41**	**30**	**27**	**33**	**43**	**34**	**208**
Euphausiacea							
Meganycliphanes norvegica	24	13	8	4	11	3	63
Meganycliphanes sp.	15	21	6	11	7	14	74
Sub-total	**39**	**34**	**14**	**15**	**18**	**17**	**137**

Source: PGM Fieldwork, 2020

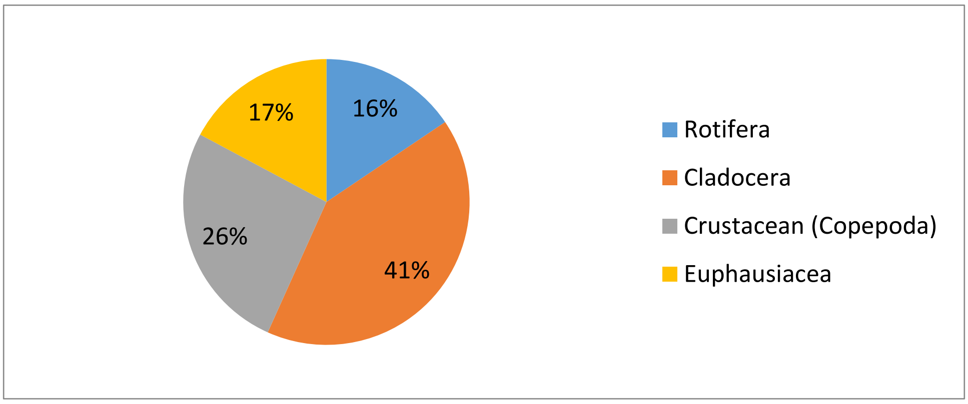


Figure 4.48: Relative Abundance of zooplankton

4.11.4 Phytoplankton

A checklist of the phytoplankton in the aquatic systems around the proposed life camp is present in the table 4.49 below. The graphs showing the contributions of the major families of phytoplankton were recorded namely: Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae and Euglenophyceae and this composition is in conformity with observations made by Chowdhury (2007). Bacillariophyceae were the dominant family and constituted 35 % of the total number of phytoplankton in the rivers.

Table **4.49: Diversity and Relative Abundance of Phytoplankton**

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Bacillariophyceae							
Achnanthes affinis	20	13	17	0	0	22	**72**
Biddulphia aurita	33	28	38	25	27	24	**175**
Chaetoceros mulleri	18	34	50	23	14	24	**163**
Chaetoceros didyma	50	58	49	28	40	45	**270**
Coscinodiscus centralis	48	75	8	45	12	34	**222**
Diatoma hiemale	0	80	0	0	24	50	**154**
Fragillriopsis oceanic	28	34	26	48	20	47	**203**

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Leptocylindricus sp.	64	70	66	72	5	38	**315**
Sub-total	**261**	**392**	**254**	**241**	**142**	**284**	**1574**
Chlorophyceae							
Staurastrun seligerum	12	45	32	58	33	4	**184**
Eudorina sp.	10	6	8	3	7	15	**49**
Halosphaera viridis	28	33	40	8	29	44	**182**
Phacocystis globose	48	0	0	26	0	34	**108**
Pleudorina sp.	51	29	59	0	45	60	**244**
Micrasterias truncate	69	24	0	78	0	0	**171**
Sub-total	**218**	**137**	**139**	**173**	**114**	**157**	**938**
Cyanophyceae							
Anabaena flosaquae	15	18	0	24	12	0	**69**
Gleocapsa rupestris	17	90	4	25	73	0	**209**
Oscillatoria limosa	29	31	48	70	22	28	**228**
Phormedium uncinatum	82	49	26	0	53	0	**210**
Phormedium brevis	46	28	33	0	0	0	**107**
Sub-total	**189**	**216**	**111**	**119**	**160**	**28**	**823**
Dinophyceae							
Ceratium hirundinella	48	50	25	0	0	26	**149**
Ceratium tripos	21	13	10	5	0	0	**49**
Dinophysis caudate	0	0	10	3	6	0	**19**
Gonyaulax hurida	58	0	0	26	13	2	**99**
Pyrocystis sp.	0	0	0	33	15	10	**58**
Sub-total	**127**	**63**	**45**	**67**	**34**	**38**	**374**
Euglenophyceae							
Euglena acus	72	65	58	77	41	29	**342**
Euglena caudate	22	13	24	8	40	15	**122**
Euglena tripteris	8	15	0	30	11	2	**66**
Phacus caudatus	2	5	15	13	0	0	**35**
Trachelomonas sp.	65	41	68	74	0	29	**277**
Sub-total	**169**	**139**	**165**	**202**	**92**	**75**	**842**

Source: PGM Fieldwork, 2020

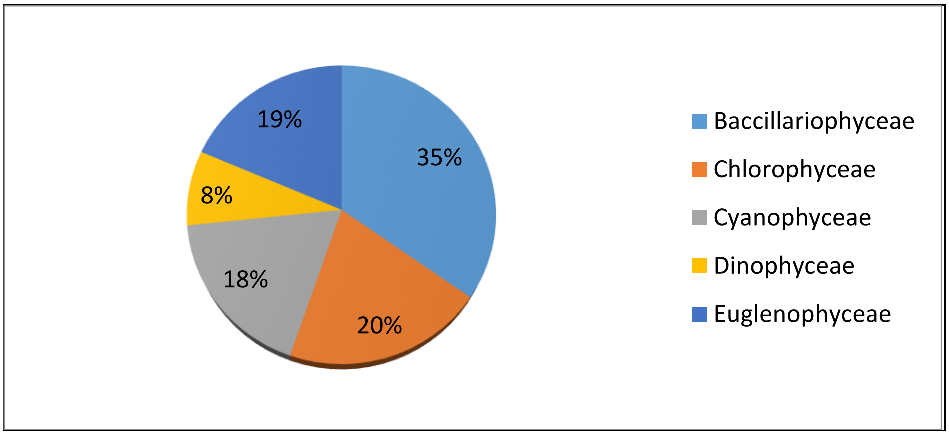


Figure 4.49: Relative Abundance of phytoplankton

The baccillariophyceae were represented by 8 species with numerical contribution ranging from 4.57 % (*Achnanthes affinis*) to 20.01 % (*Leptocylindricus* sp.). This baccillariophyceae abundance has been observed along Nigerian coastal waters (Ekwu and Sikoki, 2006). The second dominant family of phytoplankton was chlorophyceae which contributed 20 % of the total number of phytoplankton within Oras River. Euglenophyceae contributed 19 % while cyanophyceae 18 % and dinophyceae contributed the least.

4.11.5 Benthic Macro-Invertebrate Fauna

A total of sixteen (16) benthic organisms were recorded in the study area. Benthic fauna encountered belong to four (4) major taxonomic groupings comprising polychaete, crustaceans, bivalve molluscs and gastropods molluscs. Gastropods molluscs were the dominant benthos and they constituted 39 % of the macro-benthic organisms followed by Bivalves which constituted 25 % while Polychaete and crustaceans constituted 18 % apiece of the number of benthos. The population density in each station was relatively low. This may be primarily due to the study nature of the sediment. Another possible reason for the low-density benthos observed during the study is attributable to low level of organic material or detritus in the sediment (Olomukoro and Ezemonye, 2007).

Table 4.50: Diversity and Relative Abundance of Benthos

Organism	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	Total
Polychaete							
Arenicola marina	1	5	0	0	2	1	**9**
Capitella capitata	0	0	2	1	3	0	**6**
Eunice harassi	1	2	0	1	4	3	**11**
Notomastus tenuis	3	1	0	0	1	1	**6**
Scolopsis uniramus	0	5	1	2	0	4	**12**
Sub-total	**5**	**13**	**3**	**4**	**10**	**9**	**44**
Crustaceans							
Alpheus monody	0	1	2	0	1	3	**7**
Cliberanus cooci	4	0	0	2	1	5	**12**
Iphinoe tripanosa	3	1	1	0	3	0	**8**
Isodus sp.	4	2	3	1	0	1	**11**
Nototropis swamidami	1	3	1	0	1	1	**7**
Sub-total	**12**	**7**	**7**	**3**	**6**	**10**	**45**
Bivalve							
Tellina nymphalis	3	0	5	2	1	1	**12**
Stylaria sp.	1	3	4	1	2	4	**15**
Nucula sp.	0	0	1	3	3	4	**11**
Sub-total	**4**	**3**	**10**	**6**	**6**	**9**	**38**
Gastropods Molluscs							
Littorina sp.	2	0	0	0	1	1	**4**
Neritina oweniana	6	3	7	1	4	8	**29**
Tympantonus fuscatus	2	5	1	3	7	7	**25**
Sub-total	**10**	**8**	**8**	**4**	**12**	**16**	**58**

Source: PGM Fieldwork, 2020

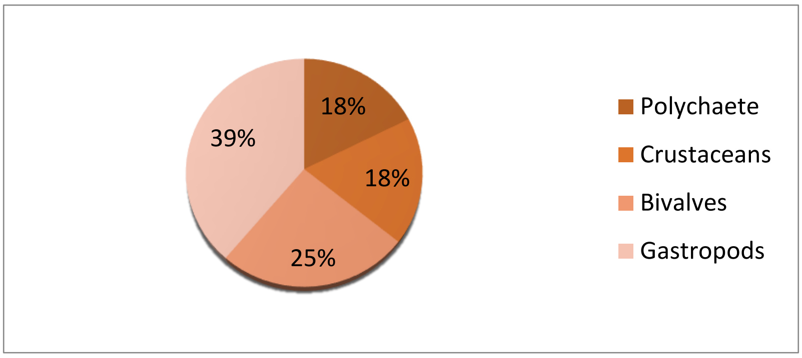


Figure 4.50: Relative Abundance of phytoplankton

4.11.6 Fisheries Studies

Fish from the study site were sampled using gill nets (mesh size: 9inches length: 6m), cast nets (mesh size: 9inches), hook (size: 2inches and lines by the local fishermen. The fish species were identified to the taxonomic level using Idodo-Umen (2003) and species were counted for number of individuals. The fish species were identified, sorted and frequency of occurrence were recorded in-situ. Further identification was completed in the laboratory using FAO literature (1988, 1994).

Plate 4.22: Fishing Activities in the study area (River Benue, PGM Fieldwork, 2020)

A total of 202 countable individuals were recorded from nine (9) families during the fishing survey (**Table 4.51**). These include families: Cichlidae, Claroteidae, Hepsetidae, Channidae, Alestidae, Sciaenidae, Milapteruridae, Mochokidae and Mormyridae.

Table 4.51. Fish Species Recorded in the Study Area

S/N	Family	Common Name	Local Name	IUCN Status	Scientific name	Abundance	%Abundance
			IMO RIVER				
1	Cichidae	Tilapia		**Least concern**	*Oreochromis niloticos*	25	33.8
2	Cichidae	Banded Jewelfish		**Least concern**	*Hemichromus fasciatus*	18	24.3
3	Clarofeidae	Bagrid Catfish		**Least concern**	*Chryischthys nagrodigitatus*	13	17.6

S/N	Family	Common Name	Local Name	IUCN Status	Scientific name	Abundance	%Abundance
4	Hepsetidae	Africa Pike Characin		**Least concern**	*Hepsetus odoe*	7	9.5
5	Channidae	African snakehead		**Least concern**	*Parachama obscura*	5	6.8
6	Alestidae	African characidae		**Least concern**	*Alestes macrophthahmus*	6	8.1
					Total	74	100
RIVER BENUE							
1	Cichidae	Tilapia		**Least concern**	*Oreochromis niloticos*	32	37.6
2	Sciaenidae	Croaker		**Least concern**	*Micropogonias undulatus*	21	24.7
3	Milapteruridae	Electric catfish		**Least concern**	*Malapterurus minjiriya*	13	15.3
4	Mochokidae	Sudan squeaker		**Least concern**	*Synodontis frontosis*	6	7.1
5	Mochokidae	squeaker		**Least concern**	*Synodontis batengoda*	5	5.9
6	Mormyridae	Trunkfish		**Least concern**	*Marcusenius senegalais*	5	5.9
7	Hepsetidae	Africa Pike Characin		**Least concern**	*Hepsetus odoe*	3	3.5
					Total	85	100
	Gongola River						
1	Cichidae	Tilapia		**Least concern**	*Oreochromis niloticos*	21	48.8
2	Sciaenidae	Croaker		**Least concern**	*Micropogonias undulatus*	11	25.6
3	Hepsetidae	Africa Pike Characin		**Least concern**	*Hepsetus odoe*	7	16.3
4	Mochokidae	squeaker		**Least concern**	*Synodontis batengoda*	4	9.3
					Total	43	100

Source: PGM Fieldwork, 2020

4.11.6.1 Physical Deformities

Examination of the 52 fish samples collected showed some of the fishes had physical deformities. Ulceration and fin rots were prevalent possibly due to the activities of piscine predator. Examination of gut contents revealed traces of planktons and fish in the diet. The abnormality status of the fish samples is presented in Table 4.52. The table shows the number of occurrences of each disease type and the percentage prevalence in relation to the total fish samples studied.

Table 4.52 Abnormality Status of Fish Samples from the Study Area

Disease	No. of Occurrence	Prevalence (%)
Ulceration	23	44.2
Epithelial hypereplatia	3	5.8
Fused gill lamellae	2	3.8

Excessive mucus secretion	3	5.8
Fin rot/erosion	18	34.6
Chilodonelosis	3	5.8
Total	**52**	

Source: PGM fieldwork, 2020

4.12 Socio-economics

4.12.1 Introduction

The ESIA guideline has made it mandatory to consult communities on the possible impact of a proposed rehabilitation and construction work on the existing Port Harcourt –Maiduguri Railway line project. It is also binding to integrate communities' views at the project design stage. The socio-economic and community health impact assessment tools for this study were designed to integrate the desires and aspirations of the communities with those of the project proponent. In line with the ESIA objectives, wide consultations were held and community aspirations were recorded.

Public forums were also held to create more awareness of the proposed project and to elicit communities' support. The views expressed at the public forums are also an integral part of this report. This phase of the study consisted of data collation on the baseline social and economic indices of the study area. Relevant data are presented under various subheadings, including social environment (socio-cultural/psychological environment, demography, education, and literacy, quality of life, poverty and inequality, human development indices); economic survey (production factors, labour force participation, employment/unemployment, and market trends).

4.12.2 Methodology

4.12.2.1 Sampling Procedure and Data Collection Techniques

In obtaining socio-economic data of the project host communities, the exploratory survey method was adopted. This involved key informant interviews and village-level group interviews using structured questionnaires. The questionnaire used in obtaining socio-economic data employed a combination of "open-ended" and "closed" questionnaire format. Open-ended questions are more suitable for qualitative data while closed questions are more suitable for quantitative data. Simple random and purposive or sampling techniques were employed in the sampling of the population of the study area.

Qualitative data were generated through informed meetings and also observation in small groups of stakeholders in the various communities with diverse socio-economic backgrounds and interests. Such groups include age grades, farmers group, market women, and youth associations. Each group meeting focused first on the political/administrative structure of the community/population characteristics, ethnic composition, and existing infrastructural facilities, predominant occupation as well as cultural practice and treasures.

4.12.2.2 Sources of Data

Primary and secondary sources were used for the survey.

a. **Primary Sources**

The administered questionnaires were employed to gather quantitative information concerning household and communal characteristics while direct observations, individual interviews, and focus group discussions were employed to assess the concerns of the community inhabitants on matters bordering on the social, economic, and health implications of the proposed project in their communities as well as their collective expectations from the proponent.

b. Secondary Sources

In instances where primary sources could not provide the required data, secondary data sources were relied upon. At the community level, such secondary data was sought from desk reviews which provided official and published information on the communities including population figures and records revealed by other existing structures such as local government records and hospital records. Information was also obtained from existing national data sources including the National Population Commission (NPC), National Bureau of Statistics (NBS), electronic maps, and websites of 12 project-affected state governments. Some other data were collected from international sources such as the World Bank, the United Nations (UN), and the African Development Bank (AfDB).

The research instruments employed for the survey were basically:

i. Desk reviews of available secondary data
ii. Direct Observation
iii. Individual Interview
iv. Questionnaire Administration
v. Focus Group discussion and
vi. Maps and published works of literature (journals)

4.12.2.3 Analytical Techniques

Descriptive statistics were utilized to analyze collated data. These included means, percentages, frequency tables, and charts. Data collected on various socio-economic parameters from all the communities were also analyzed using different tools as appropriate.

The questionnaire survey involved sampling households within the community using a set of questionnaires.

4.12.2.4 Field Study Strategy

The field study comprised the following operations:

i. Pre-testing of questionnaires;
ii. Household listing;
iii. Field identification of households selected for interviews;
iv. Questionnaire administration and interview of key informants;
v. Focus group discussions; and
vi. Photography

4.12.3 Project Area

Communities identified as directly affected in this area are those who fall within 2km on either side of the RoW for the rail line. The communities, together with the physical footprint of the project will hereafter be referred to as the "Area of Influence" for the project. The project is anticipated to impact particularly upon these communities. About 60% of the surrounding areas are farmlands. This baseline section, therefore, examines, briefly, the macro socio-economic environment, the regional and district context, and then looks in more detail at how communities, households, and individuals, directly affected by the project, currently exist.

The study was conducted in 50 representative communities in the twelve project-affected States (Rivers, Abia, Ebonyi, Enugu, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe, and Borno). In selecting the sampled communities, proximity to the railway line, the cultural and historical antecedents of the communities were all considered. The study covered the socio-cultural resources of these communities, demographic issues including population growth, age, and sex distribution, and adult literacy. Others were such indicators of the quality of life of the residents as the quality of housing, access to potable water, availability of functional infrastructural amenities, livelihood activities and patterns, and income levels. Health facilities and their patronage, disease prevalence and disease vectors, water and sanitation, and nutrition were also studied. Additionally, the study discusses the perceptions, concerns, and expectations of members and residents of these communities, and establishes the project's potential impacts, impact enhancement, and mitigation measures.

The questionnaire survey involved sampling households within the communities using a set of questionnaires. Three hundred and sixty (360) questionnaires were administered in the twelve project-affected States, that is thirty questionnaires per state. Three hundred and thirty-seven (337) were returned for analysis, representing 93.6% recovery.

The project-affected communities consulted are presented in Table 4.53

Table 4.53: The Project Affected States and LGAs

S/N	STATE	LGA
1	Rivers State	Port Harcourt
		Obio/Akpor
		Oyigbo
2	Abia State	Ukwa West
		Ugwunagbo
		Aba South
		Aba North
		Oboma Ngwa
		Isiala Ngwa North
		Isiala Ngwa South
		Umuahia North
		Umuahia South
		Bende
		Isikwuato
3	Ebonyi	Ivo

S/N	STATE	LGA
		Ishielu
4	Enugu	Enugu South
		Nkanu East
		Nkanu West
		Aninri
		Enugu North
		Enugu East
		Isi Uzo
5	Benue	Ado
		Oturkpo
		Gwer East
		Markurdi
		Guma
6	Nasarawa	Keana
		Obi
		Lafia
		Nasarawa Eggon
		Akwanga
7	Kaduna	Sanga
		Jema'a
		Kaura
		Zangon Kataf
		Kachia
		Kajuru
		Chikun
		Kaduna South
		Kaduna North
		Igabi
8	Plateau	Riyom
		Jos South
		Jos North
		Barkin Ladi
		Mangu
9	Bauchi	Tafawa-Balewa
		Bauchi
		Alkaleri
		Kirfi
10	Gombe	Akko
		Kwami
		Yamaltu
		Funakaye

S/N	STATE	LGA
11	Yobe	Gulani
		Gujba
12	Borno	Kaga
		Kondoga
		Maiduguri Municipal Council

Source: PGM Fieldwork, 2020

4.12.4 Demographics

4.12.4.1 Population Size and Growth

Over the years, the population of the project-affected States has grown, and this is largely determined by the interplay of the demographic processes of fertility, mortality, and migration. Considering these population growth determining factors, NPC estimated that the population of Nigeria grows annually at 3.0% (NDHS, 2008). At this rate of growth (and using the exponential growth model), the projected population of the states from 2006 to 2020 is presented in appendix Table 2.

4.12.4.2 Demography of the Study area

Rivers State is an oil-producing state of Nigeria, situated in the region known as the South-South geo-political zone with a population of 5,198,716, making it the sixth-most populous state in the country. The Capital of Rivers State is Port Harcourt and it is also called Pitakwa. Port Harcourt is the largest city of Rivers State, Nigeria. It lies along the Bonny River and is located in the Niger Delta. The area that became Port Harcourt in 1912 was part of Fishing settlements (fishing ports) also called Borokiri in Okrika language and the farmlands of the Diobu village group of the Ikwerre, an ethnic group in the larger Igbo nation.

The colonial administration of Nigeria created the port to export coal from the collieries of Enugu located 243 kilometers (151 mi) north of Port Harcourt, to which it was linked by a railway called the Eastern Line, also built by the British. In 1956 crude oil was discovered in commercial quantities at Oloibiri, an Ijaw settlement, and Port Harcourt's economy turned to petroleum when the first shipment of Nigerian crude oil was exported through the city in 1958. Through the benefits of the Nigerian petroleum industry, Port Harcourt was further developed, with aspects of modernization such as overpasses, city blocks, taller and more substantial buildings. Oil firms that currently have offices in the city include Royal Dutch Shell and Chevron.

Abia state in the southeastern part of Nigeria. The capital is Umuahia, and the major commercial city is Aba, which was formerly a British colonial government outpost in the region, and is also one of the most populated areas in Nigeria. Abia state was created in 1991 from part of Imo State.[6] It is one of the constituent states of the Niger Delta region. It is also the 5th most industrialized state in the country, and has the 4th highest index of human development in the country, with numerous economic activities and fast-growing populations as recorded by the United Nations in early 2018. The state also houses the biggest cattle market in Nigeria.

Ebonyi State is inhabited and populated primarily by the Igbo with the city of Abakaliki as its capital and largest city. Other major townships include Afikpo, Onueke, Ezzamgbo, Edda, Effium, Aba Omege, Amasiri, Unwana, Echara Ikwo, Egu-Ubia, Ụbụrụ, Onicha, etc. It was one of the six states created in 1996 by the then federal military government of General Sani Abacha. The State of Ebonyi was created from parts of both Enugu State and Abia State, which were the Abakaliki division from Enugu State and the Afikpo division from Abia State respectively. It has three senatorial zones, the Abakaliki division makes up Ebonyi North and Ebonyi Central senatorial zones, while the Afikpo division makes up the Ebonyi South senatorial zone. Ebonyi has thirteen local government areas as well as local development centers created by the state government. It is home to six prominent higher institutions of learning: Ebonyi State University, Abakaliki (EBSU); Alex Ekwueme Federal University Ndufu Alike Ikwo; Akanu Ibiam Federal Polytechnic, Unwana; Federal College of Agriculture, Ishiagu; Ebonyi State College of Education Ikwo (EBSCOEI) and College of Health Sciences, Ezzamgbo.

Enugu State is in the eastern part of Nigeria and is located at the foot of the Udi Plateau. The state shares borders with Abia State and Imo State to the south, Ebonyi State to the east, Benue State to the northeast, Kogi State to the northwest, and Anambra State to the west. Enugu, the capital city of Enugu State, is on the railroad from Port Harcourt, 150 miles (240 km) south-southwest, and at the intersection of roads from Aba, Onitsha, and Abakaliki. It is approximately 4 driving hours away from Port Harcourt, where coal shipments exited Nigeria. Enugu is also located within an hour's drive from Onitsha, one of the biggest commercial cities in Africa, and two hours' drive from Aba, another very large commercial city, both of which are trading centres in Nigeria. The average temperature in this city is cooler to mild (60 degrees Fahrenheit) in its cooler months and gets warmer to hot in its warmer months (upper 80 degrees Fahrenheit) and very good for outdoor activities with family and friends or just for personal leisure.

Benue State is one of the Middle Belt states in Nigeria with a population of about 4,253,641 in the 2006 census. It is inhabited predominantly by the Tiv, Idoma, and Igede peoples, who speak Tiv, Idoma, and Igede languages respectively. Its capital is Makurdi. Benue is a rich agricultural region; popularly grown crops include; oranges, mangoes, sweet potatoes, cassava, soya bean, guinea corn, flax, yams, sesame, rice, groundnuts, and Palm Tree. Benue State as it exists today is a surviving legacy of an administrative entity that was carved out of the protectorate of northern Nigeria at the beginning of the twentieth century. The territory was initially known as Munshi Province until 1918 when the name of its dominant geographical feature, the 'Benue River' was adopted. Benue State is named after the Benue River and was formed from the former Benue-Plateau State in 1976, along with Igala and some part of Kwara State. In 1991 some areas of Benue state (mostly Igala area), along with areas in Kwara State, were carved out to become part of the new Kogi State. Igbo people are found in the boundary areas like the Obi, Oju, etc. Benue state has three universities: Federal University of Agriculture, Makurdi, Benue State University, Makurdi, University of Mkar. It has two polytechnics: Benue State Polytechnic, Ugbokolo, and Fidei polytechnic, Gboko as well as the Akperan Orshi college of Agriculture Yandev. There are about four colleges of education which are Federal College of Education Agasha, College of Education Oju, College of Education Kastina Ala.

Nasarawa State is one of the seven states that make up the North Central geopolitical zone of Nigeria. It has interstate boundaries with Kaduna State to the north, the FCT to the west, Kogi and Benue states to the south, and Taraba and Plateau state to the east. Its capital is Lafia. Its Main Cities and Towns are Lafia (capital city), Akwanga, Doma, Karu, Keffi, Nasarawa, Nasarawa-Egon, and Wamba. Nasarawa State covers an area of 28,735 sq kilometers. It has a population of 1,869,377 (2006 census figures) with a population density of 65 people/sq km. Its population makes up 1.3% of Nigeria's total population. The main ethnic groups in Nasarawa State are Aguta, Alago, Basa, Ebira, Eggon, Gbagyi, Gwandara, Kanuri, and Tiv. There are 29 languages spoken in the state, the major ones being: Agatu, Basa, Eggon, Gbagyi, Gade, Goemai, Gwandara, Ham, Kofyar, and Lijili.

Kaduna is located in the North-west geopolitical zone of Nigeria. The capital city of the state is Kaduna. Kaduna city along with Zaria and Kafanchan are the main urban areas of the state. It is on the Kaduna River and has a total area of 1,190 sq mi (3,080 km2) and over 60 ethnic groups namely, the Gbayi, Hausa, Fulani, Gwong, Atuku, Bajju, Atyab, Gure, and Ninkyop among others populate the state. It is a major economic hub in the region, a trade center, and a transportation axis to nearby agricultural areas and states. Kaduna is an industrial center of Northern Nigeria, manufacturing products like textiles, machinery, steel, aluminum, petroleum products, and bearings. Pottery is highly prized from Kaduna, especially from the Nok culture. It has a large market, recently rebuilt after an extensive fire in the mid-1990s. It is endowed with mineral resources such as clay, serpentine, asbestos, amethyst, and gold. Additionally, it has been blessed with fertile land and a variety of crops. The tourist attractions in the state are endless and include the Nok Culture Safe at Kuwi, the Maitsirga Water Falls in Kafanchan, as well as the unexplored Kajuru Castle. According to the National Population Commission, the 2006 census puts the population of the state at 6, 113, 503 people. Additionally, the Housing Census of the same year stated that Kaduna is made of 3, 090, 438 males and 3, 023, 065 females.

Plateau is the twelfth-largest state in Nigeria. Approximately in the center of the country, it is geographically unique in Nigeria due to its boundaries of elevated hills surrounding the Jos Plateau its capital, and the entire plateau itself. Plateau State is celebrated as "The Home of Peace and Tourism". With natural formations of rocks, hills, and waterfalls, it derives its name from the Jos Plateau. Plateau State is located in North Central Zone out of the six geopolitical zones of Nigeria. Years of tin and columbite mining have also left the area strewn with deep gorges and lakes.

Bauchi State takes its name from the historic town of Bauchi, which also serves as the capital city and is located in the North East of Nigeria. The state was formed in 1976 when the former North-Eastern State was broken up. It originally included the area now in Gombe State, which became a distinct state in 1996. The Abubakar Tafawa Balewa University is located in the capital city of Bauchi. Other educational institutions located in the state include Bauchi State University, Abubakar Tatari Ali Polytechnic, and Federal Polytechnic, Bauchi.

Gombe State is a multi-ethnic society that consists of the dominant Fulani tribe, who inhabit the Northern part of the Gombe State. They dominated 6 out of the 11 Local Government Areas of the state. This includes Dukku, Kwami, Funakaye, Nafada, Akko, and Gombe LGAs. Apart from the Fulani, there is also the Tangale, found in Billiri and Kaltungo areas. Other ethnicities include the Hausa, Tula, Tera (Yamaltu-Deba), Waja, Bolewa, and Kanuri, with their different cultures as well as lingual affiliations.

Yobe state is located in northeastern Nigeria. A mainly agricultural state, it was created on August 27, 1991. Yobe State was carved out of Borno State. The capital of Yobe State is Damaturu; its largest city in Potiskum. The state borders four states: Bauchi, Borno, Gombe, and Jigawa. It borders to the north the Diffa and Zinder Regions of Niger. Because the state lies mainly in the dry savanna belt, conditions are hot and dry for most of the year, except in the southern part of the state which has more annual rainfall.

And Borno State is a state in north-eastern Nigeria. Its capital and largest city is Maiduguri. The state was formed in 1976 from the split of the North-Eastern State. Until 1991 it contained what is now Yobe State. The motto or slogan of the state is "Home of Peace". Borno is the homeland of the Kanuri people in Nigeria and several other ethnic groups. Borno has been the epicenter of the Islamist group Boko Haram since it began its insurgency in 2009. The conflict in Borno drew media attention in 2009 after clashes between Boko Haram and government security forces in which the founder of Boko Haram Mohammed Yusuf was reportedly captured alongside 300 of its members. Days later Mohammed Yusuf was announced dead after he reportedly attempted to escape from detention. The state has a predominance of Kanuri people. Other ethnic groups such as Lamang, Babur/Bura, and Marghi are also found in the southern part of the state. Shuwa Arabs are mainly the descendants of Arab people and is an example of the endurance of traditional political institutions in some areas of Africa, where the emirs of the former Kanem-Bornu Empire have played a part in the politics of this area for nearly 1,000 years. The current Kanemi dynasty gained control of the Borno Emirate in the early 19th century after the Fulani jihad of Usman dan Fodio. Conquered by Rabih in 1893, Borno was invaded by the British, French, and Germans at the beginning of the 20th century. In 1902, the British officially incorporated Borno into the Northern Nigeria Protectorate and established a new capital at Maiduguri or Yerwa in 1907, which remains the capital to this day.

4.12.5 Household Composition, Structure, and Size

A Household is a person or group of related or unrelated persons who live together in the same dwelling unit(s), who acknowledge one adult male or female as the head of the household, who share the same housekeeping arrangements, and who are considered a single unit. The typical household unit across the study area has a head and several members. In many cases, the head is the father and members include his wife, children, and wards. The wards are often children of relations and, in some cases, friends. These are usually fed and generally catered for from the resources of the household. Members of the household are not necessarily related biologically. The household could also be composed of members who are not related but have agreed to live together under a common household head. This latter type of household group is not common in the study area.

The average household size in Nigeria according to National Demographic and Health Surveys (NDHS) 2018 is 4.7 persons. Urban households are slightly smaller than rural households (4.3 persons versus 5.0 persons). A majority of the households in Nigeria are headed by men (82%). The average household size is also bigger in the north than in the south. This assertion by the NDS 2018 is not different from what was obtained during the fieldwork as 4.8 and 6.0 persons were gotten for project-affected states in the south and project-affected states in the north respectively.

Results from the 2003 National Demographic and Health Surveys show that there are more female household heads in the south than in the north, in Nigeria. South-South states take the lead with 28.2%, and North-west has the least female household headship with 6.5% (Figure 4.51)

The average households headed by women was 16.6% in 2003, this number increased to 18% in 2018. (DHS 2018).

Percent distribution of households by sex of head of household and household size, according to residence, Nigeria 2003

Characteristic	Residence		Region						Total
	Urban	Rural	North Central	North East	North West	South East	South South	South West	
Sex of head of household									
Male	81.0	84.8	84.3	93.5	92.1	73.5	71.8	76.8	83.4
Female	19.0	15.2	15.7	6.5	7.9	26.5	28.2	23.2	16.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of usual members									
0	0.1	0.2	0.3	0.0	0.2	0.4	0.1	0.1	0.2
1	14.9	9.8	10.7	9.1	7.1	16.8	15.1	15.9	11.7
2	12.7	11.5	10.2	9.2	11.1	15.4	13.0	14.8	12.0
3	14.0	14.2	12.3	10.8	15.8	13.8	12.4	18.9	14.1
4	12.8	13.4	13.9	12.8	14.0	11.5	12.9	13.1	13.2
5	12.2	12.0	10.9	11.0	13.3	11.6	10.7	14.0	12.1
6	10.4	11.0	11.1	11.8	9.9	12.2	10.5	10.2	10.8
7	8.4	8.4	9.8	8.8	8.6	9.2	8.6	5.2	8.4
8	4.5	5.5	5.9	6.7	5.6	3.4	5.6	2.5	5.1
9+	10.0	14.0	14.9	19.9	14.4	5.7	11.0	5.3	12.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of households	2,598	4,627	1,040	1,185	1,911	690	1,315	1,083	7,225
Mean size	4.7	5.1	5.4	5.9	5.2	4.1	4.7	4.0	5.0

Note: Table is based on de jure members, i.e., usual residents.

Figure 4.51: Distribution of households by sex of head of household. (Source: NPC, NDHS 2003)

4.12.5.1 Dependency Ratio

The dependency ratio shows the proportion of the economically dependent segment of the population (children aged 0-14 years and the elderly, 65 years and above) to the economically active (those aged 15-64 years). It is an indication of the burden of providing for the dependent in the economy. It is assumed that the potential workforce (those aged 15-64 years) bear the economic burden of the dependent. The higher the dependency ratio, the lower the labour input per capita.

Forty-six percent of individuals in Nigeria are in the 0-14 dependency age group, while 4% are in the 65 and above dependency age group. Fifty percent of the population is in the 15-64 age group. Children age 0-17 form the bulk of the population (52%). The broad base of the population pyramid shows that Nigeria's population is typical of countries with a low life expectancy and high fertility rates.

4.12.5.2 Fertility, Mortality and Life Expectancy

The total fertility rate (TFR) in Nigeria is 5.3 children per woman. The age-specific fertility rate in the 15- 19 age group is 106 births per 1,000 women; the rate peaks in the 25-29 age group (256 births per 1,000 women) and drops thereafter, to 23 births per 1,000 women in the 45-49 age group. Age-specific fertility rates are lower in urban areas than in rural areas among women in all age groups. On average, rural women have 1.4 more children than urban women (5.9 versus 4.5 children).

There has been a gradual decline in the TFR over time, from 6.0 children per woman in 1990 to 5.3 in 2018. There has been a similar decline among women in both rural areas (from 6.3 to 5.9) and urban areas (from 5.0 to 4.5) during the same period. In the last three NDHS surveys (2008, 2013, and 2018), the age-specific fertility rate has been highest among women age 25-29.

During Focused Group Discussions (FGDs) along in the communities along the RoW, groups interviewed indicated that factors that enhance fertility among them include general acceptance of the marriage institution, relatively early sexual activity and marriage, and polygamy. Fertility is best measured by the Total Fertility Rate (TFR) which is an indication of the total number of children a woman is estimated to have in her reproductive lifetime. The existence of precise estimates of the TFR values for each project-affected community could not be ascertained and no values were available. DHS of Nigeria reported fertility by state. By state, fertility ranges from 3.9 children per woman in Rivers to 7.2 children per woman in Bauchi State.

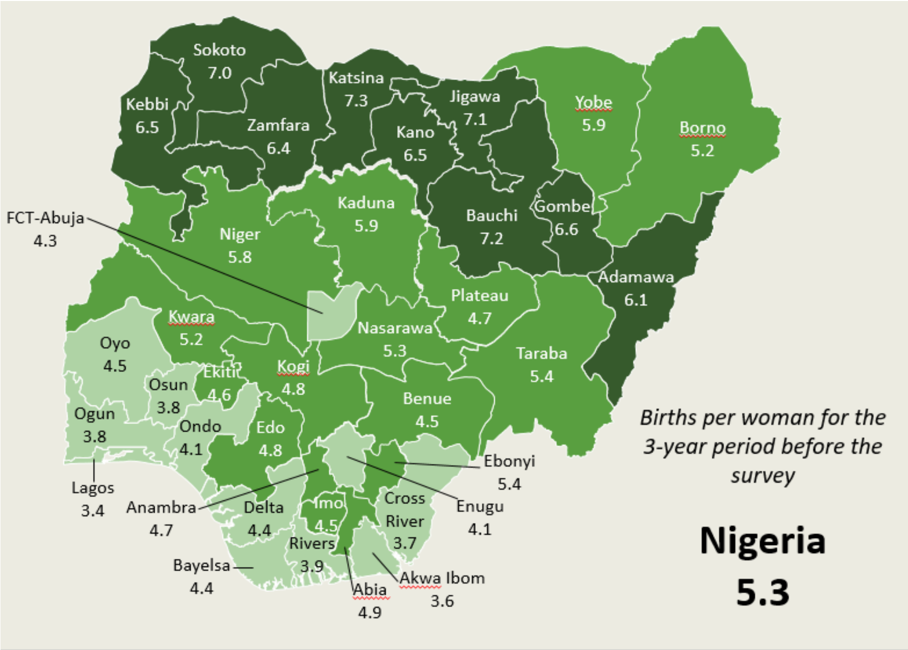


Figure 4.52: Map of Nigeria showing the fertility rate of the project-affected states alongside other states in Nigeria

The last DHS 2018 also shows that the number of children per woman declines with increasing education. Women with no education have 3.3 more children than women with more than a secondary education (6.7 children versus 3.4 children). The number of children per woman also declines with increasing wealth, from 6.7 among those in the lowest wealth quintile to 3.8 among those in the highest quintile. Since 1990, fertility has decreased from 6.0 children per woman to the current level of 5.0 per woman.

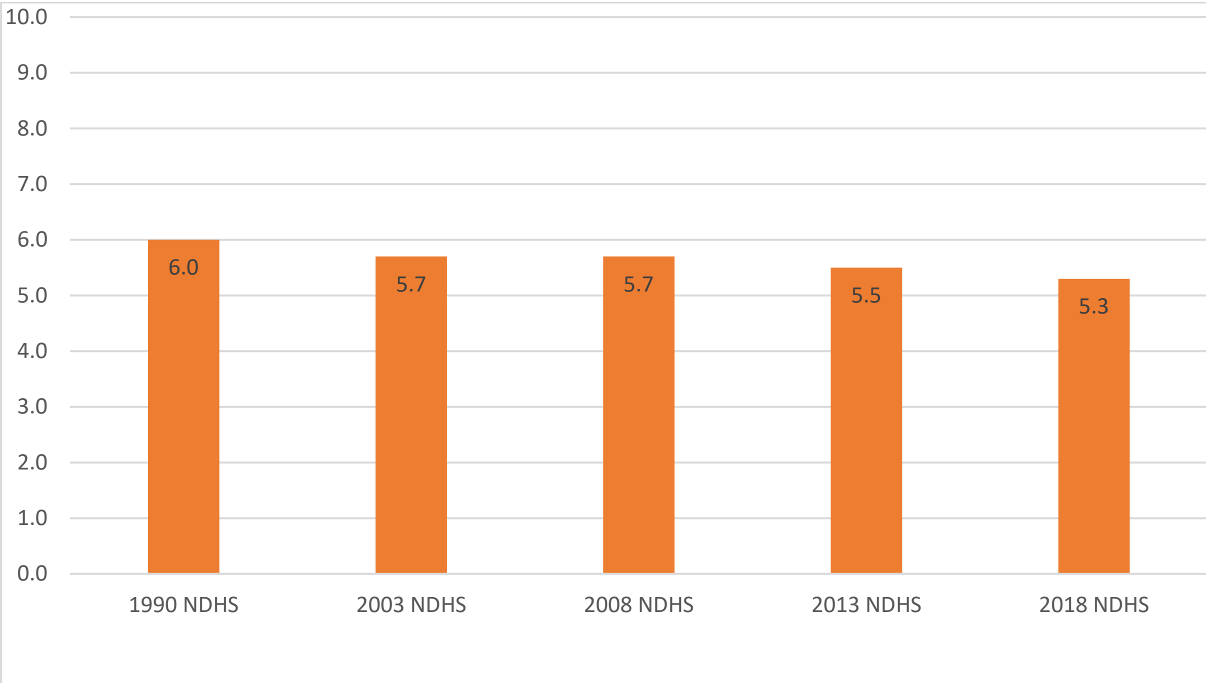


Figure 4.53: Fertility trends in Nigeria (source: NDHS 2018)

Life expectancy estimates for project-affected States are the same as the national estimates. The World Health Organization (WHO) in its World Health Statistics 2017 estimated that life expectancy for men in Nigeria is 42 years and 47 years for women.

4.12.5.3 Literacy and Education

Education is an important factor influencing a person's behaviour and opportunities. NDHS 2018 show that men are better educated than women. Thirty-five percent of women and 22% of men age 15-49 have no formal education, while 11% of women and 17% of men have more than secondary education. The percentage of women with no education has decreased since 2003, from 42% to 35%. The median number of years of schooling completed has increased from 5.0 to 6.5 years during the same period. Among men age 15-59, the median number of years of schooling has increased from 6.6 to 10.5 years.

Education is one of the most important aspects of social and economic development. It improves capabilities and is strongly associated with various socioeconomic variables such as lifestyle, income, and fertility for both individuals and societies. Overall, 36% of females and 27% of males in Nigeria have no education. Eighteen percent of females and 19% of males age 6 or older have attended some primary school; however, only 11% of both sexes have completed primary education. The median number of years of schooling is 3.6 for women and 5.4 for men. At the zonal level, the North West and North East have the highest percentages of both females (55% and 57%, respectively) and males (40% and 47%, respectively) with no education. Twenty-four percent of women in the highest wealth quintile have more than secondary education, while only 7% have no education. On the contrary, 75% of women in the lowest quintile have no education and less than 1% have more than secondary education. (NDHS, 2018)

In the South, Male-child school dropout is minimal compare to the North and is blame on poverty, mercantilism, and blind curriculum. At interviews with primary and secondary school teachers in Yobe and Borno States, the school drop-out rate was said to be high and was estimated at between 10% and 15% per class, this was attributed to the activities of Boko haram insurgents in the area. Farming activities were also cited as a major reason for low school attendance as several older children, between primary 6 and SS 3, miss school days, especially during the farming season. Several of the children go to their parents' farm to assist with the farm work. A major reason for drop out among female students in JSS and SSS is early marriage. At the Government Girls College, Damaturu, it was estimated that about 4% of the female students are already mothers in the last 12 months. This school dropout situation could worsen across the study area with the proposed project if schoolboys can secure temporary employment as casual labour during the construction, and if school girls are lured into sex or marriage by construction workers.

4.12.5.4 Migration Trend Pattern

There were no existing official records on migration in the project-affected communities, however, it was possible to examine and determine the trend and pattern. Many residents indicated they were born in the communities of their residence or had lived in them for more than ten years. Those who were born in or had lived in the communities for more than ten years were considered non-migrant while those who had lived for less than ten years were considered migrants. The result of this study shows that 55% and 80% of respondents were non-migrants in the southern states and the Northern States respectively. This trend was not entirely unexpected given the insecurity currently experience in most northern states. There were indications that some household members in the northern states of the project area had relocated over the years for various reasons. The most common reasons for relocation were insecurity especially in Yobe and Borno States, marriage, school, and work, and the most affected age groups were those between 10 and 44 years. Those who relocated went mostly to cities in Nigeria, like Sokoto, Lokoja, Port Harcourt, Abuja, and Lagos.

4.12.6 Socio-cultural Resources

4.12.6.1 Language, Marriage, and Family

Nigeria is pluralistic in ethnic composition, with a rich and diverse historical and cultural heritage. The official language, as in every state of the country, is English. However, Igbo in the south and Hausa in the north has gained wide acceptability as a medium of communication. The project-affected communities except those in the southeastern states are all multilingual as there many indigenous ethnic groups therein.

The marriage institution is accepted and revered in all the communities. Marriages are contracted between adult males and adult females; there are no accounts of either same-sex or juvenile marriages. Monogamy and polygamy are practiced but local sources say that polygamy is on the decline. The marriage process involves two basic stages, the knocking stage and the traditional marriage proper. The stages involve the intending couple, their parents and relations, friends, and well-wishers. Parents and relations, however, play more prominent roles in the first stage than other parties. Drinks and gifts are usually presented by the groom's family to the bride's family during these meetings (the stages).

FGDs In the northern axis of the project area, revealed that among the Muslim faithful, marriage is intended to be a permanent relationship, it can be terminated by the husband engaging in the Talaq process or the wife seeking a Khula. Nikah halala is a practice in the study area where a woman, after being divorced by triple talaq from her husband, marries another man, consummates the marriage, and gets divorced again to be able to remarry her former husband. Muslim men in the area are allowed to practice polygyny, that is, they can have more than one wife at the same time, up to a total of four, but Polyandry, the practice of a woman having more than one husband, is not permitted. One of the main reasons for this is the potential questioning of paternal lineage.

The family is recognized as a very important social unit and both nuclear and extended families exist in the communities. The typical nuclear family is headed by the father, with the mother and children. The extended family includes members who are not biological offspring of the same parents but relations. A nuclear family where the father was dead could be headed by the mother if the children are juveniles or by the eldest son if he is a grown man and able to bear the financial responsibility of taking care of the family. The extended family is always headed by a male member.

Considering that all the communities are used to non-indigenous residents, members have an accommodating social attitude. This attitude could be valuable for the railway line project since itinerant workers and travelers would be attracted to the communities and this kind of social attitude would foster healthy cross-cultural exchanges. This can also help in some way to limit conflicts that arise when people of different cultural backgrounds live together, thereby reducing the potentials for tension and social upheavals during the project execution.

Table 4.54: Project affected States, LGAs, and the indigenous ethnic groups

S/N	States	LGAs	Indigenous ethnic groups
1	Rivers State	Port Harcourt City	Igbo, Ikwere, Kalabari Kirike, Obulom
		Obio/Akpor	Ikwere/Igbo
		Oyigbo	Igbo
2	Abia State	Ukwa West	Igbo
		Ugwunagbo	Igbo; Anaang
		Aba South	Igbo
		Aba North	Igbo
		Oboma Ngwa	Igbo
		Isiala Ngwa North	Igbo
		Isiala Ngwa South	Igbo
		Umuahia North	Igbo
		Umuahia South	Igbo
		Bende	Igbo
		Isikwato	Igbo
3	Ebonyi	Ivo	Igbo
		Ishielu	Igbo
4	Enugu	Aninri	Igbo
		Nkanu East	Igbo
		Nkanu West	Igbo
		Enugu South	Igbo

S/N	States	LGAs	Indigenous ethnic groups
		Enugu North	Igbo
		Enugu East	Igbo
		Isi Uzo	Igbo
5	Benue	Ado	Idoma
		Oturkpo	Idoma
		Gwer	Tiv; Igede
		Markurdi	Tiv; Basa; Wannu
		Guma	Tiv; Wapan
6	Nasarawa	Keana	Alago; Eggon; Tiv; Fulani
		Obi	Alago; Hausa; Fulani; Eggon; Tiv
		Lafia	Bare-Bari; Hausa; Fulani; Ake; Alago; Eggon; Goemai; Gwandara; Kofyar; Lijili; Tiv; Wapan
		Nasarawa Eggon	Eggon; Mada; Nungu
		Akwanga	Duhwa; Eggon; Fulani; Gwandara; Hausa; Mada; Mama; Ninzo; Numana; Nungu
7	Kaduna	Sanga	Ahwai; Ayu; Bu; Gwandara; Hasha; Ninzo; Numana; Nungu; Sambe; Sha; Toro
		Jema'a	Ashe; Berom; Duya; Fantswam; Gyong; Hyam; Jju; Kanufi; Mada; Kyoli; Nikyob-Kaninkon; Ninzo; Nungu; Nyankpa; Shamang; Tyap; Tyuku Zhire; Numana
		Kaura	Gworok; Iten; Takad; Sholyio; Tyap and Tyecarak (Tyecaat)
		Zangon Kataf	Ikulu; Jju; Nghan; and Tyap; Tyecarak (Tyecaat)
		Kachia	Adara; Doka; Gbagyi; Hyam; Iku-Gora-Ankwa; kulu; Jju; Nghan; Koro Wachi; Kuturmi; Shamang; Tyap; Zhire
		Kajuru	Adara; Ajiya; Kuce; Gbagyi; Shuwa-Zamani
		Chikun	Gbagyi
		Kaduna South	Hausa; Fulani
		Kaduna North	Hausa; Fulani
8	Plateau	Riyom	Berom; Firan; Gwandara; Iten; Nungu
		Jos South	Berom; Rigwe; Iguta
		Jos North	Afizere; Iguta; Berom
		Barkin Ladi	Berom; Ibaas; Mwaghavul; Ron; Duhwa; Pyam
		Mangu	Cakfem-Mushere; Izere; Kofyar; Mhiship; Mwaghavul; Pyam; Ron; Saya; Vaghat-Ya-Bijim-Legeri
9	Bauchi	Tafawa Balewa	Sur; Vaghat-Ya-Bijim-Legeri; Zari; Bankal; Gwak; Izere; Saya
		Bauchi	Bankal; Duguri; Dulbu; Galambu; Gera; Geruma; Giiwo; Guruntum-Mbaaru; Ju; Kir-Balar; Labir; Luri; Mangas; Mbat; Pa'a; Polci; Shiki; Tala; Zangwal

S/N	States	LGAs	Indigenous ethnic groups
		Alkaleri	Dass; Bole; Duguri; Giiwo; Guruntum-Mbaaru; Labir; Tangale
		Kirfi	Bure
10	Gombe	Akko	Fulani, Tangale
		Kwami	Fulani, Bolewa
		Yamaltu	Waja; Fulani, Tera
		Funakaye	Fulani
11	Yobe	Gulani	Maaka
		Gujba	Yerwa Kanuri
12	Borno	Kaga	Yerwa Kanuri, Putai
		Konduga	Shuwa Arabic, Kanuri Maffa and Wandala / Malgwa

Source: PGM Fieldwork 2020

4.12.7 Social Structure and Organization

The project-affected communities share a lot in common concerning social structures and organizations. Membership of socio-cultural groups (Community Development Union, women's groups, youth groups, CBOs, cultural groups, and social welfare groups) by household members is quite common. The roles played by these groups are distinct and significant. A group like the Community Development Union (CDU) is set up purely to perform local administrative roles and also to liaise between the communities and all external bodies, and other communities. Similarly, a lot of the social clubs and CBOs actively participate in improving the welfare conditions of their members and by extension the community. The cultural groups mainly performed at cultural festivals, thereby ensuring the preservation of their cultural heritage.

Apart from these socio-cultural groups, the communities are also made up of compounds. This structure that incorporates compounds allows the compounds some level of autonomy in their daily administration. The compounds are made up of extended families and their affairs are directly overseen by their appointed chiefs who are mostly the eldest male members of the compound.

4.12.7.1 Traditional Governance

The communities have distinct but similar traditional administrative structures. The structure comprises the traditional ruler assisted by chiefs and a Community Development Union (CDU) with the youth and women groups. The traditional heads are elected from eligible males. Eligibility is determined by age (minimum of 35 years) and standing/integrity. Additionally, in Bauchi, Gombe, Yobe, and Borno state the candidate must come from particular families considered royal families. Occupants hold office for life except where they are deposed by the community or the government. The traditional heads report to District heads who are appointed by the various state government. The village or District heads can be deposed by the community or the government respectively if they are believed to be working against the communities' interest if they committed a heinous crime or became incapacitated by ill health. The Chiefs or the Mai Agwan as they are referred to in the Northern section of the project area are appointed by their respective community to oversee the affairs of the community and represent them in community matters. They also have the role of advising the District heads. Each council of chiefs has a Chairman.

The communities also have CDUs which are headed by a Chairman and assisted by a Secretary in the day to day running of the union. They are often referred to as community Chairman and Secretary. Membership of the CDU executive is by election among adult males from the compounds. Members of the CDU serve a fixed term of four years. The CDC is the administrative organ that has responsibility for the day-to-day running of the communities, liaison with external bodies and agencies, and development planning. They report directly to the traditional head. Other groups that make up the traditional administrative structure include the women and youth and both report to the CDU. Both are also headed by executive committees which include the President, Vice President, Secretary, among others. The executive committees are elected. Across the study area, while the youth executives serve for one or two years, the women leaders usually do not have a fixed term in office. All adult female members of each community are eligible for membership of the women's group in their respective communities. Membership of the youth groups is similarly open to adult community members of both sexes who are between 18 and 40 years. The roles of these organs of society are clearly defined and there were no indications of role conflicts.

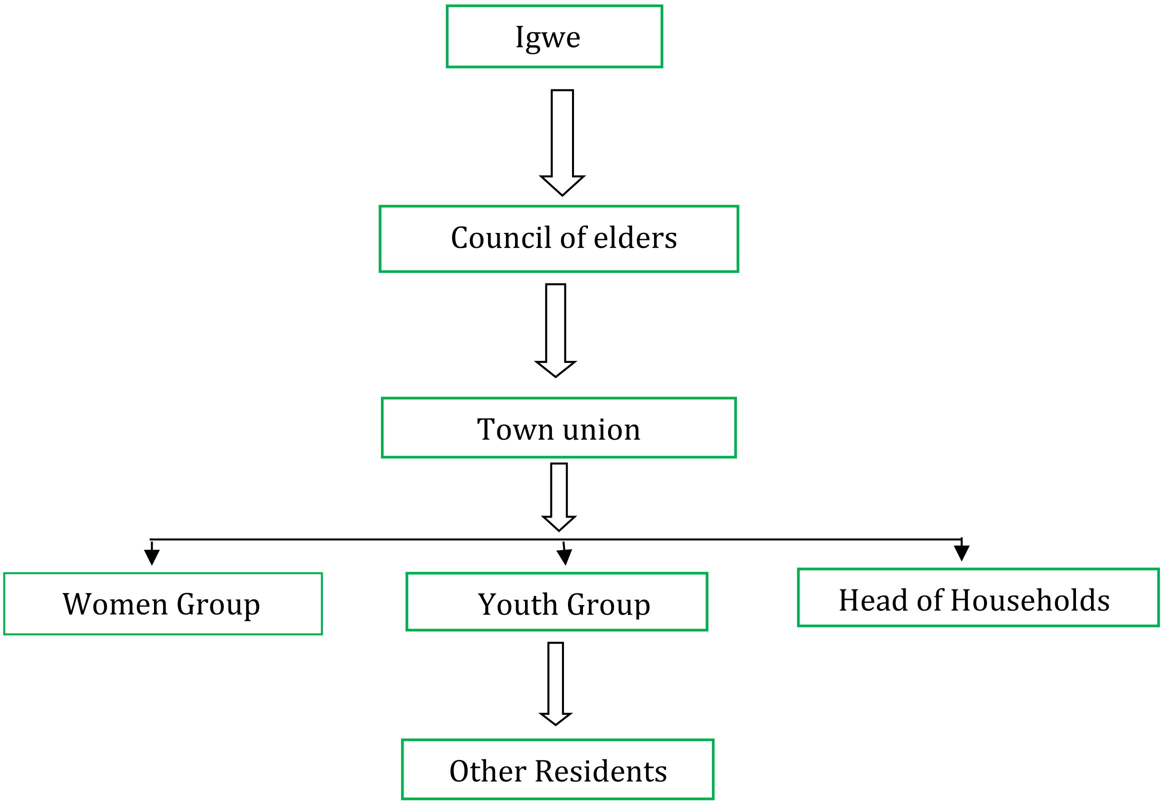


Figure 4.54: Traditional Leadership hierarchy in the study area (source: PGM Fieldwork, 2020)

4.12.7.2 Roles of Women and Youth in Community Development

Women are the fundamental human reservoir of every society as they control most of the non-monetary economy (subsistence, agriculture, bearing children, domestic labour, etc.) and play an important role in the monetary. The exclusion of women in politics has been identified in recent times as one of the major setbacks for economic development. The poor presentation of women in elective positions has been a major social development issue since the beginning of the current democratization process in

Nigeria. The women and youth groups play important roles in the communities and serve to bring their members together as well as intervene in their welfare. During the survey across the 12 project-affected states, it was noted that culturally women could not, lead the communities, head the key organs of traditional administration, seat or participate with the men in taking community decisions except on demand by the traditional leader when issues that will be deliberated is centered on them. This cultural inhibition is a clear indication of gender inequality in the communities.

The youth, on the other hand, has become a strong force in the communities. The youth across the study area is recognized as a formidable and critical segment of the population of the society whose strength and dynamism are essential in the process of development engineering. Unfortunately, the FGDs revealed that the government has not embraced the youth as a central factor in its development efforts. Successive governments apart from mere ceremonial recognition of the youth as "Leaders of tomorrow", have not articulated concrete policies for youth mobilization as a necessary tool for good governance and development. The roles of the youth in the surveyed communities include ensuring internal and external security, enforcing law and order, and development planning. Youth leadership, especially the President and Secretary are regularly invited to community meetings with the traditional councils, where decisions about development and security are taken.

4.12.8 Gender Issues

Gender inequality in Nigeria is influenced by different cultures and beliefs. It is imperative to note that while sex relates more to biological context and differences among the two dominant sexes, gender relates more affirmatively to the social meanings given to each of the sexes not without significant implications for social relations as social stratification confers honour on some and dishonour on others. In general, field observation from this study revealed that social relations in the area are based on a patriarchal relationship in which authority is vested in the male head of the household.

Gender differences were found to manifest in the study area more clearly in terms of community and political participation, in that women are generally excluded from major decision-making processes. Moreover, women across the study area are frequently at a disadvantage in terms of inheritance and tenure rights.

Gender is a central organizing principle of societies and often governs the processes of security. Nigeria ranks 118 of 134 countries in the Gender Equality Index, Nigeria has one of the lowest rates of female entrepreneurship in sub-Saharan Africa. The majority of women are concentrated in casual, low-skilled, low paid informal sector employment and women represent over 70% of the World's poor due to unequal access to economic opportunities. Increasing female participation in the workforce and the development of the female human capital will not only help to reduce poverty at the household level, but it will also radically enhance national security (UN women Report 2006).

Given the limited opportunities for local employment that will be created, it is not expected that the project will have a significant impact on the status quo of gender relations and gender equity in the project's social environment. However, gender mainstreaming remains a key principle that the project should apply when recruiting both temporary and permanent employment in the train stations in the area.

In Kaduna, Bauchi, Gombe, Yobe, and the Borno States the socio-economic survey found that gender differences in status manifest more clearly in terms of political participation and inheritance also in socio-economic attributes. The interaction during the fieldwork revealed the dominant position of men more in the aforementioned states than in Rivers, Abia, Ebonyi, and Enugu States. In Bauchi, Gombe, Yobe, and Borno States, fieldworkers found it hard to get women to participate in focus group discussions as permission is required from their husbands or male head of the household. During the Stakeholder Engagement process, there was no participation from women in the area.

Women do not have the same inheritance rights, nor could they directly access critical resources such as land or credit. Women are less mobile than men because of family responsibilities, and in particular, the need to care for children. Women hardly take part in the decision making process at the community level. Women are never recognized as part of the ruling council. They are often allowed to socialize by forming their group, but could hardly influence the decisions of men. Women are usually treated as 'children'. At best women could become group leaders.

The global gulf between job creation and the growth in the number of job seekers has worsened the employment situation for women and men alike in the 12 project-affected States. But women face greater vulnerabilities in the labour market because of their relative lack of education and training, the tendency to channel women into certain occupations, and the continuous heavy burdens of unpaid domestic work, childbearing, and childcare, which restrict the time and energy available for income-earning activities. Nigeria like other countries in the world is responding to the clear request calls made variously by the United Nations societies of all forms of discrimination, especially gender-based discrimination. Nigeria indeed has tried to respond to this development from the international arena by articulating policies and programmes that seek to reduce gender inequalities in socio-economic and political spheres, however, the success of bridging the gap between men and women is farfetched.

Results in the study area revealed that women in the area are a significant but undermined force. Economically, they constitute the majority of the peasant labour force in the agricultural sector, while most of the others occupy the bottom of the occupational ladder and continue to be channelled into service and domestic occupations. The consequence of the unequal status between men and women is a high level of economic and political powerlessness among women, and powerlessness, in turn, retards development of any level, politically, economically, and socially. FGD revealed gender inequality existed from the dawn of civilization and has continued over centuries in all the 12 project-affected states. Gender discrimination has created wide gender gaps in the project-affected communities, with very devastating social, economic and, health consequences on the members of the female gender, who have been intensely marginalized, and subjugated to the background.

The culture of the people of the study area perceives and treats men as superior to women, this is well manifested in the “son preference syndrome” that is prevalent in Nigeria. Male children in the project-affected communities often enjoy preferential treatment, like exemption from house chores; they enjoy the unlimited right to education, while the girls are limited and often given out for marriage at an earlier age by some parents for economic gains especially in the Kaduna, Bauchi, Gombe, Yobe and Borno axis. The culture of the area strictly restricts women to the stereotyped role of home keeping, childbearing, and childrearing.

The negative outcomes outlined above are the result of systemic and deeply entrenched discrimination that not only undermines the life chances of millions of individual girls and women but adversely affects their future children and the whole community. Nigeria's 2006 National Gender Policy is consistent with the global consensus when it States that women's empowerment and gender equality underpin the achievement of all the other SDGs. A well-established link exists between maternal education and child survival, for example, educated girls are more likely to avoid early marriage, plan their pregnancies, and have better maternal and child health outcomes.

Nigeria's progress and national development will be constrained if women and girls continue to be disadvantaged and gender equity is ignored. Non-discrimination is enshrined in the Nigerian Constitution but in practice, the majority of Nigerian girls and women are unable to claim their constitutional entitlement as is evident in the study area. If Nigeria is to maximize its "demographic dividend" as the population of working age increases and fertility declines, it must prioritize investment in women and girls to ensure that the next generation of all young adults is healthier, better educated, and able to contribute to economic growth and development. Investing in adolescent girls and women is not simply a question of human rights; it also makes economic sense.

Nigerian a signatory to the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), the government has adopted several institutional and policy measures that support these goals. Examples include the 1999 Nigerian Constitution; the National Gender Policy 2007; the National Gender Policy Strategic Framework (Implementation Plan) 2008-2013; the 2nd National Action Plan on Implementation of UN Security Council Resolution (UNSCR) 1325 and Related Resolutions on Women, Peace, and Security (2017); and the Violence Against Persons (Prohibition) Act 2015. The government has also shown an increasing commitment to supporting the social and economic empowerment of women and fostering gender equality through constant review of policies, reassessment of priorities, a commitment of adequate financial resources, and effective implementation of programs such as the Federal Republic of Nigeria Economic Recovery and Growth Plan (ERGP) (2017- 2020) (Ministry of Budget and National Planning 2017).

4.12.8.1 Gender-Based Violence

Gender-based violence against women has been acknowledged worldwide as a violation of basic human rights. Increasing research has highlighted the health burdens, intergenerational effects, and demographic consequences of such violence (United Nations, 2006).

Domestic violence can be defined as physical abuse, sexual abuse, emotional and verbal abuse between people who have at some time had an intimate or family relationship. What constitutes physical, sexual, emotional, and verbal abuses against women often would be influenced by the socio-cultural norms of a particular society. Gender-based domestic violence against women is often maintained or perpetrated by unhealthy societal and cultural practices.

Physical violence based on WHO study [WHO, 2005], the definition includes the women being;

- Slapped or thrown something at that could hurt her
- Pushed or shoved
- Hit with a fist or something else that could hurt.
- Kicked, dragged, or beaten up

- Choked or burnt on purpose
- Threatened with or used a gun, knife, or other weapons against her.

Sexual violence as defined based on WHO study [WHO, 2005] include;

- Being physically forced to have sexual intercourse against her will
- Having sexual intercourse because she was afraid of what her partner will do.

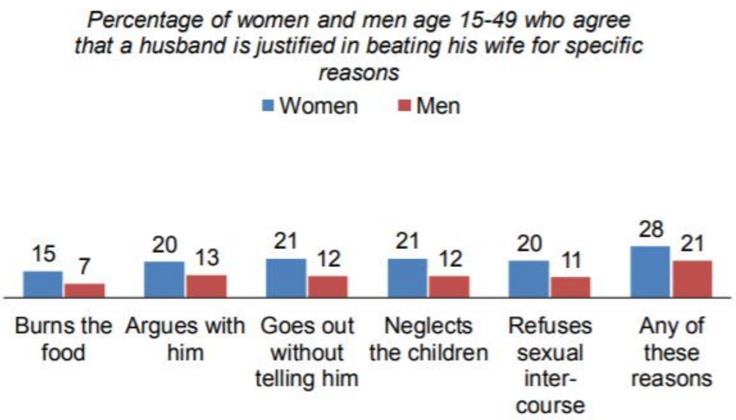


Figure 4.55: Nigerians attitudes towards wife-beating (NDHS 2018)

To gain insight into the extent to which spousal violence is accepted, the 2018 NDHS collected information on women's and men's attitudes toward wife beating in five separate circumstances. Overall, 28% of Nigerian women believe that a husband is justified in beating his wife in at least one of the five specified circumstances, as compared with 21% of men. About one in five women agree that wife-beating is justified if a wife argues with her husband, goes out without telling him, neglects the children, and refuses to have sexual intercourse, while 15% agree that wife-beating is justified if she burns the food. Overall, men are less likely to justify wife-beating in each of the five different circumstances than women.

The percentage of women who agree that wife-beating is justified in at least one of the five specified circumstances has declined substantially over time, from 43% in 2008 and 35% in 2013 to 28% in 2018. The percentage of men justifying wife-beating in at least one of the specified circumstances has also decreased, from 30% in 2008 to 21% in 2018. Based on the DHS report, women residing in Enugu State had the highest proportion (47.4%) of emotional intimate partner violence among the women in the southeast zone and the fourth highest among the 36 states of Nigeria.

With the intensification of conflict driven by Boko Haram, the prevalence of GBV has escalated dramatically in northeast Nigeria. According to the Nigeria Humanitarian Response Plan, about 30% of women in the northeast reported experiencing GBV since 2013. Women and girls are targeted for abduction by Boko Haram and are often raped, forced into labour, marriage, or religious conversion, abused, exposed to sexually transmitted infections, and are often pregnant upon escaping captivity.

Once in secure areas, women and girls remain vulnerable, due to a lack of access to food and essentials and the loss of traditional protective social infrastructure. During focus group discussions (FDGs) held with displaced women and girls in Maiduguri city, some adolescent girls were reported to be engaging in survival sex to meet their basic needs. There is also a high military presence throughout both Yobe and Borno States, which often leads to further risks of exploitation, rape, coercion, and abuse of IDP women and girls.

GBV survivors in 12 project-affected States face a lack of health and psychosocial support services in these areas, as well as few supportive reporting channels, leading survivors to avoid reporting these incidents, fearing retribution, shame, blame, and humiliation. Clinical staff in the northeast are not routinely trained in proper responses to GBV, and legal responses and judiciary systems do not acknowledge the risks faced by survivors making a complaint and acting as witnesses. Given the high prevalence of GBV in these areas, there are critical needs for specialized, comprehensive, and multi-sectoral GBV prevention.

FGD revealed cases of both domestic and sexual violence against women in the area, largely blamed on the customs of marriage in the study area which involves bride price and dowry usually paid on women, this belief promotes the values that give men proprietary rights over women and girls and encourage polygamy. The cultural practices of the people of the area as it is in most African societies, give women in the society a second fiddle role to play. This survey established that there is a high prevalence of intimate partner violence among rural women than urban women and this is because rural women were less likely to be educated, less likely to be employed, have more polygamous marital relationships, and higher parity.

4.12.8.2 Occupation of the women in the area

The contribution of women to the development of the various communities cannot be overemphasized. They are said to be very industrious and are majorly involved in agriculture and allied occupation. Focus Group Discussion also revealed that despite restrictions placed on the women of the area by the culture and religion in the north; a lot of them have been able to grow their home-based business without support from their spouse. Results revealed 55% and 35% to be involved in farming and petty trading respectively, while 10% are in other business like artisanry, civil and public service, etc.

Investigations reveal that women as a body are fairly organized and may engage in any remarkable cohesive interaction. The project-affected communities have women associations that play a vital role in community organization. The women are more socially oriented than the male as can be inferred by their propensity to adorn identical apparel during festive occasions.

4.12.9 Vulnerable Groups

Gender disparities in susceptibility to project impacts may be regarded as one aspect of a more general socio-economic attribute – that of vulnerability. Factors other than gender that may render some households or persons more socio-economically vulnerable than others include:

- Impoverishment;
- Limited diversity in livelihood resources;
- Social isolation (which may be the result of belonging to a minority group or having recently moved into an area); and
- Disease or ill health.

The socio-economic survey conducted as part of the ESIA assessed several indicators of socioeconomic vulnerability, including household ownership of moveable assets, social support networks, food security, and perceived needs and challenges. The statistics generated for these indicators show that many households in the local study area may indeed be regarded as socio-economically vulnerable. For instance, most households have suffered food insecurity in the year before the survey and lack of employment was one of the most frequently-cited challenges in most communities

Some groups in the community have also been identified as potentially vulnerable to the likely impacts of the project. Their vulnerability derives from several different factors, including the inability to cope with certain envisaged changes in the society and economy. A key vulnerable group is adolescents and youths. Within this group, it is also possible to differentiate between the adolescent male and the adolescent female. For the male adolescent, there is a tendency to abscond or drop out of school to seek casual employment at the train station or other business that will be attracted by the train station. This temptation to drop out of school is reinforced by the State of educational institutions, particularly the poor staffing and poor infrastructures which makes schooling uninteresting in public schools and high tuition fees in private schools. The adolescent male will be faced with a situation of giving in to peer pressure and groups that encourage truancy and school dropout if these groups come into the community as itinerant workers or camp followers.

The teenage girl on the other hand is faced with managing her sexuality in an environment where there will be considerable exposure to sexual excesses and the continuous advances by older and more experienced working-class males whose income would be an effective instrument to lure the girls. Again, with this group, there will be the likelihood of school dropout and teenage pregnancy. Teenage pregnancy had in some societies led to the stigmatization of the girls. Many of the teenage mothers may not be able to return to complete their schooling or embark on any academic pursuits, even after they would have given birth to their babies.

Another vulnerable group is the elderly and physically challenged persons. In any economy, the elderly and the physically challenged persons usually require special attention which includes health care and welfare, but the required facilities for the provision of these social services are inadequate in the study area.

Additionally, widows and single mothers will have an uphill task providing for their households in an environment where there are public servants who earn salaries higher than what is generally obtained in the community.

4.12.9.1 Lifestyle and Social Indulgent Practices

Lifestyle and practices raised and discussed during FGDs and interviews included, drinking of alcohol, cigarette smoking, and use of hard drugs, prostitution, teenage pregnancy, and child labour. Residents confirmed that the use of spirits and alcoholic beverages is rampant among them. About 68%, of the residents, of both genders, had been drinking since their teenage in Rivers, Abia, Ebonyi, Enugu, and Benue State, and 39% of the respondents of both sexes have been drinking since teenage in Nasarawa Kaduna and Plateau while 19 % the respondents have been drinking since teenage in Bauchi, Gombe, Yobe and Borno States. Alcohol beverages are commonly sold in Rivers, Abia, Ebonyi, Enugu, Benue, Nasarawa, Kaduna, and Plateau communities. This is not so in Bauchi, Gombe, Yobe, and Borno communities. Alcohol is sold only in few designated locations because of sharia law and fear of attack from extremists.

Cigarette smoking is also quite common among teenage and adult males in all the project affected communities visited. About 80% of the residents also believe that some of the youth smoke hemp, though nobody admits to smoking Indian hemp may be due to the implication of admitting the same. They also advise the law enforcement agencies and the various state governments to do more on enlightening the people on the danger of drug abuse and kidnapping in the area.

Child labour, another of the social vices, is not common. Children usually assist their parents in farming and running their shops. The girl child in the study area is also made to go round the streets of their community to sell merchandise for the parents. This type of work does not attract any salaries or wages.

Residents expressed fears that the proposed project would further encourage some of these vices if railway workers and camp followers take up residence among them during the train operation and maintenance. Drinking, smoking, use of hard drugs, teenage pregnancies, and prostitution were particularly mentioned by the respondents.

4.12.10 Belief Systems and Practices

Residents of Rivers, Abia, Ebonyi, Enugu, and Benue States are mostly Christians. There are various Christian denominations with worship places spread across the project-affected communities. Christian denominations in the surveyed communities include Anglican, Living Faith Church, Assemblies of God Church, Catholic Church, Cherubim and Seraphim, Redeemed Christian Church of God, The Apostolic Church, Deeper Life Bible Church, Greater Evangelism Worldwide Crusade, among others. Christian worship places are generally present in all the settlements and they are revered among residents. The main Christian festivals of Christmas and Easter are celebrated across the communities. On the other hand, residents of Bauchi, Gombe, Yobe, and Borno are mostly Moslems.

Traditional worship practices are carried out by a few adherents as many have converted to the Christian faith and abandoned traditional religious practices. Results from FGDs in the surveyed communities show that the people still have a deity called various names and it is believed to be responsible for the protection and justice in the area in Rivers, Abia, Ebonyi, Enugu, Benue State, and part of Nasarawa States.

Religious adherence as revealed by the FGDs is presented in Table 4.55

Table 4.55: Religious adherence in the project-affected communities.

S/N	Community	Christianity (%)	Islam(%)	Traditional (%)	Total %
1	Rivers	89	3	8	100
2	Abia	89	4	7	100
3	Ebonyi	89	5	6	100
4	Enugu	87	4	9	100
5	Benue	84	10	6	100
6	Nasarawa	48	48	4	100
7	Kaduna	48	49	3	100

S/N	Community	Christianity (%)	Islam(%)	Traditional (%)	Total %
8	Plateau	71	26	3	100
9	Bauchi	43	55	2	100
10	Gombe	36	61	3	100
11	Yobe	7	91	2	100
12	Borno	8	90	2	100

Source: PGM fieldwork, 2020

Plate 4.23: Winners Chapel's signpost in Bajoga, Gombe State and a Mosque in Gudi Nasarawa State

Festivals in all the 12 project-affected states can be in the context of a holiday, often marked by merriment and high-spirited cultural fulfillment as a successful celebration featuring elaborate theatrical presentation, honouring a member or marking a collective festive period of a given community, as title taking, marriage ceremony, fertility rites of passage, and forming cycles. These festivals and carnivals feature music, dances, fashion, and food, allowing visitors to join in and have a first-hand experience of their culture. Aside from major community cum culture-specific traditional festivals across the study area, there are also modern festivals, which have become a platform for younger generations to express themselves.

Traditional Igbo religion includes a belief in a creator god (Chukwu or Chineke), an earth goddess (Ala), and numerous other deities and spirits as well as a belief in ancestors who protect their living descendants. The revelation of the will of the deities is sought by divination and oracles. Many Igbo are now Christians, some practicing a syncretic version of Christianity intermingled with indigenous beliefs. The Igbo peoples have a melodic and symphonic musical style, which they designed from forged iron. Other instruments include opi otherwise known as Oja a wind instrument similar to the flute, igba, and ichaka. The yam is very important to the Igbo as it is their staple crop. There are celebrations such as the New yam festival (Igbo: Iri Ji) which are held for the harvesting of the yam. The new yam festival (Igbo: Iri ji) is celebrated annually to secure a good harvest of the staple crop. The festival is practiced primarily in Nigeria and other countries in West Africa. The Igbo are indigenous in 4 of the 12 project-affected states.

About half of the population of Nigeria adhere to the Muslim religion, with Muslims living throughout the country but particularly in the north. There are two main Muslim festivals, Eid Al Fitri and Eid Al Kabir, all national public holidays. The different ethnic groups in all the 12 project-affected states have the same way of celebrating these festivals. The three-day festival of Eid Al Fitri celebrates the end of the holy month of Ramadan, a period of fasting from dawn to dusk each day. The festival is a time to give charity to the poor and to celebrate the completion of Ramadan with family and friends. Eid al Kabir (known as Eid al-Adha elsewhere), or "Festival of Sacrifice", is an important religious holiday celebrated by Muslims in the study area to commemorate the willingness of Abraham (ʾIbrāhīm) to sacrifice his son Ishmael (Ismāʿīl) as an act of obedience to God, before God intervened to provide him with a ram to sacrifice instead. A ram, goat, sheep, cow, or camel is sacrificed, with the family eating part of the animal and donating the rest to the poor. The festival is celebrated on the tenth day of Dhu al-Hijjah, the last month in the Islamic calendar.

Table 4.56: Major cultural festival in the project affected area

S/N	States	Major Cultural Festivals
1	Rivers	• Carniriv is one major cultural festival that cuts across the study area in Rivers and mirrors the rich diversity with cultural parades and exhibitions. This involves over 10,000 dancers, masquerades, puppeteers, and warriors on the streets of the capital city, Port Harcourt. It is one whole week of pulsating and frenetic revelry. The carnival is by all accounts a true celebration of the various ancient civilizations of the people and with every passing year, it ingresses further into the global reckoning. • Wrestling is one of the most celebrated cultures of the Ikwerre people, especially in Obio/Akpor Local Government Area of Rivers State of Nigeria. Wrestling is dialectically known as " Egelege ", it is one of the physical calisthenics that tends to foster unity amongst the people.
2	Abia	The State boasts of a large variety of traditional Festivals/dances in virtually all the project affected communities in Abia State. These are celebrated at various seasons of the year. Officially, there is the State-owned Ugwuabia Festival. Ugwuabia (the pride of Abia) festival is a grassroots festival where all the LGAs in the State come to showcase the best of all their culture in a carnival. Each community in Abia State has different festivals celebrated in honour of its gods and goddesses, or to mark important events. The beginning of the planting season, as well as the harvest season, are celebrated annually. Promotes among all the project-affected communities is the New Yam Festival (also known as Iwaji) celebrated in thanksgiving to the gods for a good harvest. It is usually held at the end of the rainy season in early August. Also popular among the project affected communities in Abia is the Ekpe festival. The festival is popular amongst people from Umuahia in Umuahia LGA and Ozuakoli in Bende LGA. The festival has been in existence for hundreds of years, making it one of the oldest festivals in Abia State. The Ekpe festival occurs annually in January as a means of kick-starting the New Year. The festival involves the appearance of various masquerades complemented by cultural dance performances. During the festivals, there are performances by a group of masked dancers. The climax of the festival is the beheading of a goat at a strike, by the Ekpe masquerade. While many mysteries surround the masked figures, women and non-members of the Ekpe group, are forbidden to make any contact with them.
3	Ebonyi	Masquerade Festival according to traditional Igbo beliefs in the study area of Isiagu in Ivo LGA, masquerades represent images of deities or relatives. The identity of the masquerade is a well-kept secret and the roles are performed exclusively by men. In the study area, the festival features dozens of masquerades that thrill spectators in annual festivals and other events. The masquerades dress in colourful robes and masks made of wood or fabric. Although most of the masquerades appear at every festival, some are particularly special and only appear once. Some of the

S/N	States	Major Cultural Festivals
		masquerades are; Awuru Masquerade which is historically believed to provide security against crimes such as stealing, poisoning, and killing of persons or crop destruction: if there was a case of such a crime, the masquerade was consulted and the main suspect was asked to swear to Awuru to prove his innocence. Other masquerades in the area are; Okpontu Ulogo, Okwa-Ebu, Ota Ikonte, Okumkpo, and Lugulu Masquerade.
4	Enugu	Odo Festival; Odo is a term used to describe the returning of the dead who spend up to six months with the living during the festival. the odo festival is celebrated among the northern Igbos of Enugu state especially among the Nsukka and the Udi people. The odo appear as male and female masked figures played by men who are members of the death cult society, and whose identity it is required to keep secret. The Odo are first welcomed back with celebrations, and then make visits to their former homes, which result in more entertainment and gift-giving. Their departure is a sad one and engages the community in an emotional leave-taking event before the Odo`s journey back. This long festival is a celebration that requires extensive preparations and sacrifice for the community. Women are heavily involved in food preparation and performances as chorus members as well as the audience. The creation of costumes and masks with plant fiber, leaves, beads, and feathers, although more durable cloth costumes are becoming more common in contemporary Odo plays. A musical accompaniment, featuring xylophones, drums, and rattles, is known as obilenu music, meaning "that which lies above." the development of these music groups and plays are all done in a sacred area outside of the central village where the Odo performers reside and help train new initiates to the cult. Tribal relatives from distant communities will renew their contact with their roots by spending long periods with their family while enjoying the dramatic presentations of the Odo characters.
5	Benue	Kwagh- hir festival among the tiv encapsulates the existence, progress, and development of a group. Tiv kwagh-hir festival (theatre) employs a lot of songs and imagery in communication. The movement, acting, costume, staging techniques, colours, and characterization holds greater values in meaning. These explain the need and also situate Tiv man about the cosmic. These values generate kwagh-hir theatre in the form of a festival in which mimetic actions are presented and the community participates either directly as performers or indirectly as the audience. Thus, the Tiv kwagh-hir festival is the only institution that has the framework which can coordinate virtually all the art forms of their community. Performing arts among the Tiv promotes and preserves cultures, influences thought patterns, regulates the economy and sharpens political visions, and ultimately articulate customs and their spiritual worldview. These forms of performance take place as an interaction between performers-actors, dances, puppeteers, musicians, and the watching audience. Ujor festival most popular among the Idoma in Benue State. It is celebrated in September during the New Yam season. Ujor festival is celebrated in commemoration of past victories recorded by the Idoma at war. It is also partly a new yam festival. Prominent celebrants include the Chiefs, Clan heads, and brave warriors. The celebration is accompanied by the following cultural dances of the Idoma people namely; Agba, Atakakpo,

S/N	States	Major Cultural Festivals
		Adeigbo Oode, and Odabaru. On the eve of the festival, the traditional ruler meets with members of his traditional council in-all night session to review the activities of the community in the last twelve months. Decisions reached on this occasion are handed down to the people the next day as laws after some traditional dances.
6	Nasarawa	Oyarore Salt Festival was initiated by the founder of Keana village, Osana Akyana Adi, to celebrate the successful establishment of the Keana kingdom in the 13th century. Today, the Oyarore Salt festival is an annual event celebrated by the Alago people of Nasarawa state between October and November. The festival is a series of interrelated cultural activities and celebrations. It is a weeklong festival that serves as a period of retreat, sober reflections, supplications, and thanksgiving to the gods. The community seizes the opportunity of the festive period to celebrate freedom from oppression, conquest, and famine on one hand, and the providence of bountiful bumper harvest and salt production during the year on the other hand. Azhili festival of the Eggon People of Nassarawa state, The Eggon cultural dancers otherwise known as the 'Anzalu Dancers' are a uniquely classical dancing group so also the Ashim. Unlike the Anzalu Dancers that mainly thrills people, Ashim appears occasionally and mostly for specific occasions, Ashim is considered to be the spirit of the dead fore-fore fathers who came back to live in that form of spirit to entertain or carry out some disciplinary actions on the people. Women are advised to stay away from Ashim to avoid being barren. Nasarawa State people are endowed with enormous cultural festivals. Among these festivals are Odu, Amiri, Omadegye annual festival, Awuma dance, Oguh dance, Gbagyi Gbogum, Oyarere, etc.
7	Kaduna	The Afan National Festival is an annual event celebrated every 1 January by the Agworok (Kagoro) people of southern Kaduna State, it is said to have been observed for over 400 years. The word A̱fan means "mountain" or "hill" in Tyap. The large towering hills of Gworok are known as A̱fan A̱gworok among the natives. The glamourous hills are situated at an altitude circa 1,246 meters above sea level. Large trees grow on the hills with a rocky base. The weather of the area is significantly influenced by the hills and the climate is similar to that of the Jos Plateau and the Mambila Plateau, with heavy rainfall in the spring. The hills provided the people security from foreign Invaders and also harbours a sacred bee colony from when we unauthorized invasion is met with bee stings on a victim especially when such a one wears a perfume.
8	Plateau	There are a variety of traditional festivals in plateau state however the major festival that brings all the ruling houses together and serves as a festival of thanksgiving to the gods and the forefathers for a good harvest, peace, and unity is known as the Pu'usKa'at. It is the day when long lost friends, family members, and community members come together to meet and reaffirm their unity to the traditions of the Mwaghavul nation. During this festival which normally takes place towards the end of the year in November, sons, and daughters of the Mwaghavul nation usually converge at the venue of the festival to witness the rekindling of their kindred spirits, the unification of the kindred spirit normally involves cultural

S/N	States	Major Cultural Festivals
		performances by traditional women dance groups known as the ‘matcher’ dancers. During the Pu’usKa’at festival, the traditional horse riders also come out for racing. Women also bring out traditional wears like the kuluk, shang, shilip, tibarna, bika’a bum, and others for exhibition during this festival.
9	Bauchi	The Durbar remains one of the key festivals in Bauchi State. It features the display of elaborately adorned horses displayed in all their glory and commences from the Eid prayer ground to the palace of the traditional rulers, where horse-racing takes place. Dressed in traditional regalia, horse-riders pay homage to the Emir, as is traditional. The significance of Durbar is enormous in that various groups are identified by their communal ‘stock-in-trade’ such as warriors, hunters, and farmers. Bauchi is also rich in cultural dances which stem from its diverse cultural composition and historical antecedents. Among these cultural dances is the Kyaro war dance of the Warji ethnic group, Afizere dance, a traditional dance of the Jarawa people of the Toro LGA, the Takai dance (popular among the Hausa-Fulanis), the Ngat-al-Bajar dance (popular among the people of the Dass LGA), the Lawurba dance (peculiar to the Sayawa people of the Tafawa Balewa and Bogoro LGAs), and Gere masquerade dance. The people of Bauchi State are also known for their traditional wrestling and boxing dexterity, which attracts participants even from neighbouring countries of Niger, Chad, and Cameroon. Traditional wrestling is known as Kokowa while traditional boxing is called Dambe. Aside from these festivals, the state also holds the Bauchi State Festival of Arts and Culture (BAFEST). This annual event is held among Local Governments. It includes a display of various traditions of the people of the state in the fields of traditional dances, music, arts, crafts, and fashion designs, as well as inventions and innovations.
10	Gombe	Kamo cultural festival in the project-affected communities in Gombe State is a festival of unity. It is celebrated yearly by Kamo and Awak ethnic groupings in Gombe State. This cultural festival whose primary aim is to unite the people of the dual ethnic grouping is usually celebrated in the early month of April. During the Kamo cultural festival, there are large displays of cultural dances both from male and female folks and other competitive cultural displays like wrestling to promote integration. Daughters of Kamo who are married to both Kamo indigenes and outsiders use the opportunity to visit their homes with their children where they will unite with their brothers and parents to celebrate the festival and discuss other pressing issues affecting the family. This cultural festival is highly characterized by entertainment and merriments of various kinds. Other festivals held in Gombe state include the Pissi Tangle festival, Kaltungo festival, Chugothe, Kuram, Yeku, Bashari, Yiliri, and the Ilar-Zhare festivals.
11	Yobe	This is a famous festival performed by the three tribes of Karai-Karai, Ngoma, and Ngizim who are found in the study area. The festival is an annual event and takes place between June and September, it is performed by killing an aged cock of over one year old, and its blood is allowed to flow on all farming implements of a household (each household or a group household can perform the ritual).

S/N	States	Major Cultural Festivals
		After cooking the cock, the women carry some of the food on their heads to the oldest person's house in the community along with the farming implements. The elder will then pray for high yield, abundance, and blessed season. The women then, carry the food back home and give it to invitees to eat. After the meal, there will be different kinds of traditional dances by different age groups.
12	Borno	The Durbar festival in Borno State reflects the state's cultural and historical dignity. It is a significant royal display of horsemanship mainly organized to mark important occasions and Sallah festivities. The Durbar is characterized by royal horsemen, dances, and gorgeous - horses, trumpeters led by the Shehu, Emirs, District heads and other traditional title holders as the case may be.

Source: PGM Fieldwork, 2020

4.12.11 Conflict Management and Security

The surveyed communities like any other human community are not without human crises, which may arise from time to time due to individual differences occasioned by different socialization and orientation. Reported sources of conflict in the study community are disputes over land, politics, and grazing rights. The most frequent sources of these disputes as reported by the respondents are land ownership and boundary. The principal medium of conflict resolution in the community is traditional leadership. There are unwritten rules that govern the dispensation of justice in the area. Resort to formal judiciary (court) process is very rare in adjudicating civil disputes.

Gombe, Yobe, and Borno State segment of the railway line is part of the Northeastern region which has experienced several conflicts with violent outcomes and attacks by Boko Haram. Nearly 1 million people have been internally displaced by conflict and insecurity in the Northeastern and Middle North Regions. Over 7,000 fatalities have been attributed to the Boko Haram insurgency in 2014 and entire communities traumatized. Conflict-affected households in northeastern Nigeria continue to experience difficulty in meeting their essential food and non-food needs. Displacement has led to the abandonment of income-generating activities, cultivation, disrupted trade flows, and the closure of most markets in the conflict-affected areas.

The crisis in North-eastern Nigeria is being driven primarily by insurgent attacks attributed to Boko Haram – an Islamic Extremist group that is vehemently against western influence in any form; including government, rule of law, healthcare, and education. Boko haram has been actively engaged in terrorist activities in Nigeria since 2009. In 2014 Nigeria continued to see a rise in violence related to the activities of Boko Haram, who at the same time expanded their control of territory in mid-2014 by occupying towns in Borno, Adamawa, and Yobe states in the Northeast Region of the country. Attacks on communities in this region have been occurring at nearly a daily pace, and the degree of violence from these attacks is also rising dramatically, with the number of fatalities reaching over 7000 in 2014 alone.

In Rivers and Abia State also there was an issue of militancy in the state before the Federal Government granted amnesty to militants who would agree to lay down their arms, in October 2009. Amnesty notwithstanding, many youths in the area have become violence-prone and even social misfits. The youth will be a group to watch and also dialogue within the course of the railway operation in all the 12 project-affected states.

Conflicts do not always have violent outcomes; in fact, many conflict situations are resolved daily. In the study area, such non-violent conflicts also arise and there are traditional ways of resolving them. These communities have various organs of society traditionally involved in resolving conflicts. These organs include the social organizations to which household members belong, like the women organizations, the compound chiefs, and the Community Development Union (CDU). However, at the apex of the traditional conflict resolution process in each community is the traditional leadership. Their decisions on intra communal conflict issues are usually binding on all parties.

The active role of the community-based vigilantes in the provision of security for lives and properties is also observed in all the study areas. In Gombe, Yobe, and Borno they are called civilian JTF.

People found guilty are punished with penalties ranging from payment of fine, a public apology, and expulsion from the community, depending on the gravity of the crime committed. Formal law enforcement agencies are rarely contacted to adjudicate on contentious communal issues. They are only called in when traditional conflict resolution mechanisms do not achieve the desired effects. Law enforcement officials would rarely storm a community to arrest alleged offense perpetrators, without at least, informing the village head.


Plate 4.24: Railway infrastructure (L-R); Agbani train Station (Enugu) and Uzoakoli train Station (Abia)

4.12.12 Quality of Life

4.12.12.1 Settlement Pattern and Housing Conditions

Settlements are mainly located on stabilized dunes and around water points or where an oasis exists; villages are well spaced out on the plains to allow each settlement the minimum amount of productive land to support its inhabitants.

Centralization of political authority during the period of state and local government creation enhanced the capacity of towns for further growth. All the communities have the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the settlements. Their nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups. The building of houses in clusters has since increased in Gombe, Yobe, and Borno as a way of checking invasion from the Boko Haram terrorists. Spacing between houses is not definite and could range from three or four meters to about ten meters.

The 2018 NDHS collected data on access to electricity, flooring materials, and the number of rooms used for sleeping. Fifty-nine percent of households in Nigeria have access to electricity (83% in urban areas and 39% in rural areas) The study also found that the majority of both urban (68%) and rural (54%) households use cement flooring in their dwellings.

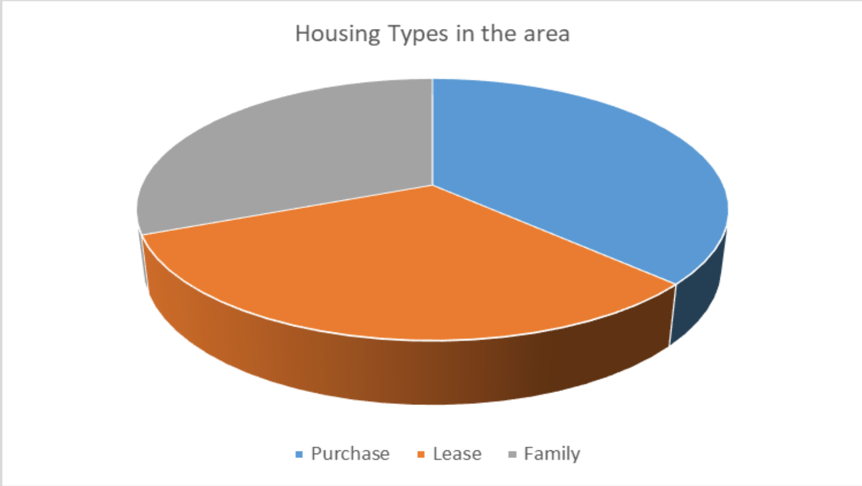


Figure 4.56: Housing Types in the area

Plate 4.25: Types of houses in the study area

4.12.12.2 House Construction Materials

Across the study area, the materials used in constructing houses are mud (wattle and daub), thatch, corrugated iron sheets (zinc), and cement blocks. About 47% of the houses are poorly designed; they do not have toilets and bathrooms in-house. Bathrooms, where land is available, may be provided in a fenced area behind the house. The most common type of toilet (about 41% and 28%) in all the communities is the pit toilet and water system toilet respectively. Another issue with the design of these houses is the provision of kitchens. About 36% of the houses have their kitchen outside the main building, in the backyard. Some of those where kitchens are provided in-house are poorly ventilated and smoke from cooking generally circulates the house and affects its occupants.

4.12.13 Local Economy

4.12.13.1 Natural Resources and their Exploitation for Sustenance

Communities in the study area are endowed with a lot of natural resources. These resources have been exploited by generations of residents, and have kept and sustained the continuous human settlements in the entire area. The resources are the water bodies, the forest, and the landmasses. Water bodies in the study area include rivers, streams, ponds, forest fruits resources, and wetlands. The ponds and wetlands are situated in bushes and forests around the communities. These water bodies yield the fishes and shellfish on which the communities in Rivers, Abia, Benue, Nasarawa, and Bauchi partly depend for food and livelihood.

The forests are home to several resources including timber, firewood, economic trees like the raffia and oil palm trees, and various wild animals. The timber is useful in building their houses. The timber also supports canoe building and repairs activities that take place in those communities along the River Niger bank. The forests in most of the communities have various economic trees that are exploited for their products. Notable among these are ‘bush mango’ (from where ‘ogbono’ is obtained), oil palm that produces palm oil, and raffia palm which produces palm wine and local gin in Rivers, Abia, Ebonyi, and Enugu. Additionally, the forests are home to various animals that residents hunt for food.

The land provides for the physical development of the communities including housing and infrastructure. It also supports the growth of a variety of crops like plantain, cassava, and vegetables in the communities. The land also provides gold, columbite, cassiterite, wolfram, topaz garnet, barite, iron, limestone, sapphire, talc, marble, gypsum, linite, coal, limestone, iron, and antimony for exploitation in Gombe, Plateau, Bauchi, Nasarawa. Local communities engage in the artisanal mining of these mineral resources for survival.

4.12.13.2 Natural Resource Conservation Practices

All the communities in the project area have had traditional practices which they have employed to conserve their natural resources. These practices are quite similar. They entail the prohibition of physical entry and exploitation of resources in designated areas. This prohibition may be permanent or temporary. Additionally, cutting down and use of economic trees in their productive life as firewood is prohibited in the surveyed communities.

4.12.14 Livelihood Activities

Livelihood activities across the surveyed communities are similar. The identified activities are mainly primary production activities like farming, hunting, fishing, timber works, and tapping and production of palm wine and palm oil.

Commerce and provision of services like trading, artisanship practices, and employment in the civil/public services were majorly identified in Rivers, Abia, Ebonyi, and Enugu. The largest proportion of household members in Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe, and Borno communities are engaged in farming and rearing livestock such as cattle, sheep, goats, donkeys, and horses at the commercial level. Artisanship practices inclusive of electrical repairs, boat building, tailoring, etc are significant in all the study area. Civil/public service employees in the communities are mostly Federal, State, and Local Government workers, teachers, and health workers. Others are inclusive of a few residents who are involved in contracting, especially in the various state capitals.

Farming is a major activity, and many residents are engaged in both crop farming, fish farming, and raising some livestock for subsistence. Most of the crops are grown on farmlands owned by extended families in the communities. The usual crops are cassava, plantain, cocoa yam, sweet potato, sugar cane, and vegetables. Farming equipment in use is still very rudimentary, comprising mainly of hoes and machetes. While farming is done by both adult males and females, fetching of firewood is usually done by adult females, and the gathering of forest fruits is done by women and children in the south part of the project area. Although incomes from these farming and allied livelihood activities vary depending on the scale of operations, local sources estimate that an average farmer earns between N200, 000 and N300, 000 annually from an investment of between N30,000 and N50,000.

Artisanal fishing is a major livelihood activity in which men, women, and children are engaged in Benue, Nasarawa, and Bauchi States. Fishing is done in the water bodies around the communities. Wooden boats and canoes equipped with nets, hooks, traps, floaters, machetes, and axes are used. The use of outboard engines is limited to a few who can afford the cost, the vast majority use canoes without engines. Among the fisherfolk are those who own and rent equipment for others to use, those who own their equipment, and those who function as assistants to others during fishing expeditions. The reward system practiced locally among resident fisher folk ensures that proceeds from any catch are shared and portions are left for all those who participate in the expedition, the equipment, and the equipment owner. This makes sure that entrepreneurship, investment, and labour are duly rewarded.

Fishing in river Benue, River Gongola, and Mada river in Nasarawa is most lucrative in the dry season months from October to March. The catch is generally reduced and expeditions are less during the rainy season. In this season the high-water level and floodwaters in the communities and bushes hamper fishing in the rivers and streams. The average healthy fisherfolk can go out fishing several times a week. Fishing households can earn between N100, 000 and N200, 000 monthly. The investment varies, depending on the type and number of equipment employed. A good canoe and the accompanying equipment would cost about N250,000 and one fitted with an outboard engine of 25 HP to 45HP would cost between N450,000 and N500,000. The usual catch includes tilapia, catfish, mudfish, electric fish, shrimps, and crayfish, among others.

Hunting, production of palm oil, and tapping of palm wine and palm oil are important primary production activities in communities in Abia, Ebonyi, and Enugu States. Significant quantities of palm oil are produced and sold at major markets in Abia, Ebonyi, and Enugu States. The production of palm wine and palm oil is common in all the communities in Enugu and Benue. Hunting is being done by a few young and physically strong adults in all the project-affected communities. The animals they catch include rodents, monkeys, bush pigs, and antelope.

The markets apart, there is considerable daily sales of goods in the communities along major roads. Some are petty traders who can only afford to sell a few things like sweets, biscuits, bread, fruits, etc from tabletops usually located in the front of their houses. Some others can afford to rent proper shops and sell from such places. This latter group usually has larger shop space and also stock more goods. Some traders tend to sell a wide variety of items like clothing, shoes and bags, electrical fittings, alcoholic and non-alcoholic beverages, and stationery, among others. Many of the indigenous petty traders are women in the southern part of the project area. Traders deal with a wide variety of goods and also operate on different scales and so their incomes are also very varied. The indications from their responses during interviews are that their monthly income varies between N30, 000 to N50, 000.

Residents commonly engage in more than one livelihood activity. Engaging in multiple livelihood activities provides household members with complementary sources of income. In many cases, it is an indication that each of these activities only provides a subsistence income and may be seasonal.

Plate 4.26: Artisanal mining activities in Kuru, Plateau State

4.12.14.1 Household Income Levels and Expenditure Patterns

NBS reports that at the national level, 31.7 percent of the households earned income of between N10,000 and 19,999 in a month, while 30.1 percent earned income of N5,000 to N9,999. Only 1.0 percent of households earned income above N80,000 per month. The states showed a similar pattern of distribution. Five states with households that earned the highest percentage of monthly income between N10,000 and N19,999 include Gombe (50.5 percent), Anambra (48.7 percent), Akwa Ibom (44.7 percent), Niger (40.8 percent), and Sokoto (40.6 percent). States with the highest percentage of households that lived on less than N1,000 include Kebbi (25.4 percent), Kwara (23.1 percent), Benue (8.6 percent), Nassarawa (7.9 percent), Sokoto (7.7 percent), and Bauchi (7.3 percent).

The average household member across the study area in the northern part of the project area earns less than 1USD per day, it implies that a majority of household members live below the poverty line.

The major items of expenditure in the households are food, health care, purchase of household items including utilities (kerosene, petrol, etc), transportation and clothing.

Table 4.57: Items of expenditure

Items of expenditure	Percentages (%)
Clothing	9%
Transportation	9%
Health	19%
Household Items	9%
Food	35%
Housing	18%
Communication	1%
Total	100%

Source: PGM field Fieldwork, 2020

The major food items are mainly those that are not grown locally. Expenditure on health care by households is quite significant because most households take their sick members to the State capitals of the various project-affected States to access functional orthodox health care facilities. Apart from this, household members also spend considerable sums of money on drug purchases from drug stores (‘chemists’) in their communities.

Data from the field shows that transportation costs are incurred mainly in accessing health and other social amenities outside the communities. Households also spend considerably on the purchase of kerosene for their lanterns and cooking stoves, and petrol for their private electricity generators. Expenditure on food and health accounts for 54% of total household expenditure. Community sources across the study area generally affirmed that for most households, expenditure on food, accessing higher education services outside their communities, obtaining health care, purchase of household items, transportation, and clothing account for between 65% and 70% of their monthly earnings.

4.12.14.2 Land Ownership and Tenure

In Nigeria, men are more than three times as likely to own a house or land as women. Thirty-seven percent of men own a house and 38% own land alone or jointly with someone, as compared with only 11% and 12% of women, respectively. The percentage of women who own a house alone or jointly with someone else declined from 18% in 2013 to 11% in 2018, and the percentage who own land alone or jointly declined from 15% to 12%. House ownership also declined among men, from 40% to 37%. However, over the same period, land ownership among men increased from 34% to 38%.

Land in all the project affected communities is primarily owned by male heads of the family. Ownership rights over lands are handed down from one generation to another within the extended family. Such inherited land is put to any use as desired by the owner(s). These are the lands on which family members build their houses and are allocated farmlands for cropping. Land could be bought from owners who were willing to sell. Apart from the family, the communities also owned some land. Most of the lands in the communities on which the railway line was constructed are owned by different families.

Any intentions to obtain land for corporate or industrial use are initiated through the CDUs, district heads, village heads, Mai Angwan in the northern part of the project area, and various councils of chiefs which are in the best position to offer proper guidance concerning ownership. This condition is important whether the required land is owned by a family or community. This approach to obtaining land helps avoid intra/ inter-communal conflicts over ownership of any land that may be required for any proposed project. The prices of land vary from one community to another and from one state to another, in Rivers and Abia state, 100 x 50-meter size land is sold for N3,000,000-7, 000,000, and sold N300,000- 1,000,000 in Plateau and N20, 000-150,000 in Yobe and Borno States

4.12.15 Infrastructural Base

4.12.15.1 Classification of Infrastructure

Infrastructure is classified as physical, social, and institutional. Physical forms include; transportation facilities (roads, railways, bridges, ferry services, canals, and foot-paths); storage facilities (silos), warehouses, cribs, open-air facilities, etc); processing facilities (machinery, equipment, building, etc.); irrigation, flood control, and water resources development facilities; and soil conservation facilities.

Social infrastructure comprises housing, leisure and recreational facilities, health facilities (hospitals, dispensaries, maternities, and health centers, etc); educational facilities (primary schools, teacher training colleges, secondary schools, technical schools, vocational schools, adult educational facilities, etc); and utilities (electricity, water supply, sanitation facilities, etc.). The main components of the institutional infrastructure are co-operative societies; farmers' unions/groups, community development projects, financial institutions; agricultural extension, research and training facilities; and post and telecommunications facilities (post offices, postal agencies, telephones, etc.).

Infrastructure has made a mesh impact of around 1 percentage point to Nigeria's improved per capita growth performance in recent years, even though the unreliable power supply held growth back. Raising the country's infrastructure endowment to that of the region's middle-income countries could boost annual growth by around 4 percentage points. The 12 project-affected State and local government authorities and some industrial and multinational companies and international agencies have been contributing different quota to the development of the social infrastructures in the study area. The various State governments, over the last 8 years have embarked on a lot of developmental projects bothering on roads/bridges/culverts rehabilitation and/or construction; provision and rehabilitation of educational and health facilities; and provision of electricity and potable water sources.

Plate 4.27: Road infrastructure in the study area (L-R) Oturkpo, Benue State and Buni Yari, Yobe State

4.12.15.2 Available Infrastructure and Their Functional Status

Public access to the project-affected communities is by dilapidated and poorly maintained tarred **roads** with most of the State and LGA headquarters having paved internal link streets. Additionally, telecommunication services from GSM service providers are received in most parts of the communities, although these services fluctuate in some of the communities.

Education facilities in the project-affected communities consist mainly of public primary, junior and senior secondary schools. The infrastructures in many of the schools are inadequate. The students' desks and chairs are broken and insufficient, classrooms are also insufficient, and some of their ceilings, windows, doors, and floors are broken. The schools do not have decent utilities like toilets and they also do not have equipped libraries and laboratories. The student to teacher ratio in the public primary schools is high, as much as 60:1. Teachers in the secondary schools are not enough to cover all the subject areas, and subjects like Mathematics, Physics, Introductory Technology, Agricultural Science, English Language, and Home Economics are often taught by teachers who did not study these core subjects in the tertiary institutions.

The cumulative effect of these inadequacies is a lack of interest in schooling among many children in the area despite the free education policy of the State government. Parents who are interested in their children being properly educated and who can afford the cost send their children to schools outside their communities and the LGA after they complete their secondary education. Many of these children end up especially in Port Harcourt, Kano, Benin, Asaba, Lagos, and Abuja as wards of their relations. Several of those left in the villages end up marrying or get pregnant and drop out of school. Local sources estimate that 2% to 3% of children of school age are not in school because of truancy or have dropped out in Rivers, Abia, Ebonyi, Enugu, Benue, Nasarawa, Plateau and Kaduna, Gombe, and Bauchi were estimated at 3-4%. Yobe and Borno have then highest at 10-12% and this figure is attributed to the activities of the insurgents in the area.

There is generally a dearth of functional government orthodox **health facilities** in the entire study area. Perhaps the only one that can be considered functional and patronized by several residents are the General Hospitals located in most LGA headquarters. The basic problems of the hospitals are inadequate staffing, broken down and unmaintained equipment, and lack of drugs. The situation is such that most households generally do not have confidence in them and would rather ‘consult’ drug stores or take their members requiring medical attention to the various State capitals.

Public water and electrification are very much dysfunctional in the project-affected communities. Several water boreholes have been constructed in the communities but most of them are not working largely because of poor maintenance culture. Similarly, most of the communities have **electricity** facilities and are linked to the national grid. The power output is however so poor and erratic that a fair number of residents, especially those involved in various economic enterprises, also possess electricity generating sets to ameliorate the effect of poor power supply and power outages.

In terms of trading opportunities, all the surveyed communities can boast of small, functional but poorly infrastructures a makeshift marketing facility which deals with foodstuff basically from which the people may procure their essential needs except for Port Harcourt, Aba, Umuahia, Enugu, Markudi, Kaduna and other state capitals with large and function markets with modern market facilities.

Plate 4.28: Market infrastructure in Agyaragu market, Nasarawa State.

Plate 4.29: Road infrastruture in Port Harcourt metropolis

Plate 4.30: Road infrastructure in Bauchi

4.12.16 Health Conditions

4.12.16.1 Health Facilities and Services

The study area has both orthodox and non-orthodox health care providers and facilities. Most Local Government headquarters have a General Hospital which provides first aid, serves as an HIV/AIDS counseling center and treatment for minor ailments, as well as immunization services for children and women of childbearing age. The vaccines they give include BCG, OPV, DPT, Measles, TT, YF, and HBV.

Apart from the orthodox facility, there are drug stores (chemists) located in some of the communities. There are also hawkers (individuals who carry drugs, especially malaria drugs, analgesics, antibiotics, and various creams and balms) hawking drugs from one settlement to another. The number and the quality of drugs being distributed could not determine during the study.

4.12.16.2 Utilization of Health Services

Patronage of available orthodox and non-orthodox health care service providers across the project-affected communities is presented in Table 4.58. In the project-affected communities, 51% of the people patronize drug stores when they feel ill.

Table 4.58: Patronage of Health Services in the Study area

Available Health Care Service Providers	Frequency (%)
Hospitals/Health Centres	36
Chemists/Drug Stores	51
Herbalists/Traditional Medicine Practitioners	7
Churches/Spiritual Healing Homes	6
Total	**100**

Source: PGM Fieldwork, 2020

4.12.17 Water Sources

In Nigeria, 66% of households have access to an improved source of drinking water, 74% in urban areas, and 58% in rural areas. Urban and rural households rely on similar sources of drinking water. The three most common improved sources of drinking water in urban and rural households are tube wells or boreholes (41% in urban and 34% in rural households), protected dug wells or springs (13% in urban and 12% in rural households), and public taps/standpipes (7% in urban and 8% in rural households) (NDHS 2018). The sources of water used in households in the study area include water from the surrounding rivers and streams, rainwater, well, and water from public and private boreholes.

In the surveyed area in Rivers State, many households avoid the use of rainwater as a result of their belief that rainwater is being polluted by gaseous emissions from flares from oil and gas activities in and around their communities. For this reason, also, the use of rainwater is mostly limited to the washing of clothes and other things and not for cooking.

Results from the NDHS of 2018 showed that the percentage of households with improved sources of drinking water is highest in the South East (81%) and lowest in the North East (60%) (Figure 4.57). Access to an improved source of drinking water is most common among residents in the fourth wealth quintile and least common among those in the lowest quintile (84% and 41%, respectively).

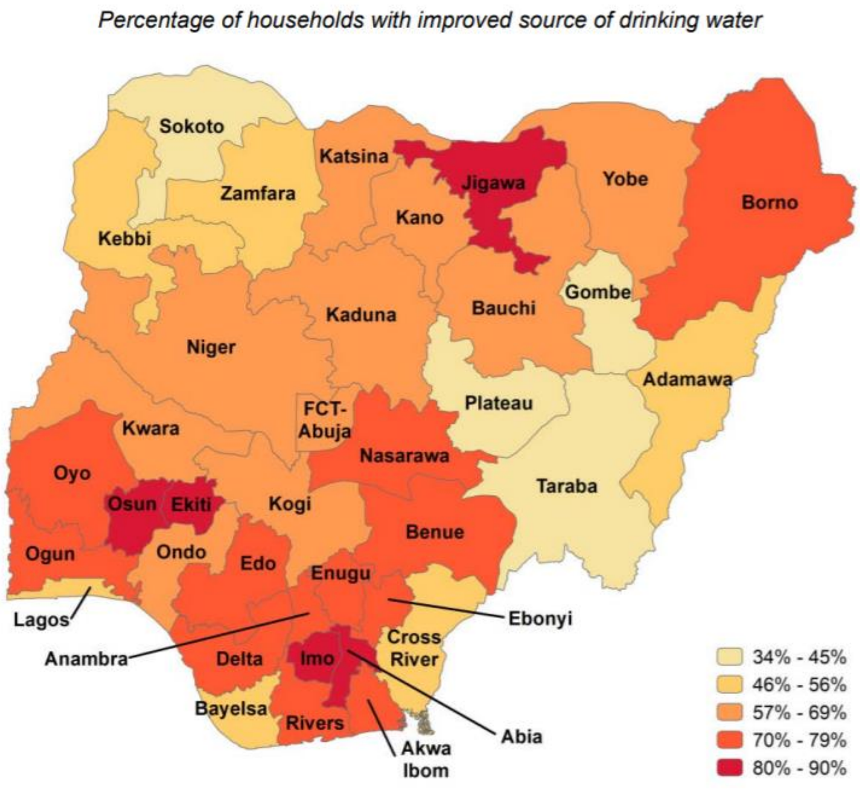


Figure 4.57: Improved water source by state (Source: NPC, 2018)

4.12.18 Sanitation and Waste Management

Since 1983, environmental sanitation has become a prominent issue in Nigeria and countless sanitation Waste disposal practices in the four LGAs are quite similar. Refuse and sewage is mostly disposed of in the surrounding farmlands and communities' dump sites. Similarly, two methods of sewage disposal practiced are the use of pier system toilets and water closet toilets. About 80% of households in the study communities dump their refuse in nearby farmlands, while 82% use the pit toilets.

Improper disposal of refuse generated by the households, apart from being aesthetically displeasing, can constitute health risks to human life which is in other words referred to as unsafe sanitation. NBS 2016 reports that 6.5 percent of households used the satisfactory refuse disposal method, while the majority of the households (93.4 percent) adopted an unsatisfactory system to dispose of their refuse in Nigeria.

NDHS of 2018 reported that 56% of Nigerian households use an improved sanitation facility, however, the common refuse and sewage disposal practices in communities across the study area are not modern, hygienic, or safe. Most of these wastes eventually end up in the water bodies around the area or are carried downstream and deposited in other communities. Although those that are easily biodegradable (including sewage), decompose and also provide nutrients for plants and fishes, they are still sources of pollution and constitute a health hazard. Those that are not easily degradable (especially metals and plastics) are always visible and obvious pollutants and litter around the environment.

4.12.18.1 Waste Management Practices

Waste disposal practices in the 12 project-affected States are quite similar. In the rural and semi-urban areas, refuse and sewage are mostly disposed of in the surrounding farmlands, rivers, and streams. Generally, three methods of refuse disposal are practiced in the rural area of the project area and they are dumping of refuse in the river, bush, and burning while the state capitals like Port Harcourt, Umuahia, Enugu, Makurdi, Jos, Bauchi, and Gombe use the services of the state own waste management agency.

Similarly, two methods of sewage disposal practiced are used and they are pier system toilets and water closet toilets. About 60% of households in the study communities dump their refuse in the rivers, while 72% use the pit toilets.

The common refuse and sewage disposal practices in communities across the study area are not modern, hygienic, or safe. Most of these wastes eventually end up in the water bodies around the area or are carried downstream and deposited in other communities. Although those that are easily biodegradable (including sewage), decompose and also provide nutrients for plants and fishes, they are still sources of pollution and constitute a health hazard. Those that are not easily degradable (especially metals and plastics) are always visible and obvious pollutants and litter around the environment.

4.12.19 Nutrition

The average household in the study area can provide two meals daily for its members. The meals consist predominantly of carbohydrate and protein. Commonly available sources of protein are fish and seafood, especially periwinkles, oysters, prawns, and crayfish in Rivers, Benue, Abia, Nasarawa, and Bauchi States and meat in Yobe, Bauchi, Borno, and Nasarawa. These proteins are always available in the soups with which corn flour meal, garri, or fufu (the staple and most common food) is eaten. Other foods eaten include yam, rice, cocoa yam, sweet potato, and beans.

Although during interviews several residents complained about the nutritional value of the meals, they can provide for their households, it did not seem from medical records in all the health facility that malnutrition was a common ailment in the area except for Yobe and Borno where an estimated 943,000 children under five years old are acutely malnourished; 440,000 with severe acute malnutrition (SAM) and 503,000 with moderate acute malnutrition (MAM). Around 230,000 pregnant and lactating women (PLW) are estimated to be acutely malnourished. The nutrition situation in Borno and the Yobe States declined rapidly due to the crisis in 2015, peaked in 2017, and has stabilized in 2018, with some exceptions in hard-to-reach areas (mainly in Damasak, Gubio, Kukawa, and northern Yobe). Recent nutrition surveillance (by UNICEF, in collaboration with the National Bureau of Statistics (NBS)) revealed GAM and SAM rates of 6.4% and 1.2% in Borno and 12.0% and 1.3% in Yobe respectively.

4.12.20 HIV/AIDS and social pathologies

Despite the measures for maximizing local employment, a large proportion of the railway line workforce will originate from outside the local area. This means that it will be necessary for workers to find accommodation near the train terminal sites.

However, as has been well-documented from other infrastructure projects, the presence of non-local workers may have a variety of social consequences:

- Railway workers and train terminal followers, being a predominantly young, male, mobile population, are often associated with promiscuous sexual activities. Long-distance truck drivers needed to transport building materials and equipment from train stations and terminals are similarly associated with cash for sex. Such behaviour could increase the prevalence of HIV/AIDS, tuberculosis, and other communicable diseases in the local study area during the operation phase. The fact that the current HIV/AIDS prevalence in Nigeria is relatively low does not completely obviate this risk. Other social pathologies frequently associated with a transitory population with disposable income (such as drug/ alcohol abuse, etc.) may also increase.

- An influx of railway workers and terminal followers may also be accompanied by an increase in crime such as petty theft, vandalism, and poaching of domestic livestock. Even if particular instances of crime are not a result of newcomers, it may still be attributed to them by the local community and landowners.

The risk of HIV/AIDs and social pathologies is assessed as being of moderate negative significance without mitigation, which remains moderate negative with mitigation.

Acquired immunodeficiency syndrome (AIDS) is one of the most serious public health and development challenges facing the world today. AIDS is caused by the human immunodeficiency virus (HIV). HIV weakens the immune system, making the body susceptible to secondary infections and opportunistic diseases. Without treatment, HIV infection leads to AIDS, which is invariably fatal. The predominant mode of HIV transmission is sexual contact. Other modes of transmission are unsafe injections, use of tainted blood supplies during blood transfusions, and mother-to-child transmission (in which the mother passes HIV to her child during pregnancy, delivery, or breastfeeding). Since 1991, the Government of Nigeria has employed a sentinel surveillance system among pregnant women age 15-49 attending antenatal care to track HIV prevalence (Federal Ministry of Health 2008). To further strengthen its coordination of the multi-sectoral response, the federal government transformed the

National Action Committee on AIDS into the Agency for the Control of AIDS in July 2007 (National Agency for the Control of AIDS 2007). To sustain and improve the effectiveness and coordination of the national HIV response, states have taken the same step of transforming smaller committees and bodies into agencies. Nationally, HIV and AIDS programmes have received a boost through the efforts of the government and the support of development partners, which has led to a scale-up of prevention, care, and treatment programmes aimed at combating the disease.

Nigeria albeit due to its population size is now the second-largest HIV disease burden in the world with 3.2 million after South Africa which has 6.8 million of the disease. In 2016, Nigeria had 220,000 new HIV infections and 160 000 AIDS-related deaths. In 2017 global information and education on HIV and AIDS report 3.1 million as having HIV/AIDS in Nigeria, 2.8% adult HIV prevalence (ages 15-49), 210, 000 new HIV infections, 150,000 AIDS-related deaths, 34% adults on antiretroviral treatment and 26% children on antiretroviral treatment. It is noted however that a good amount of awareness education and advocacy on the disease and its prevention is ongoing and from interviews, these are beginning to yield the desired results. Between 80-95% of the respondents are aware of HIV/Aids and it means of prevention in Rivers, Abia, Benue, Plateau, and Ebonyi, while 70-79% of the respondents are aware of HIV/Aids and it means of prevention in Enugu, Yobe, Gombe and Bauchi.

The most important tool in the prevention/control of STIs is health education which undoubtedly the study area can largely benefit from. The objective of health education is to create awareness of the problem and to motivate people to develop the right attitude to sex. Early diagnosis and early treatment of sick persons will eliminate the reservoir of infections from the area. Treatment however should be accessible and affordable; otherwise, people will resort to self-medication. Self-medication especially before or after exposure shall be discouraged as this may lead to drug resistance.

The federal and state governments spend billions of naira yearly to create awareness on the grave negative effects of the scourge. This awareness seems to be yielding positive results in the area as over 99% of the respondents claim to know about HIV/AIDS and its means of transmission and prevention. Collaborating this, drug vendors locally referred to as chemists in the area said there is an increase in the number of condoms sold daily. However, the FGD revealed that a quarter of respondents acknowledged that they often had unsafe sex with high-risk partners.

This project is likely to have a double-pronged effect on the study area. On one hand, it will improve the socio-economic status of the people thereby riveting their attention from sexual activities. On the other hand, however, improved economic status could precipitate a change in lifestyle leading to a high intake of alcohol and increased sexual encounter

CHAPTER 5

STAKEHOLDERS ENGAGEMENT

5.1 Introduction

Principle 10 of the Declaration of the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (Brazil, 1992) emphasizes that environmental issues are best handled with the participation of all concerned citizens, at the relevant levels. Agenda 21 adopted by United Nations Conference on Environment and Development (UNCED) recognized the important role of public participation in environmental impact assessment (EIA) in achieving sustainable development (item 23.2 of Agenda 21).

The World Summit on Sustainable Development in Johannesburg (South Africa, 2002) developed further these provisions. The principles promoted by these conferences are fully integrated into the provisions of the UNECE Convention on Environmental Impact Assessment in a Transboundary Context, which came into force in 1997 (hereinafter referred to as the Convention). When project proponents enable the public to participate in decision-making, they help meet society’s goal of sustainable and environmentally sound development.

World Bank's Environmental and Social Safeguard Policies (ESSP 10); Stakeholder Engagement and Information Disclosure consolidate and improve provisions related to borrower engagement with stakeholders, including meaningful consultation, access to information, and grievance redress. It provides for ongoing dialogue between the borrower and stakeholders, including project-affected parties, throughout the life of a project, and lays out requirements for information disclosure and grievance redress. A continuous Stakeholder Engagement Plan has been developed for this project.

Public participation in environmental decision-making and, in particular, in ESIA, may lead to some benefits in these processes. As a result of public participation, the process of decision-making, up to and including the final decision, becomes more transparent and legitimate. Public debate on proposed activities among all interested groups at an early stage of decision-making may prevent or mitigate conflicts and adverse environmental consequences of the decisions with impacts.

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the Port Harcourt-Maiduguri Railway project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also to notify the stakeholders of the nature, scale, and timing of the proposed project, thereby eliminating any fears or apprehension. The process was also used to facilitate information gathering between the ESIA consulting team/proponent and the other stakeholders. The consultation exercise commenced at the very early stage of the environmental impact process and it is planned to continue throughout the project duration.

The Stakeholders Engagement process has been designed to comply with regulatory requirements set out in Nigerian environmental legislation and, where possible, implement international good practice guidelines, for example, those of the IFC. The process provides stakeholders with an opportunity to evaluate the proposed project and to submit comments for enhancing project benefits while minimizing the project's adverse effects. The Stakeholders' Engagement process aims to achieve the following:

- To ensure that stakeholders are well informed about the proposed project;
- To provide stakeholders with sufficient opportunity to engage and provide input and suggestions on the proposed project;
- To verify that stakeholder comments have been considered and addressed;
- To draw on local knowledge in the process of identifying environmental and social concerns associated with the proposed project, and to involve stakeholders in identifying ways in which these can be addressed;
- To comply with the federal, state, and local government legislative requirements; and
- To incorporate international good practice.

5.2 Public Consultation process

The methodology employed for the public consultation process considered the following aspects:

- The Nigerian legislative requirements;
- International stakeholder engagement practice guidelines;
- Local cultural requirements such as language proficiencies;
- Social sensitivities associated with the proposed project; and
- The geographical location of communities.

The consultation team has sought to ensure that all identified stakeholders, including the project impacted communities, are aware of the proposed project and the ESIA process through extensive community consultation. The stakeholder engagement strategy was designed to attain meaningful participation and involvement that enabled stakeholders and the community to actively contribute to the development of new ideas and options as the project is planned and developed.

The Stakeholder/Public Engagement methodology is summarised and depicted graphically in Figure 5.1; the same approach was used during the Scoping and ESIA phases.

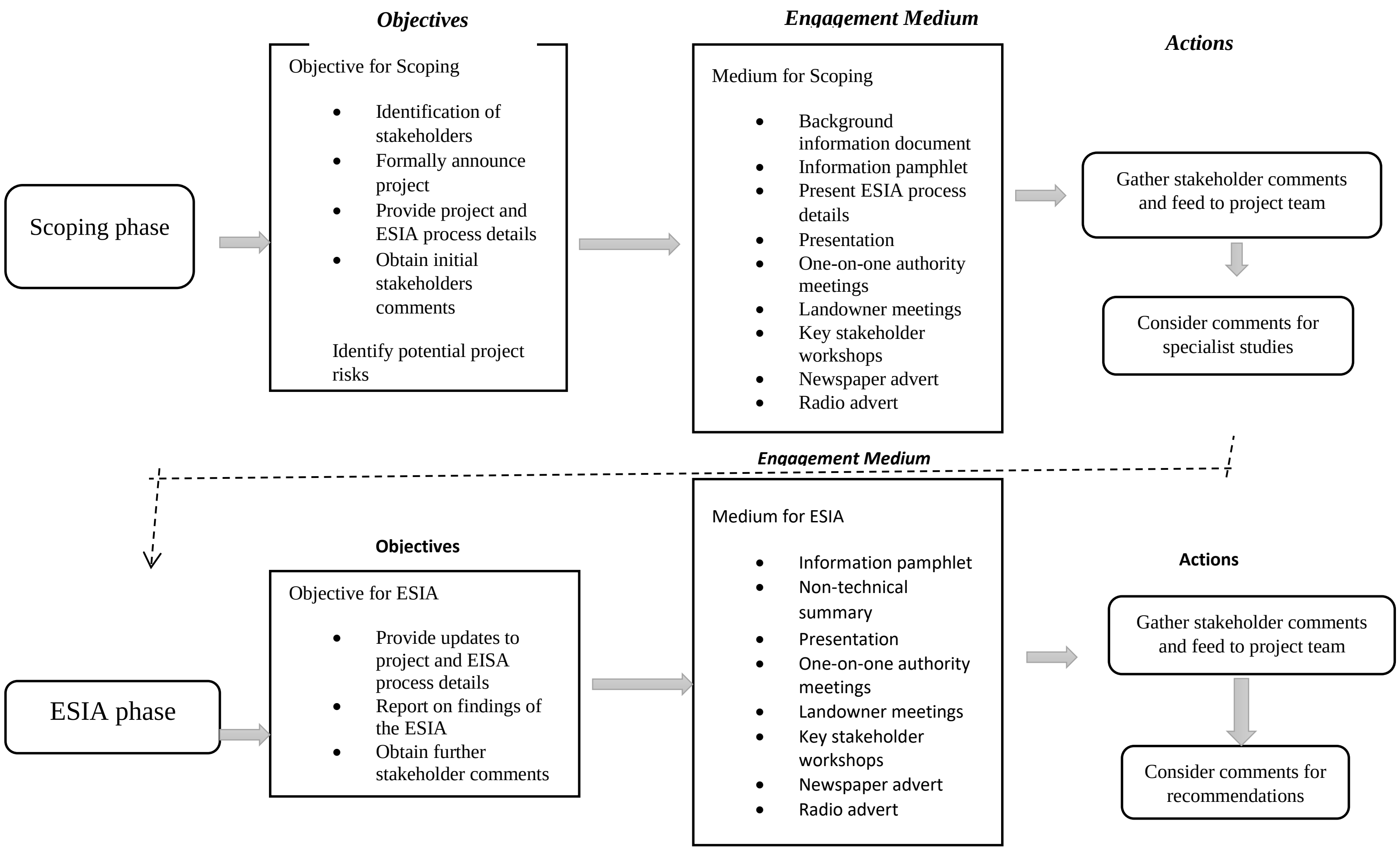


Figure 5.1: Stakeholders engagement methodology

5.3 Levels of Consultation

Two levels of consultations, as are generally recognized in the ESIA process, were held. These are institutional and Project affected communities (PACs) involvement. The subject of this section relied heavily on both, though with emphasis on PACs involvement, ie. getting the public, host communities, all other stakeholders that may be directly or indirectly affected by the project to participate in assessing the project.

The public forum with project-affected communities, NGOs, and CBOs, youth groups, women organizations, religious organizations, and traditional bodies held between 16-23 November 2020 in the project-affected communities with the various village heads and traditional rulers in attendance and also with major institutional stakeholders on the 10th, 12th, 13th, 16th, 17th and 19th November 2020 in Enugu, Umuahia, Port Harcourt, Damaturu, Kaduna, and Jos respectively.

In all the consultation meetings, a brief on the project concerning the following was given by the ESIA consultant.

- Purpose of the public fora
- Background to the project
- Project description
- Benefit description
- The benefits of the project
- Environmental management
- Community affairs and relations.

At the end of the presentation, participants were given ample opportunity to ask questions and/or make comments on the project. They were unanimous in praising the proponent for considering them suitable to host the project and promised to accord the proponent all the needed support.

5.4 Identification of Stakeholders

The proponent's policy makes it mandatory to consult with stakeholders and relevant authorities in all activities. In preparing this ESIA report the consultation process is implanted at three (3) levels: The first level of consultation identifies the social and economic issues in the project area and ensures visible management commitment to addressing them. This level starts with the project conception.

The second level streamlines the issues and makes plans for specific actions. This level recognizes various phases of engagements among project proponent, host communities, village councils, women/men's groups, and youth organizations. The third level ensures regular communication with stakeholders throughout the project's life; the second and third levels of consultation commence at project inception and continue through the life span of the project.

The key stakeholders identified and consulted for the proposed construction of the Port Harcourt-Maiduguri Railway project at Port Harcourt, Umuahia, Enugu, Jos, and Damaturu are:

xix. Federal Ministry of Environment
xx. Federal Ministry of Transportation

xxi. Federal Ministry of Works and Housing
xxii. Nigeria Railway Corporation
xxiii. National Environmental Standards and Regulations Enforcement Agency (NESREA)
xxiv. Federal Roads Safety Corps
xxv. National Inland Waterways Authority
xxvi. Nigeria Security and Civil Defence Corps (NSCDC)
xxvii. Department of State Security (DSS)
xxviii. Nigeria Police
xxix. Rivers, Abia, Enugu, Nasarawa, Kaduna, and Yobe
   a. State Ministry of Environment
   b. State Ministry of Works
   c. State Ministry of Lands
   d. State Ministry of Urban and Physical Planning
   e. State Ministry of Women Affairs
   f. State Ministry of Local Government and Chieftaincy Affairs
   g. Waste Management Agencies
xxx. The 65 affected LGCs
xxxi. Elders, youth, and women groups of affected communities (grouped into 50 clusters)
xxxii. Association of Environmental Impact Assessment of Nigeria (AEIAN)
xxxiii. Institute of Natural Resources and Environmental Management (INRES), University of Port Harcourt
xxxiv. National Union of Railway Workers
xxxv. Road Transport Employer Association of Nigeria
xxxvi. Nigeria Society of Engineers

In the course of planning, the project proponent has established a close working relationship and a sense of partnership with those key stakeholders and the host communities and shall maintain these throughout the project life.

Table 5.1: List of Project Stakeholders and Engagement Activities

Stakeholder Group	Issues	Solutions
Government authorities	Employment and local benefits	• The Project should provide employment opportunities for local communities. • Need for community agreements (eg Memoranda of Understanding (MOUs)) which should include local government agencies particularly the Commission of Community Development. • The project should result in improved infrastructural provision for local communities, particularly in terms of an access road • Encourage the communities to work together for long term benefit for all community members.
	Waste	• Develop comprehensive plans for water use and wastewater discharge during rehabilitation and waste management during operations.
	Scope of the ESIA	• The ESIA should address potential health risks and disease migration and mobility during operation on the project host communities. • The ESIA should take cognizant of the flora and fauna currently on the ROW.
	Integration with existing spatial planning	• The Project should confirm with the project affected LGAs and State government in Yobe state where there is a proposed new route that the land is not designated for other uses within the development plan for the area.
Local communities	Employment and local benefits	• Opportunities in terms of employment and procurement, particularly for local communities during rehabilitation and operations.
NGOs and CBOs	Impacts on birds	• The ESIA would need to assess the potential impacts of the project on birds.

Stakeholder Group	Issues	Solutions
	Community H&S	• The Project will need to plan for the community health risks related to the railway line and potential accidents.
	Livelihoods and resettlement	• The project needs to thoroughly understand the livelihoods within the area of influence to understand the impacts of the project on local communities • An adequate compensation package needs to be developed for property owners before the construction of the new railway line route and rehabilitation of the existing cum abandoned railway line

Source: PGM Fieldwork 2020

Table 5.2: Schedule of Meetings and Interviews

SN	Community	LGA	State	Date of consultation	Issues Discussed
1.	Port Harcourt	Obio Akpor	Rivers	16/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
2.	Elelenwo	Obio Akpor	Rivers	17/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested

SN	Community	LGA	State	Date of consultation	Issues Discussed
					mitigation and enhancement measures, community, needs, and development prospects.
3.	Ishiagu	Ivo	Ebonyi	11/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
4.	Aba, Eziama	Aba North	Abia	9/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
5.	Umuahia	Umuahia North	Abia	23/09/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
6.	Uzuoakoli	Bende	Abia	23/09/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them,

SN	Community	LGA	State	Date of consultation	Issues Discussed
					perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
7.	Ovim	Isuikwuato	Abia	24/09/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
8.	Afikpo road	Ivo	Ebonyi	28/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
9.	Obinagu	Ivo	Ebonyi	28/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
10.	Nomchi	Nkanu East	Enugu	10/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods,

SN	Community	LGA	State	Date of consultation	Issues Discussed
					environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
11.	Uduma	Anu nri	Enugu	11/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
12.	Emene	Enugu East	Enugu	11/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
13.	Oturkpo	Oturkpo	Benue	12/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.

SN	Community	LGA	State	Date of consultation	Issues Discussed
14.	Makurdi	Makurdi	Benue	13/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
15.	Agyaragu		Nasarawa	13/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
16.	Lafia	Lafia	Nasarawa	13/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
17.	Mada Station	Nassarawa Eggon	Nasarawa	13/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested

SN	Community	LGA	State	Date of consultation	Issues Discussed
					mitigation and enhancement measures, community, needs, and development prospects.
18.	Gudi	Akwanga	Nasarawa	13/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
19.	Jagindi	Akwanga	Nasarawa	13/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
20.	Kafancha	Jamaa	Kaduna	13/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
21.	Kaduna	Kaduna South	Kaduna	16/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them,

SN	Community	LGA	State	Date of consultation	Issues Discussed
					perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
22.	Bulumkutu Tsalleke	Metropolitan	Borno	13/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
23.	Eha Amufu	Isi Uzo	Enugu	12/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
24.	Bauchi	Bauchi	Bauchi	14/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
25.	*Alkaleri*	*Alkaleri*	Bauchi	14/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods,

SN	Community	LGA	State	Date of consultation	Issues Discussed
					environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
26.	Bajoga		Gombe	17/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
27.	Gombe		Gombe	17/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
28.	Nguru	Nguru	Yobe	19/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.

SN	Community	LGA	State	Date of consultation	Issues Discussed
29.	Amagu Ishiagu	Ivo	Ebonyi	23/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
30.	Kuru	Riyo	Plateau	18/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
31.	Jos	Jos North	Plateau	18/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
32.	Ugbawka	Nkanu East	Enugu	11/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested

SN	Community	LGA	State	Date of consultation	Issues Discussed
					mitigation and enhancement measures, community, needs, and development prospects.
33.	Agbani	Nkanu West	Enugu	11/10/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
34.	Ndolori	Jere	Borno	16/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
35.	Mari		Yobe	18/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
36.	Bulama		Borno	17/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them,

SN	Community	LGA	State	Date of consultation	Issues Discussed
					perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
37.	Tasha Kargo/Gadan Kargo			19/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
38.	Garin Alkali	Busari	Yobe	22/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
39.	Ajilari	Jere		16/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
40.	Shuwari	Metropolitan	Borno	13/11/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods,

SN	Community	LGA	State	Date of consultation	Issues Discussed
					environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.

Source: PGM fieldwork 2020

Plate 5.1: A cross section of participants after scoping workshops in the various project-affected states.

A- Abia State

B- Enugu State

C-Yobe State

D- Plateau State

Table 5.3: Consultation Schedule

Stakeholder Group and interest in the project	Stakeholder Name	Stakeholder Level				Engagement Activity	
		International	National	State	Local	Meeting	Letter
Scoping Study							
Government Authorities: National, State, and local government of primary political importance to the Project with permitting requirements that must be met by the Project.	Federal Ministry of Environment (FMEnv)		X			x	X
	Federal Ministry of Transportation		X			x	X
	Federal Ministry of Lands and Housing		X			x	X
	Federal Ministry of Niger Delta		X			x	X
	12 Project Affected States' Ministry of Environment			x		x	X
	12 Project Affected States' Ministry of Women Affairs			X		x	X
	12 Project Affected States' Environmental Protection boards			X		x	X
	12 Project Affected States' Ministry of Rural Development			X		x	X
	12 Project Affected States' Office of the Surveyor General			X		x	X
	Nigeria Police, 12 Project Affected States' Commands			X		x	X
	NSCDC, 12 Project Affected States' Commands		X			x	X

Stakeholder Group and interest in the project	Stakeholder Name	Stakeholder Level				Engagement Activity	
		International	National	State	Local	Meeting	Letter
	12 Project Affected States' Ministry of Information			X		x	X
	12 Project Affected States' Ministry of Health			X		X	X
	FRSC, 12 Project Affected States' Command		X			x	X
	12 Project Affected States' Ministry of Works			X		X	X
	12 Project Affected States' Office of the Secretary to the State Government			X		x	X
	Department of State Services (DSS) in the 12 project-affected states		X			x	X
Local Community(ies) and Neighbouring Land Users	Project affected Community				X	x	X
Non-Government and Community Based Organisations (NGOs and CBOs)	Clement-Gloria Foundation, Enugu		X			x	X

Source: PGM Fieldwork 2020

5.5 Public Disclosure

As part of the formal regulatory and consultation process, when the draft ESIA report is submitted to FMEnv. FMEnv makes a public notice of the opportunity for information and comment on the draft ESIA report for the project. This notification is typically done through a newspaper and radio announcement.

The notification will provide:

- a brief description of the project;
- a list of venues where the ESIA report is on display and available for viewing;
- duration of the display period; and
- contact information for comments.

The FMEnv generally requires a twenty-one (21) working day display period. Display venues will be decided by FMEnv but could be expected to include:

- FMEnv offices in Abuja;
- FMEnv Lagos office
- Rivers, Abia, Ebonyi, Enugu, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment; and
- Project Affected Local Government headquarters

Once the draft ESIA report has been submitted to the FMEnv, it will likely be subjected to a review by a panel of experts constituted by FMEnv. The panel would likely comprise experts from within FMEnv as well as external specialists included for their expertise on the specific environmental or social topic. Following the review period, the findings will be presented to the panel, likely to be in the form of a public hearing. The project will then need to take appropriate actions to address these findings and comments received from the panel members on the ESIA report. This may include additional studies; revision to the ESIA report text to correct or clarify content; or development of additional mitigation measures or management actions.

Upon satisfactory completion of the actions required to address the findings, the draft ESIA report will be finalized and the FMEnv will issue the EIA certification/authorization.

Plate 5.2: Consultation with community leaders (L-R) Nguru community in Yobe state and Oturkpo community in Benue

5.6 Outcomes of communities' Consultation

The concerns expressed by the host communities are listed below, evidence of consultation with host communities and other stakeholders is also presented in appendix 1 in form of attendance. Some of the photographs taken during socio-economic and community consultation are presented in this section too. At the project consultation/field data gathering meetings with various community stakeholders, community leaders, and members and FGDs several questions, issues and concerns were raised and certain expectations were also discussed by community members across the project impact communities.

Communities' Concerns

- **Environmental damage:** Most communities fear that the construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.
- **Social problems:** Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.
- **Health problems:** Increase in the occurrence of STDs and HIV/AIDs.
- **Payment of compensation:** Involuntary displacement and loss of property

Community Expectations

Expectations of the communities consist mainly of human capital development and the development of infrastructural facilities. They include the following:

- All compensation due to families and communities for loss of property should be adequately paid before the commencement of the project.
- Creation of employment opportunities for residents of the communities during and after the construction activities of the Railway line.
- Empowerment of community members through skills acquisition, an award of contracts, and provision of scholarships.

- Infrastructural development in communities in terms of provision of potable water, electricity, functional orthodox health care facilities, renovation, and equipping schools destroyed by the insurgency in the area, and desertification control projects.

Plate 5.3: (L-R) Consultation with community stakeholders in Makurdi with Vice Chairman of the LG and community leaders in Isiagu, Ebonyi State

5.7 Institutional consultation

Major stakeholders were also consulted for this project on the 10th, 12th, 13th, 16th, and 19th November 2020 in Enugu, Umuahia, Port Harcourt, Damaturu, and Jos respectively

Table 5.4: Specific Expectations from Stakeholders elicited during consultations

ORGANISATION/ GROUPS	ROLE IN PROJECT	INFORMATION EXPECTED AT THIS MEETING
FMEnv, NESREA, NERC, States Ministries of Environment	Regulators defined in the EIA Act	✓ Adequacy of measures ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations
Rivers, Abia, Ebonyi, Enugu, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe and Borno States Min of Lands, Office of Surveyor-General, Physical & Regional Planning	✓ Acquisition of Land ✓ PAP Entitlements ✓ Approval of Building Plans	✓ The land acquisition process for a public project ✓ Compensation rates for crops & economic trees in the various States ✓ Issues of concern concerning highlighted roles ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations
Nigeria Police, DSS, Army, and NSCDC	Security and intelligence	✓ The process to ensure the security of personnel, equipment and materials are secured during project Implementation
Federal Road Safety Corps Federal State Fire Service	• Ensure traffic flow during mobilization and construction • Ensure adequacy of fire preventing and fighting resources	✓ Required permits ✓ Transport management requirements etc ✓ Fire management requirements
Project affected Communities	Host Communities (Land, security, etc)	✓ Concerns, fears, and expectations

ORGANISATION/ GROUPS	ROLE IN PROJECT	INFORMATION EXPECTED AT THIS MEETING
Project affected States' Environmental Protection Agency Project affected States' Waste Management Agencies	Infrastructure, amenities, and services upgrade and expansion	✓ Adequacy of measures ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations
Project affected States' Ministries of Works and Infrastructure	To determine the capacity of existing road networks	✓ The design capacity of the road and bridges for equipment mobilization during construction
NGOs, CBOs	Observance and ESIA process witnessing	✓ Adequacy of measures ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations

Source: PGM Fieldwork 2020

Table 5.5: Initial Consultations' Findings

Stakeholder Group	Issues	Solutions
Government authorities	Employment and local benefits	• The Project should provide employment opportunities for local communities. • Need for community agreements (eg Memoranda of Understanding (MOUs)) which should include local government agencies particularly the Commission of Community Development. • The project should result in improved infrastructural provision for local communities, particularly in terms of an access road • Encourage the communities to work together for long term benefit for all community members.
	Waste	• Develop comprehensive plans for water use and wastewater discharge during rehabilitation and waste management during operations.
	Scope of the ESIA	• The ESIA should address potential health risks and disease migration and mobility during operation on the project host communities. • The ESIA should take cognizant of the flora and fauna currently on the ROW.
	Integration with existing spatial planning	• The Project should confirm with the project affected LGAs and State government in Yobe state where there is a proposed new route that the land is not designated for other uses within the development plan for the area.
Local communities	Employment and local benefits	• Opportunities in terms of employment and procurement, particularly for local communities during rehabilitation and operations.

Stakeholder Group	Issues	Solutions
NGOs and CBOs	Impacts on birds	• The ESIA would need to assess the potential impacts of the project on birds.
	Community H&S	• The Project will need to plan for the community health risks related to the Railway line and potential accidents.
	Livelihoods and resettlement	• The project needs to thoroughly understand the livelihoods within the area of influence to understand the impacts of the project on local communities • An adequate compensation package needs to be developed for property owners before the rehabilitation and construction of the railway line.

Source: PGM Fieldwork 2020

5.8 Grievance Redress Mechanisms

Grievances are any complaints or suggestions about the way a project is being implemented. They may take the form of specific complaints about damages/injury, concerns about routine project activities, or perceived incidents or impacts of the proposed project. Identifying and responding to grievances supports the development of positive relationships between projects and the communities, and other stakeholders, they may affect. Grievance mechanisms, therefore, provide a formal and ongoing avenue for stakeholders to engage with the proponent, whilst the monitoring of grievances provides signals of any escalating conflicts or disputes.

During the implementation of the project activities, disputes/disagreements between the project developer and the PAPs may occur especially in terms of compensation, boundaries, etc.

There are great challenges associated with grievance redress especially in a project of this magnitude. The practice of grievance arbitration over resettlement issues in Nigeria is conducted within the framework of the Land Use Act (LUA) of 1978, reviewed under Cap 202, 1990. Two stages have been identified in the grievance procedure: customary mediation and judiciary hearings.

A grievance procedure based on community grievance committees, one per community, will be established for the resolution of the disputes and complaints.

Plate 5.4: Community stakeholders' meeting (L-R) Aba, and Ozoakoli all in Abia State

5.8.1 Customary Mediation

Procedures for grievances have been clearly explained during community meetings. At the village levels, a series of customary avenues exist to deal with dispute resolutions. Those avenues should be employed, when and where it is relevant as a "court of the first appeal". Such customary avenues will provide a first culturally and amicable grievance procedure that will facilitate formal and/or informal grievance resolution for grievances such as:

- Wrongly recorded personal or community details;

- Wrongly recorded assets including land details and/or affected acreage;
- Change of recipient due to recent death or disability;
- A recent change of asset ownership;
- Wrong computation of compensation;
- Name missed out of register, etc.

A Customary Grievance Redress Committee shall be set up by the project proponent in each project affected local government to address complaints from project implementation. This committee will be assisted by the project proponent.

Project affected persons (PAPs') complaints should first be lodged verbally or in writing through this process. It is expected that the committee will deal with the grievances they receive within three days of receipt of the complaint. If the complaint cannot be resolved at this level, or if the plaintiff is not satisfied with the settlement proposed, the plaintiff will then be referred to the official legal procedures.

5.8.2 Courts of Law

The judicial process under applicable laws will be followed and the law courts will pass binding judgment on the matter.

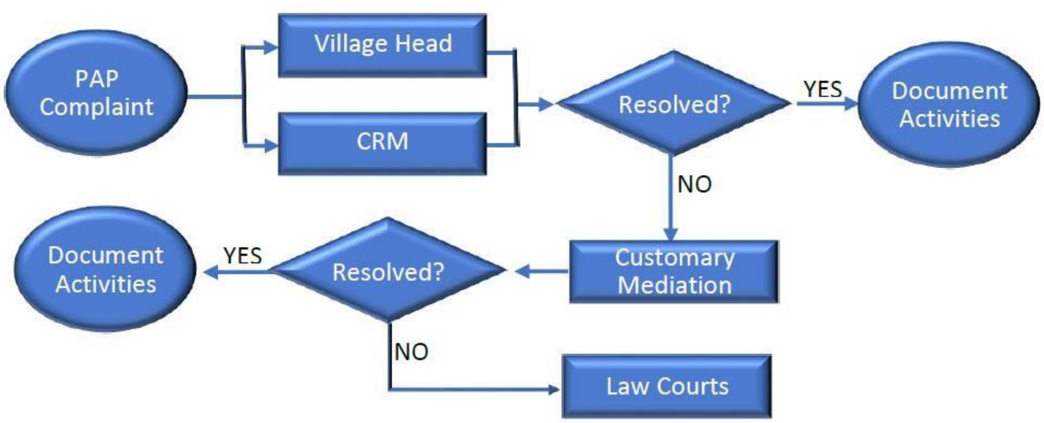


Figure 5.2 Grievance Resolution Procedure

5.9 Future Consultations

The proponent shall continue to consult with the regulatory agencies, the host communities, all stakeholders, and other relevant parties concerned with or are likely to be affected by the project at all stages of project development. On the approval of this ESIA to commence the construction activities, a detailed Memorandum of Understanding (MoU) shall be signed with the affected communities.

5.10 Conclusions

The community and stakeholder engagement undertaken by the project fulfils the requirements of the Terms of Reference and is undertaken according to the strategy prepared by the Project. A variety of communication activities and tools were used to seek broad and informed communities and stakeholders' responses, and the issues and opportunities identified through stakeholders' engagement informed the development of the ESIA. Specific communication activities undertaken to facilitate effective two-way communications included the Community Information Session, briefings of key stakeholders including government agencies and NGOs, and community-based groups. Throughout the project design and data gathering process, multiple avenues were provided for stakeholders to access information and provide comments and/or ask questions and receive answers. The engagement program engaged the community by:

- attracting approximately major community members to the Community Information Session
- providing briefings to government agencies and Community-Based Organisations (CBOs) and NGOs.
- generating feedback from community leaders and institutional stakeholders.

CHAPTER 6

IMPACTS AND MITIGATION MEASURES

6.1 Introduction

This Chapter will summarize the predicted positive and negative impacts of the project. Cumulative impacts of the project will be assessed as appropriate. Also, this Chapter outlines general and specific mitigation measures to reduce, remove or avoid negative impacts to environmental and social receptors. Any residual impacts (post mitigation) will be outlined.

6.2 Impact Assessment

6.2.1 Impact Prediction

The impact assessment process predicts and describes, qualitatively and quantitatively, impacts that are expected to occur for different phases of the proposed project.

The significance of each impact is evaluated by defining and evaluating two key aspects:

• The **magnitude** of the impact; and

• The **sensitivity** of the feature or receptor that will be impacted.

6.2.2 Impact Magnitude

Magnitude describes the degree of the change that is predicted to occur in the receptor/resource as a result of the impact. A magnitude rating reflects a combination of the size of an area that may be affected, the size, degree or scale of the impact, and the duration of the impact.

Magnitude of positive socio-economic impacts is usually categorized as **Positive** except there is enough information available to support a more robust qualification and quantification of magnitude as Small, Medium or Large.

For instance, if the number and volume of contracts to be reserved for the local community members is confirmed or if the size or value of those contracts will contribute to the national, State or Local economy is known then a magnitude rating of Small, Medium or Large can be assigned. Otherwise, the significance rating will be based on the sensitivity of the feature impacted by a specific activity or change.

Magnitude encompasses all the characteristics of the predicted impact as defined and designated in Table 6.1.

Table 6.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	The relationship of the impact with the Project (describes the cause and effect).	Direct Indirect Induced
Extent	The "spread" of the impact (e.g., a long distance of several kilometres or confined to a small space within the Project footprint, etc.).	Local Regional International
Duration	The time over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.).	a numerical value: no fixed designations
Frequency	A measure of the periodicity or constancy of the given impact.	a numerical value: no fixed designations

Source: PGM Fieldwork, 2020

The evaluation of pre-mitigation impact significance considers control measures that have been built-in into the project design. This avoids the situation where an impact is assigned a magnitude based on a theoretical account of the project that considers none of the built-in controls that are defined as part of the project description.

These built-in controls could include sound lessening measures around noisy equipment or servitude and buffer requirements the development is obliged to implement and is part of the layout. Additional mitigation measures to further reduce the significance of 'residual' impacts are appropriately proposed where necessary.

In the case of **type**, the designations are defined generally (i.e., the same definitions apply to all receptors/resources and associated impacts) as provided in Table 6.2.

Table 6.2 Definitions of Designation

Designation	Definition
Type	
Direct	Impacts that result from a direct connection between the Project and a Receptor / resource (e.g., between land-take and the affected habitats).
Indirect	Impacts that trail the direct connections between the Project and its environment as a result of subsequent contacts within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a portion of land).
Induced	Impacts that result from other activities that occur as a result of the Project (e.g., influx of camp followers resulting from the mobilization of a large Project workforce).
Extent	
Local	Impacts that affect an area close to the development area within the area of influence of a receptor/resource.
Regional	Impacts occurring at a regional (interstate) scale as determined by political boundaries or which affect regionally important resources or ecosystems.
International	Impacts that transcend national boundaries or affect resources or areas protected by international treaties or conventions.
Duration	
Temporary	Impacts are predicted to be of short duration (in the order of days) and/or intermittent /occasional (e.g., traffic congestion during equipment haulage to site).
Short term	Impacts that are predicted to last only for the duration of the construction period (e.g., traffic diversions)- for about 8 years.
Medium term	Impacts that will continue for a period of 5 to 10 years following the commissioning of the project (e.g., where the impact may reverse or affected resources or receptors recover within this period of time).
Long term	Impacts that will continue for the life of the Project, but will cease when the Project either stops operating or is decommissioned, or where the impact may reverse or the affected resource / receptor recovers after 10 or within 20 years following the commissioning of the project.
Permanent	Impacts that cause a permanent change in the affected receptor / resource that lasts beyond 20 years following the commissioning of the project.

For **scale** and **frequency**, the features are not allotted standing descriptions, as they are typically numerical measurements (e.g., number of hectares affected, number of times per hour, day, week or month, etc.).

The terminology and descriptions are given for uniformity when these features are described in an impact assessment deliverable. However, it is not a requirement that each of these features be discussed for each identified impact.

To derive the magnitude rating of unintended events (e.g., accidental release of hazardous materials), the **likelihood** of the occurrence of an impact is considered and it is expressed as a probability and is designated using a qualitative scale (or semi-quantitative, where appropriate data are available), following the qualities described in Table 6.3.

Table 6.3 Likelihood Designations for unplanned events

Likelihood	Definition
Likely	The event will inevitably occur during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.

Likelihood is projected on the basis of experience and/or evidence that such an outcome has previously occurred under similar condition or situation.

Likelihood is a measure of the degree to which the unplanned event is expected to occur, not the degree to which an impact or effect is expected to occur as a result of the unplanned event, and therefore is qualitative and not quantitative.

For impacts from unplanned events, the same receptor/resource-specific approach to arriving at magnitude description is adopted, but the 'likelihood' factor is considered, alongside the other impact features, when assigning a magnitude description.

It is quite tasking to discuss impacts resulting from Project activities and those resulting from unplanned events. This methodology, based on professional judgment, and assisted by quantitative data, incorporates likelihood into the magnitude description (i.e., in parallel with consideration of the other impact characteristics), so that the likelihood-factored magnitude can then be considered with the receptor/resource sensitivity/susceptibility /importance in order to assign impact significance.

Once the impact characteristics are understood, they are used to allot each impact a magnitude. Magnitude is a function of the following impact features:

- Extent;
- Duration;
- Scale;

- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the receptor/resource. As in the case of extent and duration, the magnitude descriptions themselves (i.e., negligible, small, medium, large) are universally used and across receptors/resources, but the definitions for these descriptions will vary on a receptor/resource basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts considers all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the range (in the case of adverse impacts) from negligible to large. Some impacts cause inestimable or imperceptible alterations to the environment or remain within the range of normal natural variations. Such changes can be regarded as having no impact, and are be characterized as having a negligible magnitude.

6.2.3 Sensitivity

The other principal step necessary to allot significance for a given impact is to define the importance/ susceptibility/sensitivity of the impacted receptor/resource to the type of proposed activity (e.g., habitat clearance, topsoil removal, etc.) or the consequences of a Project activity (e.g., dust, noise, water pollution, or induced population influx). This requires a range of biophysical, social factors to be considered and may also include other factors such as legal protection, government policy, public perception and economic value.

Classification of sensitivity for a biophysical resource or receptor (e.g., air quality or parameter) considers importance (on a local, national and international scale), its susceptibility to disturbance, and its resilience to recover or withstand a specific impact or type of impact. Where the receptor is social or cultural, the value of that social and cultural heritage receptor/s and its susceptibility to the impact is considered, taking into account the receptor's resilience, including ability to adapt to alteration or employ alternatives where available.

As in the case of magnitude, the sensitivity/susceptibility/importance designations themselves are universally consistent, but the definitions for these designations will vary on a receptor/resource basis. The universal sensitivity/susceptibility/importance designations are:

• Low;

• Medium; and

• High.

6.2.4 Assessing Significance

When the magnitude of impact and sensitivity/susceptibility/importance of receptor/resource has been characterized, the significance of the impact is assigned using the impact significance matrix shown

This methodology applies to impacts from unplanned events (e.g., a major oil spill or other event that cannot be reasonably predicted), but likelihood is also considered when assigning the magnitude designation, as classified in Table 6.4.

Table 6.4 Impact Significances

Assessment of Significance		**Sensitivity/Susceptibility/Importance of Receptor/resource**		
		Low	Medium	High
Magnitude of Impact	Negative Impacts			
	Negligible	Negligible	Negligible	Minor
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Critical
	Positive Impacts			
	Positive	Minor	Moderate	High

The matrix applies to all receptors/resources, and all impacts to these receptors/resources, as the receptor/resource or impact-specific considerations are factored into the description of magnitude and sensitivity descriptions that enter into the matrix. Box 6.1 provides a context for what the various impact significance ratings signify.

6.2.4.1 Residual Impacts Assessment

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

6.2.4.2 Cumulative Impacts/Effects

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process will predict cumulative impacts/effects to which the Project may contribute. The approach for assessing cumulative impacts and effects resulting from the Project and another activity affecting the same resource/receptor is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

Box 6.1 Context of Impact Significances

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude shall be well within applicable standards.

An impact of **Moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **Major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

An impact of **Critical** significance after all feasible mitigation measures have been identified and assessed warrants the highest level of attention and concern. As with residual impacts of major significance, the regulators and stakeholders will need to closely evaluate whether the positive impacts of the project outweigh residual negative impacts of critical significance. In many cases residual critical impacts can be considered as a potential fatal flaw of the project.

6.3 Results of impacts Assessment and Profferred Mitigation Measures for the proposed project

The identified and associated potential impacts of the proposed project have been evaluated. Table 6.5, presents the proffered mitigation measures for the significant and adverse impacts with the anticipated residual impact taking into account the effective implementation of the mitigation measures quantified.

Table 6.5: Mitigation measures for significant impacts of the proposed project

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
Pre-Construction Phase						
Land Acquisition	Socio-economic	Restriction on land available for farming and other land use activities	Indirect, adverse, normal, long term and reversible	High (new branch lines)	FMoT/EPCC shall: Limit land acquisition to the minimum required for operational effectiveness and safety.	Low
Site Preparation Vegetation clearing	Flora & Fauna	Vegetation clearing exposes forest areas to increased human activities Loss of habitat for fauna leading to migration or death of species Loss of native species Loss of nesting grounds or homes for avifauna	Direct, abnormal, adverse, long term and residual	Medium	FMoT/EPCC shall: restrict access to work areas thereby discouraging increased human activities in the area. Create a gene bank to preserve genes of endangered and important native species	Negligible
	Socio-economic	Increased earnings to local labourers from vegetation clearing and site preparation	Impact is beneficial		To enhance this beneficial impact FMoT/EPCC shall: ensure that all contractors engage unskilled labour from the local area only. encourage contractors to maintain a list of short-term employees for future call-ups when required	
	Socio-economic	Economic loss arising from clearing of farm lands and plantations	Direct, abnormal, adverse, short	High	FMoT/EPCC shall:	Low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
			term, reversible and Residual		duly inform owner of such economic crops to harvest or remove them before commencing vegetation clearing. ensure vegetation clearing is limited to minimum area required for work. ensure adequate compensation is paid to owners of such economic crops	
	Geology & Soil	Erosion problems resulting from deforestation	Direct, abnormal, adverse, long term reversible and Residual	High	FMoT/EPCC shall: construct drainages to control runoffs. ensure vegetation clearing is limited to minimum area required for work	Low
	Air Quality & Noise	Increased noise levels and gaseous emissions from machines used in site clearing and excavations	Direct, reversible, short term	Medium	FMoT/EPCC shall ensure Use of machines in optimal working conditions to reduce noise and gaseous emissions Scheduling working times during the day to reduce noise levels at night	Negligible
Mobilisation of personnel,	Health and Safety	Increased traffic on local roads with risk of accidents during	Direct, abnormal, short term and reversible	Low	FMoT/EPCC shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
equipment and materials to project site and recruitment of workers		mobilisation of heavy equipment which may lead to injury/asset damage.			use competent drivers throughout the project. develop and maintain an effective journey management plan. ensure vehicles are periodically maintained and records kept. ensure pre-mobilization checks are carried out on vehicles before departure. Use out riders to warn other road/water way users. give prior notice to the communities on transport ways diversion and warning signs will be conspicuous.	
	Health	Increased rate of STDs and other communicable diseases in the locality.	Abnormal, indirect, Adverse, Long term	High	FMoT/EPCC shall: ensure all personnel are medically fit before mobilization to base camp. also subject all workers to periodic medical test. Periodically organize base health and safety awareness training for all its workers	Low
	Socio-economic	Socio-cultural conflicts due to difference in customs of migrant	Indirect, abnormal, short term and reversible	Medium	FMoT/EPCC shall: sensitize the general public on the importance of the project so as to	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
		workers and residents of surrounding localities			establish a co-operative and open working relation especially with residents within the immediate project area. educate workers on the culture and norms of the host communities. encourage mutual existence between the workers and the communities by appointing community liaison officers (CLO)	
	Socio-economic	Conflicts / community agitations over employment issues	Abnormal, indirect, Adverse	Medium	FMoT/EPCC shall: adopt procurement practices that favour skilled and semiskilled indigenes of the area. Liaise with the community leader to ensure all focus groups are represented in the employed workforce, encouraging them to grow through additional trainings/qualifications	Low
	Noise	Increased noise levels, from machinery movement	Direct, short term, reversible	Medium	FMoT/EPCC shall: maintain all equipment at optimal working condition. adopt the use of low noise generating equipment in all its operations.	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					enforce the use of ear muffles, where noise level exceeds the recommended FMEnv limit	
1st Phase Decommissioning						
Dismantling of coaches, wagons, metals/cables	Aesthetics	Metallic and Solid wastes,	Direct, short term and reversible	Low	FMoT/EPCC shall: Clear all metallic / concrete rubble or debris. Sell reusable parts to locals at greatly reduced prices	Low
	Air quality/Noise	Local residents could be subject to noise and air impacts during dismantling.	Direct, normal, shorter and reversible	Low	FMoT/EPCC Shall; Ensure decommissioning in the daytime to limit night time noise impact to locals Ensure all machines are well serviced and in optimal working conditions	Low
	Land take	Unrest during dismantling of encroached structures	Direct , Shorter	Low	FMoT/EPCC Shall; -Limit land acquisition to the minimum required for operational effectiveness and safety. - pay adequate compensation to land owners. - create awareness for the project through consultations with host communities and public media, in	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					order to avoid communal disturbances	
Construction Phase						
Construction of access roads and work plateaus to projected locations and Quarry	Climate Geology & Soils	Change in climatic conditions leading to deflect of natural geological pattern of the area inducing flooding and compaction of soil due to use of heavy equipment	Direct, abnormal, adverse, short term and reversible	High	FMoT/EPCC shall: construct drainages to control runoffs. ensure compaction of soil is minimal as existing roads will be used	Low
	Air quality	Increased release of SOx, NOx, CxHx, COx (greenhouse gases) and SPM into the atmosphere from vehicular exhaust and heavy equipment	Direct, normal, adverse, long term and reversible	High	FMoT/EPCC shall: maintain all vehicles and internal combustion engines at optimal working conditions. ensure equipment/vehicles are periodically maintained and records kept. Carry out pre mobilization checks to ensure all vehicles/equipment designated for the job are at optimal working conditions. ensure an inventory of emissions is developed and maintained	Low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
	Noise	Noise nuisance to human and wildlife by heavy machines	Direct, normal, adverse, short term and reversible	Medium	FMoT/EPCC shall: maintain all equipment at optimal working condition. adopt the use of low noise generating equipment in all its operations. enforce the use of ear muffles, where noise level exceeds the recommended FMEnv limit. Use of noise barriers or noise canceling acoustic devices should be considered as necessary. shall avoid dropping materials from height, where this is possible. shall avoid metal-to-metal contact on equipment, where possible. shall provide intermissions in the event of inevitable maximum noise level events. These respite periods shall be negotiated with the relevant local stakeholders. shall when possible, reduce the throttle settings on plant and machinery; and turn off equipment and plant when they are idle. shall develop and implement a grievance procedure in the event of any noise complaints being received.	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					At Quarries and Burrow pits, FMoT/EPCC shall: Appropriate consideration must be given in the blasting design. Consider social issues in designing the transport routes for construction vehicles carrying materials and spoil to and from quarries and borrow pits. Transport routes shall (as far as possible) avoid residential areas. This not only for noise impacts, but to reduce other impacts such as dust exposure and health and safety risks associated with heavy vehicle movement. Method statements for each quarry and borrow pit site shall be developed. These method statements shall include plans to retain rock structures as noise barriers between the quarrying area and any potentially affected noise receptor. Night-time operation shall be minimized where receptors are located close by.	

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					All employees are to be provided with, and are to wear, appropriate hearing protection in recognized noise zones. At quarry or borrow pit sites, supervision of the subcontractors who run these sites shall be performed to ensure that legislative requirements are complied with.	
	Health and safety	Personnel injury/death from work place incidents/accidents	Direct, abnormal, adverse, long term and irreversible	High	FMoT/EPCC shall: Manage all associated constructional risks through the use of competent professionals/engineers or isolating the source of risk or use of acceptable administrative measures in the workplace. ensure all personnel wear appropriate personnel protective equipment (PPE). ensure only competent and well trained personnel are used for the job.	Low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					ensure safety awareness meetings are held prior to work each day. provide first aid facilities/administrators on work site. ensure all incidents are reported and documented and corrective actions taken. employ the use of personnel and environmental friendly construction techniques in its operations	
	Socio- economic	Engagement of indigenous labour and suppliers in different areas of construction activities with attendant economic empowerment	Direct, normal, beneficial, short term and irreversible	High	To enhance this beneficial impact FMoT/EPCC shall: ensure that local merchants are involved in supply of goods and services. ensure that all contractors engage unskilled labour from the local area only. encourage contractors to maintain a list of short-term employees for future call-ups when required. ensure that contractors do not unduly exploit the local workers through salary cuts and payment delay	Low
	Health and	Personnel injury/death	Direct, abnormal,	High	FMoT/EPCC shall:	Low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
Excavation of foundations, construction of access tracks and Quarry sites	Safety	from work place incidents/accidents	adverse, long term and irreversible		Manage all associated constructional risks through the use of competent professionals/engineers or isolating the source of risk or use of acceptable administrative measures in the workplace. ensure all personnel wear appropriate personnel protective equipment (PPE). ensure only competent and well trained personnel are used for the job. ensure safety awareness meetings are held prior to work each day. provide first aid facilities/administrators on work site. ensure all incidents are reported and documented and corrective actions taken. employ the use of personnel and environmental friendly construction techniques in its operations	
		Respiratory tract infections	Direct, abnormal, adverse, short term and reversible	Medium	FMoT/EPCC shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
		(to onsite workers) due to inhalation of SPM			ensure all onsite welders wear appropriate PPE (nose mask, eye goggle etc.). provide first aid facilities on work site and also train personnel on first aid administration. Carryout daily safety briefings before commencement of work each day. ensure the best available welding techniques are used in its operations. ensure all electrical wires are insulated	
	Surface water Resources	Potential direct and indirect pollution of surfacewater	Direct, Normal, short term, irreversible, adverse	Medium	FMoT/EPCC shall: shall consult with the Lower Niger River Basin Development Authority and Benue River Basin Development Authority to confirm the need and applicability for water discharge permits/licenses necessary for the successful construction of the railway. develop Method Statements detailing spill emergency response and clean-up procedures for spills. undertake Training regarding proper methods for transporting, transferring and handling	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					hazardous substances that have the potential to impact surface- and groundwater resources. excavate areas where spillage of soil contaminants, to the depth of contamination and appropriately rehabilitate them. All contaminated material shall be suitably disposed of. shall prohibit the washing of project vehicles in any surface water bodies in and around the railway alignment. All railway project vehicles shall be washed at designated wash bays on site. These wash bays shall include oil/grease and sediment traps for grey water. maintain all construction areas and associated facilities in a good and tidy condition; debris and wastes shall be contained in such a way that they cannot become entrained in surface run off during periods of heavy rain. shall not carry out construction 70m to any water body, except at crossing. shall provide sufficient toilets at active work areas for site staff and	

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					workers and these shall be serviced regularly by a competent and suitably qualified person. ensure that discharged treated sewage quality conforms to FMEnv standard prior to discharge. ensure that hydrocarbon-contaminated water is not released into the environment and oil-contaminated wastewater is managed in accordance with an approved Waste Management Plan. ensure that water velocities in the culverts are similar to those at the site before the culverts were constructed. design and construct the culverts so that their hydraulics are similar to those of the watercourse. Culverts shall have natural beds wherever possible.	
	Fauna	Forced migration of fauna species due to vibrations from heavy machinery	Direct, abnormal, adverse, short term and reversible	Medium	FMoT/EPCC shall: Operate heavy machinery on bunded grounds to reduce felt vibrations As much as possible avoid thriving habitats	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
	Socio-economic	Provision of social amenities Potable water supply	Impact is beneficial	-	FMoT/EPCC shall Ensure provision of amenities in close-by communities Ensure all roads in good condition to improve economic conditions of locals (through exchange of goods and services with other communities)	-
	Air Quality	Increased release of green house gases (GHG) and SPM into the atmosphere from vehicular exhaust and heavy equipment	Direct,normal, adverse, long term and reversible	Low	FMoT/EPCC shall: maintain all equipment at optimal working conditions. ensure all equipment are periodically maintained and records kept. Carry out pre mobilization checks to ensure equipment designated for the job are at optimal working conditions. enforce policies on efficient use of energy i.e., no equipment will be kept running when operation is down. ensure an inventory of emissions is developed and maintained	Negligible
	Health and safety	Respiratory tract infections (to onsite workers) due to	Direct, abnormal, adverse, short term and reversible	Medium	FMoT/EPCC shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
		inhalation of dusts and fumes from machines			Enforce the use of nose masks and other PPE by all personnel on site Ensure Concrete batching plants are located at least 300 m downwind or as far as practicable from the nearest dwellings in order to reduce the impact of fumes on humans and to be fitted with necessary ensure Stockpiles of materials such as sand are managed to reduce dust emissions, ensure before material is moved Stockpile covered with tarpaulins and fenced in to form a high barrier and prevent wind lifting and dispersing. Ensure water will be sprayed on construction sites and approach roads to suppress dust in dry weather	
		Risk of electrocution and burns to onsite workers	Direct, abnormal, adverse, short term and reversible	Medium	Use of signs, barriers, Locks on doors, use of gates.	Negligible
	Socio-economic	Increase in economic activity around construction areas Influx of small scale marketers to provide	Impact is beneficial	-	To enhance this beneficial impact FMoT/EPCC shall: Hold seminars for the petty traders on safe actions while on site	-

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
		food and other essentials to on site workers Improved road infrastructure Employment creation for locals			Provide jobs for both the local/indigenous men and women during construction	
		Capacity building, programmes for workers Health and safety awareness campaigns for locals and on site workers	Beneficial long term	-	FMoT/EPCC shall: Schedule training programmes for workers Involve the community in awareness campaigns	-
	Air quality	Increased levels of SPM Cox. NOx (GHG) from vehicular exhaust and heavy equipment	Direct, normal, adverse, long term and reversible	Medium	FMoT/EPCC shall ensure: Stockpiles of materials such as sand be managed to reduce dust emissions. before material is moved Stockpile be covered with tarpaulins and fenced in to form a high barrier and prevent wind lifting and dispersing. Water be sprayed on construction sites and access roads to suppress dust in dry weather	Negligible
	Groundwater Resources	Groundwater contamination	Direct, abnormal, adverse, long term and reversible	Medium	FMoT/EPCC shall; consult with the Lower Niger River Basin Development Authority and River Benue Basin Development	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					Authority to obtain any groundwater permits/licenses required for the construction camps. Before sources of groundwater for the proposed construction camps can be selected, thorough assessments shall be conducted on water availability and vulnerability along the alignment. These studies shall be undertaken by a suitably qualified specialist and shall ensure that the design of the Construction Camp water supply scheme is such that it minimizes or avoids abstraction rates beyond the safe yield volume and subsequent impacts to sensitive social receptors. Moreover, these studies shall also consider the potential to reuse wastewater from the camps, especially for activities such as dust suppression. develop and implement a grievance procedure in the event of any water reduction and subsequent water availability complaints being received.	

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
Removal of vegetation for construction activities	Flora and fauna	Increased frequency of people and construction workers, particularly in the context of potential risk of disturbance to birds and other vertebrates, which prevents nesting and usual nourishment and rest of the autochthonous fauna, especially birds and mammals	Direct, Normal, Short term, reversible	Medium	FMoT/EPCC shall: Ensure construction workers are discouraged from engaging in the exploitation of natural resources such as hunting and collection of forest products such as wood. Consider establishing herbaceous species and shrubs or some low-growing trees that are considered desirable ground cover and valuable wildlife habitat along the right-of-way in the vegetation management and revegetation plan	Negligible
		Potential fires in the area of construction work, which could have Irreversible consequences in terms of vegetation and biodiversity of flora	Direct, Abnormal, long term, irreversible, Adverse	Medium	FMoT/EPCC shall ensure: Planting and managing of fire-resistant species (e.g. hardwoods) within, and adjacent to, rights-of-way; Establishing a network of fuel breaks of less flammable materials or cleared land to slow progress of fires and allow firefighting access	Negligible
		Increased traffic frequency and vehicle movement which will result in increased levels of noise, which can cause disturbance, especially of	Direct, Normal, long term, irreversible, Adverse	Low	FMoT/EPCC shall: Prepare traffic management plan for safe access during construction. Use Clear signs to guide and advise road users.	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
		birds and mammals in their usual activities for nourishment and rest. Obstruction of bird nesting and some mammals.			Where possible Road control staff should be deployed. In particular children should be warned not play near the access roads when vehicles are passing, especially if it is after dark.	
Transportation of materials and equipment	Groundwater	Potential direct and indirect pollution of aquifer rock masses (hydro-geological collectors), through vertical infiltration (leakage) of fuel, oil, or cement solution from vehicles and construction machinery	Direct, Normal, short term, irreversible, adverse	Medium	FMoT/EPCC shall: bund storage rooms of lubricants and fuel. ensure compaction of soil is minimal as existing roads will be used	Negligible
Operation Phase						
Maintenance and servicing of locomotives**,** fuel storage, handling, and refuelling activities	Health and Safety	Workplace incident/accident leading to injury/death	Direct, abnormal, adverse, long term and irreversible	Medium	FMoT/EPCC shall: ensure all personnel wear appropriate personnel protective equipment (PPE). ensure only competent and well-trained personnel are used for the job. ensure all incidents are reported and documented and corrective actions taken	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
	Ground Water	Groundwater contamination due to large waste water Disposal	Direct, abnormal, adverse, long term and reversible	Medium	FMoT/EPCC shall: employ the best available Waste technology in its operations. put in place a dedicated waste management system to account for the waste (i.e., cuttings, chemicals will be evacuated). ensure an inventory of waste is developed and maintained	Negligible
	Ground Water	Soil and groundwater contamination resulting from spillage	Direct, abnormal, adverse, long term and reversible	Medium	FMoT/EPCC shall: Put in place emergency response personnel and facilities and also make use of existing ones. Enforce the use of safe fuel handling procedures. Ensure workers undergo environmental awareness training in safe fuel handling and spill containment. Enforce the use drip pans especially at transfer points to control spills	Negligible
	Health and Safety	Risk of fire / explosion due to improper fuel handling and storage	Direct, abnormal, adverse, short	Medium	FMoT/EPCC shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
			term, irreversible and residual		enforce the use of safe fuel storage and handling procedures. provide dedicated fire fighting personnel and equipment within the work area. prohibit fire/explosion escalation factors (cigarette lighters, smoking etc.) in work area.	
Operation of the Facility	Socio-economic	Provision of social amenities - Potable water available to host communities of Railway Stations	Impact is beneficial	-	FMoT/EPCC shall: Provide fetching points outside the station premises, to allow the public fetch the water without constituting nuisance to the operations of the stations	-
	Socio-economic	Direct employment to qualified Nigerians and local inhabitants,	Impact is beneficial	-	This beneficial impact shall be enhanced by: Adopting procurement practices that favour skilled and semiskilled indigenes of the area. encouraging them to grow through additional trainings/qualifications. also employing qualified Nigerians in its work force.	-
	Air Quality	Degradation in air quality due to exhaust emissions (NOx, SOx, CxHx, etc.) by heavy equipment	Direct, normal, adverse, short term and reversible	Medium	FMoT/EPCC shall: maintain all equipment at optimal working conditions.	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
		effecting change in climatic conditions			ensure all equipment are periodically maintained and records kept. Carry out pre mobilization checks to ensure equipment designated for the job are at optimal working conditions. enforce policies on efficient use of energy i.e., no equipment will be kept running when operation is down.	
	Socio-economic	Increased revenue to state and nation through payment of fare	Impact is beneficial	-	This beneficial impact shall be enhanced by: Encouraging diversification of national economic base) Prompt payment of all bills and fees to the appropriate government authorities. Ensuring that tax deductions from employees get to the appropriate government agencies	-
	Noise	Noise nuisance to human and wildlife by the trains	Direct, abnormal, adverse, long term and reversible	high	FMoT/EPCC shall: maintain all equipment at optimal working condition.	low

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					adopt the use of low noise generating equipment in all its operations. enforce the use of ear muffles, where noise level exceeds the recommended FMEnv limit. Use of noise barriers or noise canceling acoustic devices should be considered as necessary. shall resort to the use of hydraulic or electric-controlled units, where possible shall be informed of the nature of works to be carried out, the expected noise levels and duration, as well as contact details for an appropriate representative that be contacted in the event of a complaint. All complaints shall be managed as part of the railway projects external feedback and grievance mechanism. shall provide and enforce the use of appropriate hearing protection personal protective equipment (PPE) to all personnel working in noisy zones	
		Vibration Mitigation Measures at Active along the Railway alignment	Direct, normal, adverse, short term and reversible	Low	FMoT/EPCC shall:	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					develop and implement a grievance procedure in the event of any vibration complaints along the railway being received. Identification of buildings located within 50m of significant sources of vibration ahead of construction works. Evaluation of the sensitivity of the identified buildings and building occupants to vibration impacts will be undertaken. This will include photos to show the structural conditions of the buildings and its foundation (i.e., whether buildings are prone to structural damage), type of building material, cracks in building, etc. Monitoring of vibration on to ensure that the vibration levels are within recommended limits	
		noise reduction or prevention measures at the source	Direct, normal, adverse, short term and reversible	low	FMoT/EPCC shall adopt: Use of modern non-metallic disc brakes, which can reduce rolling noise by 8-10 decibels (dB) compared to cast-iron block tread brakes utilized on older vehicles (non-metallic disc brakes also	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					reduce wearing of wheels and rails). Reducing the roughness of running surfaces through regular maintenance of wheels and tracks, and consideration for replacing traditional jointed track with continuously welded rail. Installation of noise controls at the source for improved sound-proofing, and other noise reducing features (e.g., engine enclosures and exhaust muffling for diesel engines, and shielding of wheels with vehicle-mounted shrouds). Depending on the location of noise-sensitive areas, noise and vibrations shall be considered in the design, construction, and operation of railways (e.g. through alignment choice, relocation of nearby buildings, and soundproofing, such as noise barriers, along railways or next to buildings. The IFC EHS Guideline for Railways also highlights that crew members may be exposed to noise from locomotives, rolling stock, and machinery, as well as to	

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					significant repetitive mechanical shocks and/or vibration	
Influx of workers and businesses	Socio-economic	Increased foreign and local investments in the area and in the country, leading to wealth creation, employment generation, infrastructural development and economic empowerment	Impact is beneficial	-	To enhance this beneficial impact FMoT/EPCC shall: employ and train resourceful Nigerians and expatriates in its work force. put in place a dedicated waste management system, in order not to impact negatively on the environment. assume its corporate responsibilities by assisting the host communities in their developmental drive, such as provision of infrastructures and social amenities where possible.	-
		Stimulation of local economy through increased earnings by the locals and other inhabitants	Impact is beneficial	-	This beneficial impact shall be enhanced by: - adopting procurement practices that favour skilled and semiskilled indigenes of the area. - encouraging them to grow through additional trainings/qualifications. - employing other resourceful Nigerians and expatriates who will be based in that locality.	-

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
		Pressure on infrastructures (housing schools health centres etc.) and social amenities (potable water, electricity etc.) in the area	Direct, normal, adverse, short term and reversible	Low	FMoT/EPCC shall: assist the communities in provision of social amenities (potable water, electricity etc.) where possible. put adequate arrangement in place for housing of its workers. employ most unskilled workers from the host communities thereby eliminating the issue of housing them.	
		Risk of socio-cultural conflicts between the workers and villagers	Risk of socio-cultural conflicts between the workers and villagers	Medium	FMoT/EPCC shall: educate the workforce on the culture and norms of the host communities. encourage mutual existence between the workers and the communities by appointing community liaison officers (CLO). sensitize the general public on the importance of the project so as to establish a good working relation especially with residents within the immediate project area.	
		Increase rate of STDs and other communicable diseases in the locality	Direct, abnormal, adverse, long term and reversible	Medium	FMoT/EPCC shall:	

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					ensure all personnel are medically fit before mobilization to base camp. also subject all workers to periodic medical test. Periodically organize base health and safety awareness training for all its workers	
	Socio economic	Provision of employment for locals	Impact is beneficial	-	To further enforce this impact FMoT/EPCC shall: Meet with community leaders to select suitable persons from their community for the jobs Maintain a good relationship with the communities to reduce cases of insecurity	-
Sewage and solid waste generation	Groundwater	Contamination of soil and groundwater from disposal of sewage and solid wastes	Direct, abnormal, adverse, short term and reversible	Medium	FMoT/EPCC shall: Develop and maintain contingency procedures and measures to minimise the consequence of accidental leakages Put in place a comprehensive and dedicated ESMP, to carter for all generated waste.	Negligible

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
					ensure workers undergo environmental awareness training in waste handling and management	
		Change in climatic conditions and soil geology leading to increased risks of tremor, flooding, due to excavation, use of heavy equipment and pressures of heavy vehicles Risk of contamination of soil and groundwater due to solid waste and wastewater generation	Direct, abnormal, adverse, long term, reversible and residual	Medium	FMoT/EPCC shall: Reduction of use of heavy equipment on sites ensure that process wastewater is treated before discharging to nearby water bodies. ensure that treated waste water is reuse to minimize its discharge volume. put in place a dedicated waste management system to account for generated waste. ensure an inventory of waste is developed and maintained	Negligible
Decommissioning/Abandonment						
Dismantling of rails, coaches, wagons, metals/cables	Socio-economic	Availability of land for alternative uses	Impact is beneficial	-	FMoT/EPCC shall consult with relevant stakeholders (FMEnv, Host communities etc.) to decide on the best option for landuse after abandonment. ensure re-vegetation is effected with local species	-

Project Activity	Environmental Aspect	Associated and Potential Impact	Impact Characterization	Overall Impact Rating	Mitigation Measures	Residual Impact Rating
	Flora and fauna	Invasive flora species could colonise former sites on decommissioning following removal of structures, buildings and hardcover.	Direct, abnormal, adverse, short term and reversible	Medium	To mitigate FMoT/EPCC shall: Introduce previous banked native species gene to decommissioned areas Where soil conditions can't support growth of native species appropriate herbicides shall be used to control and inhibit growth	Negligible
	Aesthetics	Solid wastes, e.g. brick/concrete rubble from demolition activities	Direct, short term and reversible	Low	FMoT/EPCC shall: Clear all concrete rubble or debris Sell reusable parts to locals at greatly reduced prices	Low
	Air quality/Noise	Local residents could be subject to noise and air impacts during demolition.	Direct, normal, shorter and reversible	Low	FMoT/EPCC shall; Ensure decommissioning in the daytime to limit night time noise impact to locals Ensure all machines are well serviced and in optimal working conditions	Low

Source: PGM, 2020

6.3.1 Mitigation and enhancement measures for Impacts Related to Labour and Working Conditions and Economy and Employment

FMoT/EPCC shall apply the following mitigation measures, to minimize negative impacts from labour and working conditions:

Employment and Procurement

- FMoT/EPCC shall prioritize the recruitment of workers and procurement of goods and services from within the Districts then to national companies. This will not apply to the provision of highly technical equipment.

- FMoT/EPCC shall develop a fair and transparent employment and procurement policy and processes to avoid any potential for nepotism or favouritism. The policy shall be shared with the local community members and leadership.

- A Local Recruitment Procedure shall be developed by EPC Contractor which outlines the percentage of skilled, semi-skilled and unskilled employment that shall be sourced from the communities and LGAs along the railway alignment. For unskilled workers, this target shall be set as high as possible, i.e., at least 90%. The procedure will also include requirements for recruitment of vulnerable groups (women, indigenous people and disabled workers) to ensure equal opportunities, involvement of local Chiefs in ensuring local employment is achieved, no hiring of workers at the gate etc. The requirements of this procedure will form part of the Conditions of Contract with sub- contractors.

- EPC Contractor will notify identified representatives of the Local Government and Local Administration (i.e., the Location Chiefs) of the specific jobs and the skills required for the railway project, prior to the commencement of construction phase. This will give the local population time to prepare and apply for the available job opportunities on time. This is mainly applicable to unskilled and semi-skilled workers who will be locally sourced.

- Employment and procurement opportunities will be publicly advertised in appropriate newspapers, public libraries, Local Government Council secretariats, and Chiefs' Offices and in all relevant languages in a timely manner, to allow fair competition.

- There will be no requirement for applicants to make payments for applying for, or securing employment on the proposed railway project.

- FMoT/EPCC shall ensure that recruitment procedures are transparent and monitored to ensure that those recruited present their actual experience, geographical location, health status, and age and that requirements for local employment are being met.

- FMoT/EPCC shall develop and implement a program of up-skilling, training and development for workers to assist them in accessing opportunities associated with the railway project and in finding work following completion of their contracts.

- FMoT/EPCC shall provide training on health and safety and quality standards required by the railway project for provision of goods and services to the railway project to ensure that local businesses have the opportunity to benefit.

- FMoT/EPCC shall ensure that contracts are unbundled to allow a number of small businesses to provide goods and services rather than the supply being monopolized by one larger sub-contractor.

Management System

FMoT/EPCC shall develop a Human Resources Policy and Plans. This shall include a Labour and Employment Plan and Worker Grievance Mechanism. These requirements shall also be passed on to any sub-contractors. Key issues with the Human Resource (HR) management will include, but not be limited to the following:

i. Provision of clear and understandable information regarding rights under national labour and employment law, and any applicable collective agreements, including those related to hours of work, wages, overtime, compensation, etc.

ii. Provision of reasonable working conditions and terms of employment.

iii. Provision of adequate accommodation (where relevant).

iv. Provision of employment, compensation/remuneration and working conditions, including working hours, based on equal opportunity and fair treatment, avoiding discrimination on any aspects.

v. Provision of adequate welfare facilities on site.

vi. Implementation of a grievance mechanism for the railway project workers.

vii. Adoption and implementation of a sexual harassment policy.

viii. Adoption of open attitude towards freedom of association.

FMoT/EPCC shall develop a H&S programme which will include risk assessments (such as working at heights, confined space machine guarding), work permit systems and a H&S management system, in line with industry best practice, including worker performance safety tracking (safety observations) to assure worker safety. All workers will receive induction and continuous training regarding this system.

FMoT/EPCC shall develop a Retrenchment Plan to assist workers in finding alternative work following completion of the construction activities relevant to each Section of the railway alignment.

Sub-Contractor and Supplier Management

i. Subcontractor and Supplier Contracts shall make explicit reference to the need to abide by Nigerian law, international standards (in particular IFC PS 2) and the ratified ILO conventions and the FMoT/NRC's policies relating to health and safety, labour and welfare standards.

ii. As part of the subcontractor and supplier selection process, EPC Contractor shall take into consideration performance with regard to worker management, worker rights, health and safety as outlined in Nigerian law, international standards and the Proponent's policies.

iii. EPC Contractor shall provide support to sub-contractors and suppliers to ensure that labour and working conditions are in line with Nigerian legislation and IFC PS 2 through gap analysis, awareness raising and information provision, as necessary.

iv. Regular checks / audits by EPC Contractor shall be undertaken to ensure the relevant labour laws are adhered to at all times.

Workers' Rights

i. EPC Contractor shall ensure no employee or job applicant is discriminated against on the basis of his or her gender, marital status, nationality, ethnicity, age, religion or sexual orientation.

ii. All workers (including those of subcontractors) shall, as part of their induction, receive training on worker rights in line with Nigerian legislation to ensure that positive benefits around understanding labour rights are enhanced. This process shall be formalized within the Code of Conduct that would be provided by EPC Contractor.

iii. All workers (including those of subcontractors and suppliers) shall have contracts, which clearly state the terms and conditions of their employment and their legal rights. These contracts shall be aligned with Nigerian labour law, the ILO core conventions and the requirements of IFC PS2. Contracts shall be verbally explained to all workers where this is necessary to ensure that workers understand their rights. Contracts shall be in place prior to workers leaving their home location if applicable.

iv. FMoT/EPCC shall put in place a worker grievance mechanism that shall be accessible to all workers, whether permanent or temporary, directly or indirectly employed. The worker grievance mechanism shall be open to EPC Contractor and the subcontractor workforce in the event that their grievance is not adequately resolved by their direct employer. EPC Contractor would then have the authority to act to resolve this grievance.

v. All workers (including those of EPC Contractor and the subcontractor) shall have access to training on communicable diseases and STIs and community interactions in general.

vi. Accommodation shall be provided to workers in accordance with international good practice on workers' accommodation, including IFC standards to prevent transmission of diseases associated with poor living conditions.

vii. EPC Contractor shall undertake surveillance and assurance that no children or forced labour is employed directly, and to the extent possible by third parties related to the railway project and primary suppliers where such risk may exist.

FMoT/EPCC shall develop and implement a program of up-skilling, training and development for workers to assist them in accessing opportunities associated with the railway project and in finding work following completion of their contracts.

6.3.2 Mitigation / Management Measures for physical and economic displacement

In order to mitigate impacts to physical and economic displacement for the new rail branches, a Resettlement Action Plan (RAP) is required. This shall include the following components:

- Assessment of alternatives to minimize or avoid displacement;
- Identification of affected households and land users that will be affected by physical and / or economic displacement. This shall include a comprehensive mapping process to identify affected areas;
- Vulnerability assessment to identify vulnerable households and individuals that may require assistance;
- Census and asset inventory to assess compensation measures for those affected and to act as a basis to monitor the success of the RAP;
- Assessment of eligibility and entitlements for those affected;
- Identification of host sites for housing and farmland;
- Participatory physical planning for housing, including design of structures, access to water points, sanitation etc.;
- Identification of gender differentiated and sustainable livelihood improvement and / or restoration measures (these may include but are not limited to financial literacy training, training on improved farming practices etc.);
- Provisional implementation budgets and provisional schedule;
- Roles and responsibilities, including details of an institutional structure / RAP Steering Committee; and
- Reporting and monitoring and evaluation requirements.

6.3.3 Mitigation measures for Green House Gasses (GHG) Risks

Mitigation proffered to reduce the most significant sources of GHG emissions includes utilizing the wood for commercial timber and fuelwood rather than clearance by fire during the construction period.

Although there is a high initial GHG impact primarily associated with the clearance of vegetation during construction, the emissions over the railway project lifetime will depend on the fuel mix used in locomotion.

The emissions associated with the diesel trains represent the overwhelming majority of transport emissions (about 98%). Reducing GHG emissions from transport shall primarily focus on minimizing diesel fuel use and incorporating catenary infrastructure in the project, to use electric locomotives.

Further emissions reduction would rely on a shift from the high carbon intensity electricity generation methods (439.7gCO_2/kWh) to renewable energy sources to power the system. These options will allow the project to have a much lower contribution to climate change over its lifetime compared to the current scenario.

Mitigation Measures

Construction

Mitigation of GHG emissions during construction can be achieved through a series of measures that can be included within the Environmental Management Plan. These mitigation measures are split between the impacts, as follows and identified in Table 6.2 and offers a qualitative rather than quantitative approach to mitigation due to a lack of data.

i. Emissions associated with land use changes

- Current use of the land (quantity of carbon stored pre construction)

ii. Emissions associated with excavation transport

- Quantity of the subsurface material excavated
- Density of excavated subsurface material

iii. Emissions associated with transport of raw materials

- Type and quantity of raw material
- Distance the raw material is transported
- Type and efficiency of transportation vehicle
- Optimum working conditions for transportation vehicles

iv. Emissions associated with construction activity

- Type and efficiency of construction vehicles
- Optimum working conditions for construction vehicles
- Source of on-site power generation

Table 6.2 Construction Mitigation Measures

Impact	Mitigation Measures
Emissions associated with land use change	FMOT/EPCC shall: - Reduce GHG releases through a thorough salvage of commercial timber and fuelwood. However, it is doubtful that the reduction of GHG emissions from this would significantly change the conclusions of this impact assessment. - Ensure the productive utilization of biomass material (wood) subsequent to land clearance.
Emissions associated with transport of raw materials	FMOT/EPCC shall: - Favour the use of raw materials that are easier to transport (lighter less volume) plus consideration for on-site assembly of parts. - Reduce and / or optimize the quantities of construction material transported (dependant of the final project design and its implementation). - Ensure the management of transport logistics to ensure efficient haulage of raw materials. - Ensure the management of voids and compaction of loads to ensure maximum safe payloads are transported. - Reduce vehicle idling times through focus on scheduling of construction operations. - Source materials from suppliers closest to the construction site - Prioritize the use of fuel-efficient transportation vehicles and ensure regular maintenance of vehicles - Provide efficient driving guidelines to transportation vehicle drivers, to promote fuel efficiency.
Emissions associated with construction activity	FMOT/EPCC shall: - Prioritize the use of fuel-efficient construction vehicles and ensure regular maintenance of vehicles - Provide efficient working guidelines to construction vehicle drivers, to promote fuel efficiency. Reducing vehicle idling times through focus on scheduling of construction operations. - Ensure that on-site power generation is designed, sized and operated for emissions performance as well as reliability. - Where possible, minimize the area of land clearance associated with riparian or hillslope forest

Operation

GHG emissions associated with the operation the railway is primarily associated with use of trains. A small number of measures for supporting efficiency of these are set out in *Table 6.3*:

Table 6.3 Operational Mitigation Measures

Impact	Mitigation Measure Operation
Emissions associated with operations of trains	FMOT/EPCC shall: - Prioritize the use of fuel-efficient trains - Minimize idling time for diesel trains - Have a long-term plan for the development of catenary infrastructure for the use of electric trains.

Decommissioning

GHG emissions, noise and waste generation associated with the demolishing the railway are primary associated impacts of decommissioning of railway projects. A small number of measures for supporting efficiency of these are set out in *Table 6.4*:

Table 6.4 Decommissioning Mitigation Measures

Impact	Mitigation Measures
Emissions associated with transport of dismantled, demolished and salvaged materials	FMOT/EPCC shall: - Ensure the management of transport logistics to ensure efficient haulage of demolition materials. - Ensure the management of voids and compaction of loads to ensure maximum safe payloads are transported. - Reduce vehicle idling times through focus on scheduling of demolition operations. - Prioritize the use of fuel-efficient transportation vehicles and ensure regular maintenance of vehicles - Provide efficient driving guidelines to transportation vehicle drivers, to promote fuel efficiency.
Disposal of dismantled, demolished and	FMOT/EPCC shall: - Ensure the proper management of dismantled, demolished and salvaged materials, in line with the prevalent policies, laws and guidelines of the time.

Impact	Mitigation Measures
salvaged materials	

CHAPTER 7

ENVIRONMENTAL MANAGEMENT PLAN

7.1 Introduction

An ESMP is an organizational programme used in the management of operations to ensure environmental sustainability. It is the component of an ESIA that provides the procedures and processes that can be incorporated into an organization's activities to measure and check on a continuous mode, the compliance with statutory requirements and the effectiveness of mitigation measures recommended for the identified negative impacts of a project.

This ESIA, having identified the key environmental and socioeconomic aspects, potential impacts and mitigation measures associated with the project, will serve as a basis for the Environmental Management Plan (ESMP).

This ESMP is based on ISO 14001 standards and is divided into the following sections:

- Leadership and Commitment.
- Training, Awareness and Competence.
- Communication.
- Operational Control.
- Environmental and Waste Management Approach.
- Safety and Health.
- Emergency preparedness and response.
- Management of Socio-Economic Impacts.
- Institutional Arrangement for ESMP.
- Monitoring and Measurement.

- Environmental Audit.

7.2 Leadership and Commitment

FMoT is committed to the implementation of the ESMP of the Port Harcourt – Maiduguri railway project. They shall demonstrate visible commitment to HSE management to enhance the credibility of the HSE policies and objectives. This commitment means providing resources to develop, operate and maintain the HSE-MS and to adhere to the policy and achieve objectives.

7.3 Training Awareness and Competence

FMoT shall pay deliberate attention to **Training, awareness and competence of staff**. They shall identify training needs and ensure that all personnel whose work has impact on the environment receive appropriate training on a continual basis knowing that real progress is possible only when everyone is kept informed of the policy and trained to implement required actions.

With regard to the training of all categories of staff on environmental awareness and competence, FMoT/NRC, shall put the following arrangements in place:

i. Training of Heads of Departments who in turn shall train their functional heads and supervisors, who shall in turn train the operators

ii. Budgetary provision for participation of staff in periodic seminars organized by environmental consultants, government agencies and similar bodies.

7.4 Communication

With regard to the dissemination of information relating to the environment between the various levels and functions of the corporation, FMoT will establish and maintain information, in paper and/or electronic form, to describe the core elements of its policy on environment, and make the retrieval of such information available to all concerned staff.

FMoT recognizes effective communication as an HSE management tool aimed at:

- Informing staff, sub-contractor staff and others about the company HSE policy, objectives and target
- Emphasizing the importance to staff of complying with the HSE policy and objectives and other individual roles and responsibility in achieving it.
- Disseminating information about HSE risk and hazard.
- Obtaining feedback as evidence of implementation and as a tool for corrective action and improvement.

Communication shall be carried in appropriate language to achieve understanding. The Project Management Team shall maintain external communication with relevant stakeholders/governmental agencies. Daily toolbox meetings, weekly operational meeting, monthly and quarterly HSE meetings shall be the basic media of communication in addition to any other safe means of communication that may be adopted.

7.5 Operational Control

The Project Manager shall have overall responsibility for environmental matters and shall be assisted by the Project HSE Officer. There shall be an Environmental Committee consisting of personnel from departments/sections whose activities have a bearing on the environment. The committee shall meet periodically to review the environmental performance of the railway project.

7.5.1 Accidents and Contingency Plan

The Project Manager shall be responsible for all emergencies and contingency response. All emergencies shall be addressed to him or, in his absence, to **the HSE Officer.** The Project Manager shall telephone the nearest State Emergency Response Agency, the Fire Service, the Police Command, FMEnv, and the National Environmental Standards and Regulations Enforcement Agency (NESREA) as the case at hand may require.

7.5.2 Monitoring of Operations

a. **The Project Manager** assisted by the HSE Officer shall monitor and measure on a regular basis the key environmental characteristics of the proposed project.

b. He shall keep a record of the status of the projects' compliance with national environmental legislations and regulations.

c. He shall establish and maintain a periodic programme of "checks and corrective action".

d. He shall periodically disseminate information relating to the environment among all relevant departments of the Project implementation.

e. He shall store all data relevant to the environment so that they are easily retrievable.

7.6 Environmental / Waste Management Approach

7.6.1 Air quality, Dust and Noise

i. Construction Plan

Water shall be sprinkled on roads, cleared project right of way and spoils to control dust emissions. Air emission shall be limited by maintaining equipment's and vehicles in line with manufacture's recommendations to meet relevant international standards. Noise emission shall be limited by using noise abatement equipment where appropriate except where it unavoidable. Local resident shall receive prior notification of particularly noisy activities. Vehicles shall be used responsibly; machines shall not be left idling for long period if they are not in use.

7.6.2 Surface Water and Wastewater Quality

i. Construction Plan

Construction camps shall be provided with sanitary latrines so that surrounding surface water is not polluted. The oily wash water waste generated in camps and workshops shall undergo treatment in oil separator. Waste water from the passenger's station/terminal shall be treated by tricking filters or equivalent. Construction sites shall be located at least 100meters away from water bodies and settlement ponds of sufficient sizes shall be used to treat the sewage from construction camps and from washing of vehicles before it is discharged.

ii. Operation Plan

The industrial waste that will be generated in the workshops shall be treated with oil/water separator before discharged.

7.6.3 Soil and Erosion

i. Construction Plan

The soil construction management measures shall include;

- All available spoil shall be used for structural fill for access roads, stations and embankment before borrow pits are excavated.
- Borrow pits shall be centrally located where possible in order so they can serve more than one site
- Sites for spoil and borrow pits shall be removed and set aside. When the project is completed, the area shall be re-graded, the topsoil replaced, and the area reseeded. Intercepting ditches shall be constructed on the high side of restored pit to prohibit surface scouring by storm run off
- Spoil shall be spread on the lowest yield/least production land available.
- When soil is spread on slopes for permanent disposal, it shall be buttressed at the tree by a retaining wall. The surface of the slopes, if necessary, shall be stabilized by shortcreting, rip rapping, or laid rubble prior to seeding.
- All steep cuts shall be flattered and benched
- Special attention shall be given to ensuring that watercourses are not blocked and temporary soil stock piles shall be designed so run-off shall not induce sedimentation of waterways.

ii. Operation Plan

The following plan is recommended to minimize loss of soil along the track during operation

(i) There shall be optimization of horizontal and vertical sections of the line

(ii) The use of spoil shall be maximized as refilling materials along the route

(iii) There shall be re-vegetation of exposed areas.

7.6.4 Flora and Fauna

i. Construction Plan

No spoil sites, borrow pits and work camps shall be allowed close to water sources.

Workers shall not trap or hurt, log, take crops/ foliage or otherwise damage any area along the route that passes through the forest reserves.

ii. Operation Plan

After the completion of civil works, FMoT shall develop or plant trees on both sides of the railway line but ensuring a proper RoW even when any of the tress fall; trees shall be planted at stations with green area or flower bet established

7.6.5 Hazardous Material Management

i. Construction Plan

Personnel shall be trained in safe use and handling of hazardous materials.

A record shall be kept of all hazardous material on site and Material Safety Data Sheet (MSDS) maintained. Hazardous material shall only be stored within designated storage areas and using appropriate procedures (e.g. bonding, impermeable surface, secure drainage, limited access, labeling).

7.6.6 Solid Waste

i. Construction Plan

Secured waste storage sites shall be established in defined areas away from watercourse and drains. There shall be a prohibition on uncontrolled burning or burial of waste. Retaining walls and revegetation shall be adopted for disposal sites to minimize erosion and safety risks. Small quantities of domestic refuse from construction camps shall be collected and disposed in government approved sites.

ii. Operation Plan

Passengers shall be allowed litter garbage along the rail line; bins shall be provided in the trains to collect garbage.

7.6.7 Traffic Management

i. Construction Plan

Construction traffic shall be restricted to approve access roads and the route RoW. Drivers shall receive safety and environmental awareness training and be subjected to assessments and monitoring. Warning signs shall be placed at road crossings and other appropriate locations as required. Temporary traffic control shall be established where necessary at road crossings and junctions. A local community safety awareness programme shall be implemented and communities shall be discouraged from use of the RoW as a road.

7.7 Safety & Health

(A) Operational Code

7.7.1 Safety Management System

FMoT knows that safety on every project is essential. Site safety is a primary concern for senior management of the company. FMoT operates its own safety management system. This system sets out corporate safety standards, safety management plans, implementation guidelines etc. The system is implemented for every project and it is audited internally by the company.

7.7.2 General Safety Wear

Safety wears such as overalls, head gears, boots, nose covers, hand gloves, eye goggles, safety shoes shall be supplied wherever their use is essential. Workers shall be made to wear them.

7.7.3 Safety Awareness

The Project Manager or in his absence the HSE Officer are basically the custodians of safety. All Management and Staff are expected to be highly conscious of safety and hence any hazard shall be reported promptly. Reporting accidents that almost happened" enhances safety awareness. Prevention is always better than cure.

7.7.4 Public Health and Safety

i. Construction Plan

FMoT shall provide a mobile health team that will conduct regular health checks of construction workers. The construction sites and construction workers' dormitories shall be disinfected regularly. Training on safety procedures and precautions shall be provided to workers especially machinery operations. Safety officers shall be appointed to conduct regular safety inspection of the construction sites.

ii. Operation Plan

Rail safety education campaign shall be conduct among locals of surrounding communities. FMoT shall collaborate with local school authorities and community leaders to find ways of integrating railway safety into their curricula and local people's daily living practices. Advance warning sign shall be set up at major intersections together with staffed safety booths and barricades. Pedestrian walkways shall be provided at the culverts for use by people and animals to reduce the risk of accidents.

7.8 Emergency Preparedness and Response

7.8.1 Contingency Plan and Emergency Procedures

The Project's site camps/offices during construction and the stations during the operational phase shall be equipped with:

(a) An internal communication/alarm system capable of providing immediate emergency instructions to all personnel;

(b) Telephones capable of summoning emergency assistance from the police/security organizations and fire service department:

(c) Portable fire extinguishers, fire control equipment, spill control equipment.

(i) Water at adequate volume and pressure to supply water hose streams, automatic sprinklers, or water spray systems.

(ii) First aid materials in boxes.

(iii) Emergency assembly points within the premises.

(iv) Emergency response arrangement containing details of response bodies and their contact details.

All the above equipment shall be maintained regularly, and tested periodically to ensure steady effectiveness.

7.8.2 Emergency Co-Coordinator (EC)

The official who shall have over-all responsibility for coordinating all emergency response measures shall be the Project Manager during construction or the Station Manager during operations and shall be designated Emergency Coordinator (EC). He/she shall be assisted by the Security Manager and the HSE Officer. The emergency coordinator (EC) shall have the authority to commit the resources needed to carry out the contingency plan.

7.8.3 Emergency coordinator's response

(a) The emergency coordinator (or his assistant in his absence) shall immediately activate the internal company alarms or communication systems to notify all company personnel, and, in the case of fire, the nearest municipal fire-fighting service, if needed.

(b) Concurrently all the emergency response arrangement should be brought to bear on the particular problem on hand.

(c) If the emergency involved an incident that could threaten human health or the environment outside the facility, the emergency coordinator must submit a report of his findings to NESREA and Federal Ministry of Environment office.

7.9 Management of Socio-economic Impacts

Socio-economic impacts that have been identified relate not only to the aspect of the project but also to individual and communities' perception and attitude towards these aspects, gleaned through the consultation process.

The addition of perception and community attitudes toward the issues means that the impact will vary according to the individuals or community involved. Socio-economic issues that were identified and relate to the project construction are:

- Local employment and procurement opportunities
- Land acquisition and land-based livelihood
- Local infrastructure and services

- Community relations, management of construction workers and camps.

The managements measure that shall be put in place by FMoT in each component include: -

7.9.1 Employment and Local Sourcing Opportunities

Preference shall be given to suitably qualified and experienced application from communities along the project route.

1. Recruitment procedures shall be developed that will be transparent and fair.
2. A training programme for local workers shall be developed and implemented.
3. To maximize local sourcing opportunities, a plan shall be developed for implementation.

7.9.2 Land and Land Based Livelihoods.

A fair, adequate and transparent compensation process shall be developed for land owners and land users. Consultation on land acquisition entitlements and compensation shall be held with land owners and users along the route. Land owners and users shall be allowed continued access (with restriction) to the route corridor after constructions

7.9.3 Infrastructure and Services

There shall be upgrade of some existing roads and construction of new access roads. Roads used by the project shall be maintained during construction and any damage to roads caused by the project shall be rectified. All roads shall be restored to a condition at least as good as that existing before the project.

7.9.4 Community Relations

- All workers shall receive cultural sensitivity and health awareness training where appropriate
- Code of conduct for camp workers shall be established to facilitate relationships with communities during construction phase.
- A community liaison team shall be established to facilitate relationships with community during construction phase.

The operational phase of the project is expected to bring about positive impacts to communities. The communities expect improved commercial activities to result from the project.

7.10 Institutional Arrangement for ESMP

FMoT is committed to ensuring that the project is integrated harmoniously into the host environment and that the project operation shall provide an opportunity to play active parts in national development. The HSE unit of FMoT during operations shall be responsible for ensuring that the overall environmental targets are achieved and that the environmental responsibilities and obligation of the project and the respective offices of rail stations and sections are satisfied during project implementation.

In each station and section, an environmental officer shall be appointed, who shall monitor the implementation of the environmental management and monitoring plan in the field. Initiatives shall be taken to ensure that each person identified to implement specific aspects of the ESMP fulfill their responsibilities as part of their activities.

The Project Manager shall ensure that the implementation of the ESMP occurs in a structured and formal manner and that employees identified to assist in performing tasks defined in the ESMP has the necessary skills to manage the environmental aspect of their work.

Environmental awareness training for the team is an integral part of a comprehensive environmental management policy. FMoT shall be responsible for training and awareness seminars to all staff. EPCC shall present all result of environmental monitoring to the regulatory agencies and shall indicate which specific member of the ESMP team should be contracted for clarifications of issues outlined in the result presented.

An accredited environmental consultant shall be retained to provide services that are critical to the effective implementation of the environmental management plan which includes laboratory services.

7.11 Monitoring and Measurement

The environmental Monitoring plan shall serve as an integral part of the construction and operational activities and is expected to generate the requisite information dissemination. The plan shall play a pivot role in ensuring that the trends for specific parameters are traced and also shall provide information on compliance with legislation norms, set guidelines or desirable operational limits; and form basis for corrective action and modification of activities if necessary. Monitoring will require sampling and analysis of environmental components like soils, water and air emissions.

Monitoring will also involve community perception surveys, HIV/AIDS awareness, worker's health, availability of facilities/skills, etc so as to identify issues of discontent and address them before they escalate.

The Environmental Monitoring Plan of the project is summarized in table 7.1:

Table 7.1 Details of Environmental Monitoring Plan

Monitoring Scope	Parameter	Location	Frequency				Responsibility
			Project Phase				
			Pre-construction	**Construction**	**Operation**	Decommissioning	
Air	TSP, NO_2, SO_2, CO	Settlement areas, close to stations schools rail track traverse	Weekly	Bi-weekly	Bi-annual	Weekly	FMoT/NRC, LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Kaduna, Plateau, Bauchi, Gombe, Yobe, and Borno States Ministries of Environment
Wastewater and surface water	TSS COD, DO, pH, Oil, phenol etc	Effluent outlets and important water bodies	-	Monthly	Quarterly	-	FMoT/NRC, LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment

Monitoring Scope	Parameter	Location	Frequency				Responsibility
			Project Phase				
			Pre-construction	**Construction**	**Operation**	Decommissioning	
Noise	Sound level (dBA)	Sensitive spots, e.g., school, residential close train stations	weekly	weekly	Monthly	Daily	FMoT/NRC, LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment
Solid waste	Ignitability, Corrosivity, Reactivity etc	Disposal sites. e.g; Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State designated dump site	Monthly	Quarterly	Bi-annual for first two years, then annual thereafter	Monthly	FMoT/NRC, LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment

Monitoring Scope	**Parameter**	**Location**	**Frequency**				**Responsibility**
			Project Phase				
			Pre-construction	**Construction**	**Operation**	Decommissioning	
Spoils	Visual inspection	Entire route	Weekly	Bi-weekly	Twice a year at start and end of wet season	Weekly	FMoT/NRC, LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment
Soil erosion	Visual inspection	Entire route	-	Biweekly	Twice a year at start and end of wet season	-	FMoT/NRC, LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment
Public safety	Signs, culvert, incidence/accident records	Entire route	Weekly	Monthly	Quarterly for the first year, then annually	Weekly	FMoT/NRC, LRHSE Unit,

Monitoring Scope	Parameter	Location	Frequency				Responsibility
			Project Phase				
			Pre-construction	**Construction**	**Operation**	Decommissioning	
					thereafter		FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment
Land acquisition and population and structures resettlement	Compensation, income, housing, Employment, social adaptation	Relocated families and receiving communities	Middle and end of land acquisition and resettlement	- Middle and end of land acquisition and resettlement	Annual community survey in first five years; once every 2 years in 1st 10 years	-	FMoT/NRC, LRHSE Unit, Environmental Consultant, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment

Monitoring Scope	Parameter	Location	Frequency				Responsibility
			Project Phase				
			Pre-construction	**Construction**	**Operation**	Decommissioning	
Socioeconomic benefit	Increased transportation of local products; increased number of tourists; increased local revenue and increased income of locals	Entire project area	Weekly	Middle and end of land acquisition and resettlement	Year 2, 5 and 10 of railway operation	Weely	LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment
Community participation	Number of participants	Project communities	Weekly	bi-annual	Year 2, 5 and 10 of railway operation	Weekly	FMoT/NRC, LRHSE Unit, FMEnv, Rivers, Abia, Enugu, Ebonyi, Benue, Nasarawa, Plateau, Bauchi, Gombe, Yobe and Borno State Ministries of Environment

LRHSE Unit= Local Rail Health, Safety and Environmental Unit, FMEnv= Federal Ministry of Environment

7.12 Environmental Auditing

In line with the FMEnv requirements, the project shall be audited every three years, this is to check the prediction of the environmental assessment and assess the general performance of the project to ensure that environmental standards are maintained and environmental management and monitoring plan are followed.

Environmental audit acts as an internal control process that ensures that environmental protection and management procedures are enforced. The audit objectives are to examine the line management system and procedures, facility operations and monitoring practices. It shall cover the following: Verification of prediction in the ESIA.

- Verification of implementation of mitigating recommendations
- Review incident reporting and remedy schemes
- Identification of current and potential environmental problems
- Recommend necessary improvements to management operation practices
- Thorough documentation, feedback and implementation procedures

CHAPTER 8

CONCLUSION AND RECOMMENDATION

8.1 Conclusion

The Environmental and Social Impact Assessment (ESIA) of the railway line 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 ESIA 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 project's life cycle has also been put in place to assure environmental sustainability of the project.

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.

The identified adverse impacts of the proposed project include; air pollution, soil, sediment, groundwater water and surface water contamination from accidental/ routine discharges of effluent, workplace accidents, improper waste management has been identified.

Consequently, cost-effective mitigation/ amelioration measures have been designed to ensure that these impacts are prevented, reduced or controlled to as low as reasonably practicable in order to ensure conservation of biodiversity in the area and enhance continual compliance with environmental standards and requirements in Nigeria.

It is understood that the project will result in substantial social and economic benefit for Nigeria. The ESMP developed would ensure the plans/ procedures for managing the significant impacts of the project are maintained throughout the project implementation.

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.

8.2 Recommendation

We strongly recommend the Port Harcourt - Maiduguri Railway project for ESIA Approval because the mitigation measures that have been proffered will adequately address the identified impacts from the project; and the commitment of FMoT to ensure strict implementation of the project's ESMP.

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Appendix

Appendix 1: Attendance Register of Stakeholders Engagements

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE REHABILITATION / RECONSTRUCTION OF THE EXISTING PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES.

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Community: MADA

Group: Community

Date: 15-11-2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	Alhaji M Aliyu	District head	M	08162571030	
2	Aliyu Oja	madaki	M	07032403331	
3	Salalami musa	Gadima	M	08144016711	
4	Baba Audu	Sarkin pada	M	08083290824	
5	Sale Aliyu	upangari	M		
6	Adamu Dangana	Sarkin noma	M	08139270600	
7	Danlami Alade	sarkin dawaki	M		
8	Isa musa	magaji	M		
9	Ahmadu Haruna	marafa	M		
10	mahammadu Gado	Tukura	M		
11	Immurana musa	Sardauna	M		
12	Danladi Dauiyu	Dangmaje	M		
	Musa Sule	youth leader	M	08162820081	
	Haruna Musa A	youth	M	08036020449	
	Ismaila Adamu		M		
	Jibrin Sule		M		
	Abubakar Mohammed		M		
	Isayaku Musa		M		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE REHABILITATION / RECONSTRUCTION OF THE EXISTING PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES.

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Community: MADA

Group: COMMUNITY

Date: 13 — 11 — 2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	Aliyu Musa Aliyu		Male	08139414253	
2	Musa Audu		M	08140118744	
3	Ismaila Dauda		M	07061018526	
4	Ibrahim M. Aliyu		M	08069299494	
5	Musa Mudeen A.		M	09065482186	
(6)	Aliyu Suleiman		M	07067119807	
	Haladu Musa A.		M	08068935184	
	Mohammed D. Aruwa		M	08037711467	
	Abdullahi A. Adamu		M	07035262909	
	Iliya Ibrahim		M	08063186554	
	Adamu Abdullahi		M	07062667894	
	Yakubu Mohammed		M	07065918424	
	Isiyaku D. Iliyasu		M	07060856315	
	Inuwa Abdulhamid		M	09061692965	
	Abdulrasheed M A		M	08032966657	
	Aliyu Audu		M	08108880578	
	Madu Bilyaminu		M	08037678702	
	Aliyu M Iliyasu		M	07060856315	

15/11/2020 KURU COMMUNITY

SN	Name	Phone	Sign
1	DAKOR Alexfam	08030981169	[illegible]
2	Bulus Anggiji	08037830434	[illegible]
3	Nehemiah Tanko	0703789 5160	[illegible]
4	BABATUNDE AKINOLA	08140678930	[illegible]
5	Yohanna Garba	07035501722	[illegible]
6	Daniel maisaje	08037544662	[illegible]
7	Simon J Gregory	07032317953	SM
8	Joshua Jnathang	07077434923	[illegible]
9	Horas Aalyop muss	08084547021	H.G.M
10	Gyang Luka	08064766626	[illegible]
11	Amos Yakubu	08124212888	[illegible]
12	GyANG Harunla	09077926905	[illegible]
13	Danes Yakubu		[illegible]
14	uscah Dam	07086512974	
15	David M Gyang		
16	ChoJi Danlady		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE REHABILITATION / RECONSTRUCTION OF THE EXISTING PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES.

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Community: MAKURDI, BONUE STATE

Group:

Date: 12 NOV. 2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1.	Eng. Adegoke Williams	FMOT, Abuja	M	07036223891	[illegible]
2.	Ogbogu Jacinta .C.	FMEN. Abuja	F	080333325 12	[illegible]
3.	Awah Ogar Ngan	" "	M	08037071222	[illegible]
4	TOYONTFON UKPONG	PGM	M	08068765405	[illegible]
5.	Eneh Emmanuel	PGM	M	08066227074	[illegible]
6.	Anyiman Orseer	MAWRE	M	08022489514	[illegible]
7	Engr. Bridget D. Damjer	FMOT, Abuja	F	08055518107	[illegible]
8.	FRANK C. ATAKU	NRC	M	08033956455	[illegible]
9	JAMES V. TORTIM	NRC	M	08072564147	[illegible]
10	GBUKU JULIANA	NRC	F	07035783006	[illegible]
11	Ikyo Terkaa, A	FMENV MKD	M	08100532566	[illegible]
12	Amb. Frank Mbashimja	MKD L.G.	M	07040985438	[illegible]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE REHABILITATION / RECONSTRUCTION OF THE EXISTING PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES.

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Community: Makurdi
Group: Community
Date: 12 - 11 - 2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1.	Engr. Adegoke M. Williams	FMoT, Abuja.	M.	07036223891	
2.	Engr. Bridget D. Damja	FMoT, Abuja	F	08058518107	
3.	Ogbogu Jacinta. C.	FMoT Abuja	F	08033332312	
4	Aula Ogar Xizay	FMEnv - Abuja	M	08037071272	
5	Asukwo Udoh	NRC	M	0806774450	
6	Adamu Idris	NRC	M	08060620036	
7	Abari Musa	–	i.	07035643732	
8	Gante Lucky	NRC	M	08035700231	
9	Umar Musa	N.R.C	M	07030905888	
10	Augustine Longtang	NRC	M	08169560955	
11	Ododo Daniel	N.R.C	M	08133880953	

ENVIRONMENTAL IMPACT ASSESSMENT

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: RECONSTRUCTION & REHABILITATION OF PH – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

Community: AFIKPO ROAD, ISHIAGU IVO LGA, EBONYI STATE

Group:

Date: 28/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	EZE Moses Okafor Nnale	Traditional Ruler	Male		
2	Chief S.A. Nweke	Prime minister	Male	09033935653	
3	Arc Moses Ajah	Town Union President	Male	08035931221	
4	Chief Godfrey Ajah	Cabinet member	Male	07035726249	
5	Chief Zachary Joseph I.C	Cabinet member	male	08143217496	
6	Anyim Ndubuisi Joseph	A Community leader	Male	07039503923	
7	Emenike Okechukwu G.	A community leader	Male	08035988076	
8	Anyim Ogbonna festus	A Community leader	Male	09034752265	
9	Chidiebere Innocent	Youth leader	Male	08031965094	
10	O Gozie John	Secretary	Male	08109188098	
11	Nwaeke Emmanuel	Youth leader	Male	08155794434	
12	Eginne Faith G.	Woman leader	female	08132584699	
13	Ikekere Blessing	Woman leader	Female	07092366950	
14	Okereke Uche	Elder	Female	08062787769	
15	Friday Biko	Cabinet member	Male	08143217496	
16	Emmanuel Okereke	Security official	Male	07086295924	EMA
17	Ngozi Ajah	Woman Secretary	female	08101524766	
18	Daniel Ndubuisi Oji	Youth leader	Male	08163266199	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE REHABILITATION / RECONSTRUCTION OF THE EXISTING PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES.

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Community: AGYARAGU STATION.

Group:

Date: 12 – 11 – 2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	IDRIS ALIYU	STATION MASTER	MALE	08033211775	
2.	YAHAY ADAMU	WAKILIN AGY			
3	Hon Balarabe DM	Stakeholder	Male	08063427581	[signature]
4	Isiaka S. Foven	maiangwan	Male	08061192124	[signature]
5	Abubakar Rabiu	stake holder	male	07032332804	[signature]
6)	Adamu Abubakar	stake holder	male	08032534524	[signature]
7)	Dahiru Rabiu	V.G.N	male	08100776616	[signature]
8	ABDULLAHI USMAN	CHAIR ACDA	MALE	07063692609	[signature]
9	ANUKA A. ALPHONSUS	SYS	MALE	08132222750	[signature]
10	FIDELIS AJA CHUK	DSIT	MALE	08161756122	[signature]

ENVIRONMENTAL IMPACT ASSESSMENT

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: RECONSTRUCTION & REHABILITATION OF PH – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

Community: OBINAGU, ISHIAGU IVO LGA EBONYI STATE.

Group:

Date: 28/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	Chief Ike Kenneth K	Cabinet member	male	07037463352	[illegible]
2	Monday Nweke	Youth leader	male	08037676092	[illegible]
3	Chukwuma Chinedu	Youth secretary	male	08062102310	[illegible]
4	Sunday Kalu	Youth leader	male	08076249781	[illegible]
5	Onyebuchi Kalu	Youth leader	male	08139904892	[illegible]
6	Pastor Peter Nwigwe	Elder	male	08039667200	[illegible]
7	Flourine Ama	Fin. Sec Women Meeting	Female	08052457203	[illegible]
8	Ndubuisi Ikechukwu	A community leader	male	08138216054	[illegible]
9	Nkechinyere Ajah	A woman leader	female	09037241308	[illegible]
10	Florence Alexander	Treasurer women union	female	08088243042	[illegible]
11	Fidelia Azubuike	Sec. women union.	female	08096994872	[illegible]
12	Kingsley Okereke	Family chairman	male	08172526171	[illegible]
13	Emmanuel Nwatagbala	Neighbourhood security officer	male	09037241308	[illegible]
14	Zachary Ijeoma	A woman leader	Female	08088243042	[illegible]
15	Chinasa Obi	Secretary women meeting	female	08096974872	[illegible]
16	Peter Chinedu O.	A Community leader	male	08067296044	[illegible]
17	Oluchi Kalu	Woman leader	female	08138695634	[illegible]
18	Ugochukwu Nwokoro	Youth Secretary	Male	08109466195	Nwokoro

ENVIRONMENTAL IMPACT ASSESSMENT

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: COMMUNITY CONSULTATION ON ENVIRONMENT SOCIAL IMPACT ASSESSMENT

Community: ABA (EZIAMA AMA ATTA, THE HOST COMMUNITY OF ABA RAILWAY STATION)

Group:

Date: 22/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	HRM. EZE UDODIRIM A SUNDAY	CHAIRMAN ABA-NORTH TRAD. COUNCIL	MALE	08175854433 08030971436	[signature]
2	CHIEF FRIDAY AZUBUIKE AHUKANNA	TRADITIONAL PRIME MINISTER	MALE	08063544189	[signature]
3	CHIEF NWAEZE AKOZIE	CHAIRMAN OF THE COMMUNITY	MALE	08055972622	[signature]
4	CHIEF DAVID CHIGBU	PROVOST OF THE COMMUNITY	MALE	08163024938	[signature]
5	CHIEF PROMISE MONDAY	CHIEF SECURITY	MALE	08037689014	[signature]
6	MR CHRISTIAN AHUKANNA	PALACE TREASURER	MALE	08064347108	[signature]
7	MR. CHIBUZOR NKORO	PALACE MEMBER	MALE	07017338721	[signature]
8	HON. IZUCHI ANYAUMUNNA	PALACE MEMBER	MALE	08038261360	[signature]
9	MRS AKUDO IZUCHI	WOMEN LEADER	FEMALE	07067217544	[signature]
10	CHIEF CHIGBU NNABUGWU	PALACE MEMBER	MALE	08068715009	[signature]
11	PASTOR DANIEL NKORO	PALACE SECRETARY	MALE	08104670199	[signature]
12	MR MONDAY IKECHUKWU	PALACE MEMBER	MALE	08131378592	[signature]
13	MRS OKORO. IFEOMA ESTHER	SECRETARY	FEMALE	07035783382	[signature]
14	MRS MARY CHIBUZOR	MEMBER	FEMALE	08104319099	[signature]
15	HON. OKORO PAUL CHIGOZIE	P.A. TO HRM	MALE	08102590549	[signature]
16	CHIEF NWOKEOMA UKOMADU	PALACE CHAIRMAN	MALE	08023793384	[signature]
17	MR PETER MONDAY	PALACE MEMBER	MALE	08064330639	[signature]
18	MRS SYLVIA AHUKANNA	CHAIRLADY	FEMALE	07035331837	[signature]
19	UGOEZE BLESSING UDODIRIM	UGOEZE	FEMALE	08130797575	[signature]
20	LOLO UCHECHI DAVID	SECRETARY	FEMALE	07036627955	[signature]

ENVIRONMENTAL IMPACT ASSESSMENT
COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: COMMUNITY CONSULTATION ON ENVIRONMENTAL SOCIAL IMPACT ASSESSMENT

Community: UZUAKOLI

Group:

Date: 23/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
01	HRH Eze Joseph E Okorie	Tradl. Ruler	Male	08164406521	Okorie
02	Chinedum Ikwuako	Cabinet member	Male	08036969170	[illegible]
03	Chief K. O. Arisa	Elder/Secretary	Male	07068021983	[illegible]
04	Chief Ekeleme C. Nwamuo	Elders Council	Male	08134883409	[illegible]
05	Chief Emmanuel Akaukwu	Cabinet Member	Male	08023645839	[illegible]
06	Kanu A Chilekwu	Ex-president	Male	08130748840	[illegible]
07	Chukwuemeka E. Enwere	Chairman kingship	Male	0808316[illegible]1	[illegible]
08	Okezie J. Irokwem	P.R.O/Hymee	MALE	08[illegible]69321188	[illegible]
09	Ibezim Gold M.	Chair Person	FAMELE	07060768958	[illegible]
10	SUNDAY NWOCHIRI	ELDER	MALE	08080677598	S.N
11	NDUAKA NDUKWE	ELDER	MALE	08160648573	N.N
12	EMINIKE OGBONNAYA	✓	MALE	07067907275	E-O
13	UZODINMA NWANKWO	SECRETARY GEN	✓	08069335325	[illegible]
14	IKEDIEZE KANU	ELDER	✓	08135902247	I.K
15	OBINECHE NWOKOCHA	✓	✓	08132077036	[illegible]
16	OGBONNAYA BEKEE	✓	✓	08069335325	O.B
17	AMADIYEZE ONYEBUCHI	✓	✓	08064108532	A-O
18	CHINONYEREM OGBONNAYA	✓	✓	070625[illegible]5093	C.O

ENVIRONMENTAL IMPACT ASSESSMENT
COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: COMMUNITY CONSULTATION ON ENVIRONMENTAL SOCIAL IMPACT ASSESSMENT
Community: UMUATTIA
Group:
Date: 23/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	Chief Chimechefulam Ogbonnaolam	Traditional Prime Minister.	Male	09036456607	[signature]
2.	Chief Ikeanacho Ariwodo	Palace sec/Village Head	male	08068183768	[signature]
3.	Elder Augustine O. Onwuzuruigbo	Secretary Elders Council	male	08062676359	[signature]
4.	ARIWODO CHISOM E.	Youth leader	male	07062132332	[signature]
5.	Ogbonna Friday Chimezie	V/P General	male	08077730793	[signature]
6	Chief Joel Chukwuma Onyeku	Cabinet Member	male	08151761827	[signature]
7.	Pastor Nwokeukwu Kingsley	Assist. Sec.	male	08033098709	[signature]
8.	OKEZIE UCHECHI M	PRESIDENT GEN	Male	08030607723	[signature]
9.	Mr Innocent Ndudim	Treasurer	male	08185204690	[signature]
10.	Engr Ogbonna Dhuogba	Vice chairman	male	08053322727	[signature]
11.	Nwachukwu Chijindu H.	Community leader	male	08068201010	[signature]
12.	Chief Onyebuchi Iwebuke	Council member	male	08066381653	[signature]
13.	Okechukwu Innocent R Obichiri	Former chairman Umuobesi Umuatthia	male	08030699627 / 07011978647	[signature]
14.	Lawrence Agouwa U.	Cabinet member/Village head	Male	08137218965	[signature]
15.	Ezinna Timothy Nmerequ	Former Chairman Elder	male	08036194420	[signature]
16.	Chief S. A Ogbonna	Former President General	male	07034518958	[signature]
17.	Uchenna Ikeokwu	Chairman	male	07035347173	[signature]
18	Chukwuemeka Emmanuel I.	Youth leader	male	07062132332	[signature]

ENVIRONMENTAL IMPACT ASSESSMENT

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: COMMUNITY CONSULTATION ON ENVIRONMENTAL SOCIAL IMPACT ASSESSMENT

Community: Uduma, ENUGU STATE

Group:

Date: 26/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1.	HRH IGWE DONATUS CHUKWU	TRADITIONAL RULER	MALE	07033221174	Donatus
2.	CHIEF SYLVESTER EKWENTA	CHAIRMAN OF THE COMMUNITY	MALE	07084584015	[illegible]
3.	PASTOR UKACHUKWU THEOPHILUS	PASTOR	MALE	08108985656	[illegible]
4.	PROPHET GABRIEL ASHI	COMMUNITY LEADER	MALE	09026255689	[illegible]
5.	MR EKWE IFEANYI	YOUTH LEADER	MALE	08124403747	[illegible]
6.	CHIEF PIUS ANIH	PRESIDENT GENERAL OF THE COMMUNITY	MALE	07089597516	[illegible]
7.	MR FRANCIS ~~EKWE~~ EKWE	ELDER	MALE	08121009637	[illegible]
8.	MR ~~I~~ LOMBAH LIVINUS	YOUTH CHAIRMAN	MALE	09028670757	[illegible]
9.	CHIEF FERDENADI UKACHUKWU	PRESIDENT GENERAL	MALE	07067444400	[illegible]
10.	CHIEF FRANCIS ONYEABO	FIN. SEC.	MALE	09027809445	[illegible]
11.	CHIEF LIVINUS NJOKU EZE	GEN. SEC.	MALE	07069799514	Njokueze
12.	MR FERDENADI MADU	CABINET MEMBER	MALE	08082796847	Madu
13.	MR DANIEL UDE	ELDER	MALE	08015346404	Daniel
14.	MR NWAUBARA GEORGE	CABINET MEMBER	MALE	08027389633	[illegible]
15.	MRS EVELYN UWAKWE	A MEMBER OF THE WOMEN COUNCIL	FEMALE	08085461806	[illegible]
16	CHIEF FIDELIS CHUKWU	VICE PRESIDENT GENERAL	MALE	08024341724	Chukwu
17.	COMRADE GODWIN ANTIM	FIN. SEC. NAT.	MALE	08080413605	Godwin
18	MRS BLESSING ONYEABO	WOMAN LEADER	FEMALE	09020068779	Blessing

ENVIRONMENTAL IMPACT ASSESSMENT

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: RECONSTRUCTION & REHABILITATION OF PH – MAIDUGURI NARROW GUAGE RAILWAYS & ITS ACCESSORIES

Community: AMAGU, ISHIAGU IVO LGA EBONYI STATE

Group:

Date: 28/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	HON. NDUBUEZE JOHN	A COMMUNITY LEADER	MALE	08068091005	
2	MR LEONARD O. AJAH	VICE CHAIRMAN OF THE COMMUNITY	MALE	08164543233	
3	MR MAKWO OKORO	PROVOST OF THE HAMLET	MALE	08138924586	Okoro
4	MRS AJAH STELLA	WOMAN LEADER	FEMALE	~~08144145616~~ 08144145616	Stella
5	MR AJAH PAULINUS	A COMMUNITY LEADER	MALE	07030544383	
6	MRS UKAMAKA OKORO	WOMAN LEADER	FEMALE	08181326215	
7	MRS BLESSING AJAH	TREASURER WOMEN MEETING	FEMALE	08107749671	
8	HON. DENIS UKPAI N	A COMMUNITY LEADER	MALE	08068630181	
9	MR UCHE IGWE AGWU	YOUTH LEADER	MALE	09067697825	
10	MR FIDELIS OFFOR	YOUTH LEADER	MALE	07081255931	
11	HON MOSES OKORO	A COMMUNITY LEADER	MALE	08039108698	
12	MR OSI AJAH	FAMILY CHAIRMAN	MALE	07031144934	
13	MR ANANYO OKERIE	FAMILY SECRETARY	MALE	08030821424	
14	MR OKORO MADUABUCHI	SEC. OF THE FAMILY MEETING	MALE	07035100747	
15	MRS JUSTINA NDUKWE	FIN' SEC WOMEN UNION	FEMALE	08136906849	
16	MR EMMANUEL IVOKE	A COMMUNITY LEADER	MALE	08060806804	
17	MRS AJAH HELEN	SEC. OF WOMEN UNION	FEMALE	08156888614	
18	MR JONAH OKERIE	Elder	MALE		

ENVIRONMENTAL IMPACT ASSESSMENT

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: COMMUNITY CONSULTATION ON ENVIRONMENTAL SOCIAL IMPACT ASSESSMENT

Community: NOMEH, ENUGU STATE

Group:

Date: 26/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1.	HRH IGWE I. O MBAH	Traditional Ruler of The Community	male	08034053141	I. Mba
2.	HIGH CHIEF ANTHONY NWANKWO	CABINET MEMBER	Male	08088477379	[illegible]
3.	MR CHIBUIKE OFFOR	Youth leader	male	07034199482	[illegible]
4.	MRS ANI CHUKWU NKECHI E	Secretary of the Women group	Female	07066792571	ANEE
5.	HIGH CHIEF EMMANUEL ANI	CABINET MEMBER	Male	08030955214	[illegible]
6.	HIGH GODWIN ONUBA	CABINET MEMBER	male	08050414864	Emmanuel
7.	CHIEF JONATHAN ANIEKWE	SOLE ADMINISTRATOR OF THE COMMUNITY	male	08039241317	Joni
8.	CHIEF FRIDAY ANIMKPUMA	CHAIRMAN OF THE COMMUNITY	male	08053556001	Friday
9.	ONOWO CLEMENT MBAH	CABINET MEMBER	male	08129804979	Clement
10.	MRS GRACE NWANKWO	WOMAN LEADER	Female	08103463177	Nwankwo
11.	MR MORDECAI OKEKE	Neighborhood chairman	male	08038257886	[illegible]
12.	CHIEF EGBU NWANKWO ANI	CABINET MEMBER	male	07084364946	Egbu
13.	MR MICHEAL UCHE OGBU	Youth leader	male	08079420998	[illegible]
14.	MR CHUKWUMA EDWARD	Elder	male	09025432255	[illegible]
15.	MR SAMUEL ORJI	Youth Secretary	male	08037407546	[illegible]
16.	MR ANI FRIDAY	NEIGHBOURHOOD SECURITY	male	08163789227	[illegible]
17.	MR NKUME IKECHUKWU	✓✓	male	08161326944	[illegible]
18.	MRS NGOZI EGBOH	Woman leader	female	08080742386	[illegible]
19	MR UNOVO PATRICK	CABINET MEMBER	male	09055612855	[illegible]
20	MR FRIDAY OKAFOR	Elder	male	08168404827	[illegible]

ENVIRONMENTAL IMPACT ASSESSMENT
COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: RECONSTRUCTION & REHABILITATION OF PH — MAIDUGURI NARROW GAUGE RAILWAY & its ACCESSORIES
Community: AGBANI, NKANU WEST
Group:
Date: 27/09/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1.	HRH IGWE SAMPSON NNAMANI	TRADITIONAL RULER	MALE	08037421074	[signature]
2.	HRH IGWE ~~ANA~~ NWODO	Traditional ruler	MALE	08037442847	[signature]
3.	MR SIMEON NWOBODO	SECRETARY OF THE COMMUNITY	MALE	08038679118	[signature]
4.	CHIEF GODWIN NNAMANI	HIGH CHIEF (CABINET MEMBER)	MALE	0803762[illegible]	[signature]
5.	MR OKENWA DENIS	Youth leader	MALE	08035978079	[signature]
6.	CHIEF ~~MR~~ ANTHONY NJOKU	Cabinet member	MALE	08037204943	A. O Njoku
7.	MR CHIMAOBI NWOBODO	Neighbourhood Security officer	MALE	08030621249	[signature]
8.	MR UCHENNA OKENWA	Youth leader	MALE	07068116823	U. Okenwa
9.	CHIEF SUNDAY EDEAGU	Cabinet member	MALE	08026675748	[signature]
10	PRINCE SAM EJIOFOR	A Community leader	MALE	08104944444	Samsam
11.	~~HON~~ MONDAY OKENWA	A Community leader	MALE	08036266488	[signature]
12.	CHIEF W. O AGBO	Cabinet member	MALE	08033387385	[signature]
13.	MR FIDELIS NGELE	A Community leader	MALE		[signature]
14.	MRS DONATUS CHIEBO	Secretary of the women union	FEMALE		Chiebo
15.	MR NWOBODO FRANCIS	A Community leader	MALE	08063961701	[signature]
16.	MR CHUKWUDI NWOBODO	Chief of staff of the Community	MALE	08383361364	[signature]
17.	MRS KATE NNAJI	A woman leader		08033259211	[signature]
18.	MR DENIS NJOKU	Secretary of the Community	MALE	07067015915	Denis Njoku for

ENVIRONMENTAL IMPACT ASSESSMENT

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Project: RECONSTRUCTION & REHABILITATION OF PH – MAIDUGURI NARROW GUAGE RAILWAYS & ITS ACCESSORIES

Community: ISHIAGU (~~[illegible]~~) IVO LGA EBONYI STATE.

Group:

Date: 28/9/2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1.	IFEANYI AJAH	HAMLET (JOINT) CHAIRMAN	MALE	08160440257	
2.	CHIBUIKE AJAH	TASK FORCE CHAIRMAN	MALE	08135170523	
3.	MR AJAH CHIKA PHILIP	FORMER COMMUNITY CHAIRMAN	MALE	08060171205	
4.	MR PHILIP CHUKWU	FIN. SEC.	MALE	08032531647	
5.	MR NDUKWE ANTHONY O.	FORMER YOUTH CHAIRMAN	MALE	07026850976	
6.	MR ONU CHRISTOPHER ONU	YOUTH LEADER	MALE	08034696559	
7.	MR FRIDAY DAVID	YOUTH LEADER	MALE	08165910495	
8.	MR NDUKWE CHRISTOPHER	Family Chairman	MALE	0703300824	
9.	MR UDOKA OSI	Family Secretary	MALE	07067039752	
10.	CHIEF NICODEMUS ONWU	Cabinet Member	MALE	07031274281	
11.	MR MADUBUIKE AJAH	Youth leader	MALE	08061357788	
12.	MR NDUKWE IFEANYICHUKWU	A Community leader	MALE	08059283545	
13.	MR CHIBUEZE ORIEJI	Elder	MALE	07037412687	
14.	MR ANYIM BENJAMIN	SEC. of JOINT HAMLET	MALE	07059098371	
15.	MRS AJAH UCHECHUKWU S.	WOMEN LEADER	FEMALE	07025692130	
16.	MR AKACHUKWU OKORO	Family Chairman	MALE	08160440257	
17.	MRS OBIGERI OKORO	WOMEN SEC.	FEMALE	07060845929	
18.	MRS PHILOMINA ONWU	Secretary women Union	FEMALE	09039645352	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE REHABILITATION / RECONSTRUCTION OF THE EXISTING PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES.

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

~~Community:~~ YOBE STATE STAKEHOLDER WORKSHOP

Group:

Date: 16 NOV. 2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	ENGR. ISYAKA LAWAN	MIN. OF TRANS. & E	MALE	08036248579	[signature]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE REHABILITATION / RECONSTRUCTION OF THE EXISTING PORT HARCOURT – MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES.

COMMUNITY/STAKEHOLDERS CONSULTATION MEETING

Community: YOBE STATE STAKEHOLDERS WORKSHOP

Group: INSTITUTIONAL STAKEHOLDERS

Date: 16TH November, 2020

SN	Name	Organisation/position	Sex	Phone Number	Signature
1	Ladan Ahmad	MLPF MINISTRY OF	'M'	08030721932	[illegible]
2	MUSTAPHA A. DALAH	Land & Solid Min	✓	08066556849	[illegible]
3	Aisha Isa	YBSMOH	✓	08065569932	[illegible]
4	BUKAR BALUMI	SMOH	✓	08036374679	[illegible]
5	ENGR. GARBA SATOMI	YSMOW	✓	08034999541	[illegible]
6	ESV ADAM B. ZANNAH	HABIBU & CO. ESV	✓	08060565140	[illegible]
7	ABDULSALAM MUSA	MTE	✓	07037398880	[illegible]
8	ALH. Aliyu Mai Bule	JAJERE EMIRATE COUNCIL	M	08036781028	[illegible]
9	Engr Adamu Saidu	Min of Housing &	M	08034394373	[illegible]
10	TPL Adamu Umar	MIN of Housing & URBAN DEV	✓	08067360449	[illegible]
11	Dr Ibrahim MANA	NSCAC	M.	08065732292	[illegible]
12	Moh'd S. Hassan	TCN	M	08036052610	[illegible]
13	Ogbodo Kingsley O.	TCN	M	07061111705	[illegible]
14	RUSKIN, I.B.A (MRS)	TCN, CHQ	F	07082339096	[illegible]
15	Sanni S. Usman	TCN	M	08037527534	[illegible]
16	Nguwap Hoyea Y.	FMENV ABUJA	M	08052497644	[illegible]
17	Abubakar Umar Badi	FMEnv. Abuja	M	08034551159	[illegible]
18	Mohammed Wakil	KIZITO (CX PARTNERS	M	08034363900	[illegible]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF PROPOSED
REHABILITATION AND CONSTRUCTION OF PORT HARCOURT – MAIDUGURI RAILWAY AND ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP
BRIDGEWATERS HOTEL, GARDEN AVENUE, ENUGU
ON 10 NOVEMBER 2020

ATTENDANCE REGISTER

SN	NAME	ORGANIZATION/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
38.	Chuka Ezike	Min. of Rural Dev.	08036743253	chukaezike@gmail.com	[signature]
39.	Mbah Christian	U.O.I	08033422891	Krischidiso[illegible]@yahoo.com	[signature]
40.					
41.					
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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF PROPOSED
REHABILITATION AND CONSTRUCTION OF PORT HARCOURT – MAIDUGURI RAILWAY AND ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP
BRIDGEWATERS HOTEL, GARDEN AVENUE, ENUGU
ON 10 NOVEMBER 2020

ATTENDANCE REGISTER

SN	NAME	ORGANIZATION/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
1.	Awa Ogar Nzan	FM Env-Abuja	080370712-72	awaogar@yahoo.com	
2.	AYA FRIDAY C.	EBSMENV	07026770209	ayafonyreal@yahoo.co.uk	
3.	Ogbogu Jacinta C.	Fmenv-Abuja	08033332212	Jacinta_ogbogu@yahoo.com	
4.	Odanwy Francisca O.	" "	07067743026	francas_odaoku@yahoo.com	
5.	Sir Matthias Ani	Obeagu Ugwuogo	08039691162	Obeagu Ugwuogo ESLGA	
6.	ENGR. UGWUAGBO CHARLES	MINISTRY TRANSPORT	08032477544	—	
7.	Engr. Uchenwa N. Ujam	NSE-Enugu	08033420973	ucheujam@yahoo.com	
8.	Engr. Adegoke Williams	Fed. Min. of TRANSPORT	07036223891	goke_williams@yahoo.co.uk	
9.	Engr. Nwosu Isaac	FMOT	08033505561	zikykim@gmail.com	
10.	Engr. Bridget D. Damjur	FMoT	08058518107	bridnic_doo@yahoo.com	
11.	Ifeanyi Echefu	CCECC	08060213393	anyicom@yahoo.com	
12.	UDEH EBERE B.	NESREA	08062678235	eberudeh1@gmail.com	
13.	UKPONG, ITUEN M.	NESREA	08055584258	laurel2it@gmail.com	
14.	IBE EBELEMA	NPF EnuComm	08083551040	—	
15.	Chinwe Nwuko	ENS MENV	07033617982	ctmcy@yahoo.com	
16.	Onowu Boniface Ani	Obeagu Ugwuaji Awkunanaw ESLGA	07088435147		
17.	OSIDIPE, T. OLUSOJI	NRC/EAST DIST.	08032093639	olusojiosidipe@yahoo.com	
18.	Esv. Anthony Atlandenor	2m(E) NRC/RAMC	08023046616	tonydenor1@gmail.com	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF PROPOSED
REHABILITATION AND CONSTRUCTION OF PORT HARCOURT – MAIDUGURI RAILWAY AND ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP
BRIDGEWATERS HOTEL, GARDEN AVENUE, ENUGU
ON 10 NOVEMBER 2020

ATTENDANCE REGISTER

Esqp No # 0916820024

SN	NAME	ORGANIZATION/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
19.	Ngene Edmund P-	Nigerian Railway	07039114400	Edmund Ngene at [illegible]	
20.	Nwosu Stanley C. (Prefect Secretary)	Nigerian Railway Corp.	08033192508	stanleychukwuma83@gmail.com	
21.	Chief Nyia Edwin Smoby	Osegu Ugwuiji	08037370505	nnecddytech@gmail.com	
22.	Odo Alphaeus Agbo	FMI/NY. Enugu	08032336156	odoalphaeus@yahoo.com	
23.	DR. OKAFOR CHRISTOPHER	Ministry of Health Enugu	08034485540	okaforchristopher74@yahoo.com	
24.	Clement Anoliefoh	Clement Eliora found.	08033778384	canoliefoh@gMail.com	
25.	Sam Chukwudi O.	Min of Gender & Soc	08100670067	Samchxxz@gmail.com	
26.	Ikegbunam Benedict .O	FRSC	08139226588	ikegbunamben@gmail.com	
27.	Okechukwu Daniel	NSCDC	08137292022	okeydaniel19@Gmail.com	
28.	Toyumfun Ukpong	PGM	08068760405	toyumfunukpong7@gmail.com	
29.	Uzochinma Chosen	PGM	08142928629	chosenuzochinma@gmail.com	
30.	David Sanni	PGM			
31.	Emmanuel Enoch	PGM	08066227074	!	
32.	ROBERT MARTINS	PGM NIG LTD	08039725510	Martinsalu@yahoo.com	
33.	DR. BASSEY UZODIMMA	✓	08037135876	drbassey chukwuma @yahoo.com	
34.	Ugwunnadi Anthony	NSCDC	07038167485	Gwunnadi@yahoo.com	
35.	Chief Cyril N. Nwuzor	Nike	08036739890	[illegible]	
36.	Chief, Edwin Mgbo	NIKE	08064511461		
37.					

STAKEHOLDERS' ENGAGEMENT WORKSHOP

AT DMATEL HOTEL, 91 KEN SARO-WIWA ROAD, PORT HARCOURT CITY, RIVERS STATE

ON 13 NOVEMBER, 2020

ATTENDANCE LIST

S/N	NAME	ORGANIZAITON/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
18.	Prof. A.I. HART	United Chiefs Assembly BONNY/INRES	08033129803	ibitoryh@gmail.com	Hart
19.	PAUL YUSUF	Nigerian Ports Authority	08037992426	payus2873@gmail.com	[illegible]
20.	ENGR UGWUANYI FABIAN O.	NIMASA/MEM Unit	09080033664	morganlawrenceej@yahoo.com	F.O.U
21.	IBIASO KELLY BROWN	FINIMA ENVIRONMENTAL PROTECTION INITIATIVE	07038272469	ibiasobrown1782@yahoo.com	[illegible]
22.	SRC TAMUNO BALA	FRSC [illegible]	08034540578	dhatemuno@yahoo.com	[illegible]
23.	Elder Sam Woludam	Rebisi Kingdom	08033346715	Santamoe@gmail.com	[illegible]
24.	Felix Anokwuru	Rebisi Kingdom	08033088924	felixanokwuru@yahoo.com	[illegible]
25.	Dr I.F. Vincent-Akpu	Association for Env. Impact Assessment of Nig (AEIAN)	08163807135	ifeoma.vincent-akpu@uniport.edu.ng	[illegible]
26.	Vincent-Akpu chinogozim	AEIAN	08160384902	mercyvincent700@gmail.com	[illegible]
27.	Prof. S.A Abere	Bonny Kingdom	08033107597	abereausti@yahoo.com	[illegible]
28.	SIR AMAIRISHA E. HART	BONNY KINGDOM	08033102601	hartamazmint@yahoo.com	[illegible]
29.	Engr Prof H.I. Hart	BONNY KINGDOM/NSE	0803-309-5712	harthi78@yahoo.com	[illegible]
30.	Dr Mrs Justina A. Jumbo	Bonny Kingdom TCA	08033424866	jawjumbo@yahoo.com	[illegible]
31.	Ikpesa Solomon	OBIO/AKPOR LGA	07063302769	Sikpesa@yahoo.com	[illegible]
32.	Dan-Jumbo Catherine	FMEnv	08035497724	amolyhw@yahoo.com	[illegible]
33.	ABBEY ISRAEL AWALA	ELEME LGA	08032343302	bizzysignature2@gmail.com	[illegible]
34.	TPL Chimezie Onwuduye	OBIO/AKPOR L.G.C	08064131803	achimedge@yahoo.com	[illegible]

ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP
AT DMATEL HOTEL, 91 KEN SARO-WIWA ROAD, PORT HARCOURT CITY, RIVERS STATE
ON 13 NOVEMBER, 2020

ATTENDANCE LIST

S/N	NAME	ORGANIZAITON/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
18.	Prof. A.I. HART	United Church Assembly BONNY/INRES	08033129803	ibitoryh@gmail.com	Hart
19.	PAUL YUSUF	Nigerian Ports Authority	08037992426	payus2973@gmail.com	
20.	ENGR UGWUANYI FABIAN O.	NIMASA/MEM UNIT	09080083664	morganlawrencee@yahoo.com	F.O.U
21.	IBIASO KELLY BROWN	FINIMA ENVIRONMENTAL PROTECTION INITIATIVE	07038272469	ibiasobrown1702@yahoo.[illegible]	
22.	SRC TAMUNO BALA	TRC [illegible]	08034540578	[illegible]@yahoo.com	
23.	Elder Sam Wokolam	Rebisi Kingdom	08033366715	Santomoe@gmail.com	
24.	Felix Anokwuru	Rebisi Kingdom	08033088924	felixcanokwuru@yahoo.com	
25.	Dr I.F. Vincent-Akpu	Association for Env Impact Assessment of Nig (AEIAN)	08163807135	ijeoma.vincent-akpu@uniport.edu.ng	
26.	Vincent-Akpu Chinogozim	AEIAN	08160384902	mercyvincent700@gmail.com	
27.	Prof. S.A Abere	Bonny Kingdom	08033107592	abereausti@yahoo.com	
28.	Sir AMAIRISHA E. HART	BONNY KINGDOM	08033102601	hartamazmint@yahoo.com	
	Engr Prof H.I. Hart	BONNY KINGDOM/NSE	0803-309-5742	harthi75@yahoo.com	
	Dr Mrs Justina A. Jumbo	Bonny Kingdom TCA	08033421866	jawjumbo@yahoo.com	
	Ilepesa Solomon	OBIO/Akpor LGA	07063302769	silepesa@yahoo.com	
	Dan-Jumbo Catherine	FMEnv	08039457724	amaigh[illegible]@yahoo.com	
	ABBEY ISRAEL AWALA	ELEME LGA	08032343302	bizzysignatures@gmail.com	
	TPL Chimezie Onwuduya	OBIO/AKPOR L.G.C	08064131803	achimedan@yahoo.com	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF PROPOSED
REHABILITATION AND CONSTRUCTION OF PORT HARCOURT – MAIDUGURI RAILWAY AND ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP
ROYAL HOTEL DAMGRETE, UMUAHIA
ON 12 NOVEMBER 2020

ATTENDANCE REGISTER

SN	NAME	ORGANIZATION/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
18.	SP GEOFFREY OGBONNA	NIGERIA POLICE	08039148294	geoogbonna@gmail.com	
19.	DCC Uba Leonard	NSCDC	08062770311	uba.leonard73@gmail.com	
20.	Uwaoma Chinedu S.	ASPC	08035683485	uwaomachinedu@[illegible].com	
21.	Engr (Dr) OB Amiri	FRSC	08139578149	amiribenjamin@yahoo.com	
22.	Unwanaobong Young	MIN. OF ENV'P.	08027478323	[illegible]@yahoo.com	
23.	KALU BONIFACE	ASEPA	07035546371	bonnykalu1975@gmail.com	
24.	Chinedu Njoku	NESREA	08063400163	chinedunjoku@gmail.com	
25.	UCHEGBULAM OBIOMA	FRSC	08067860275	ov.uchegbulam@[illegible]	
26.	Engr. Oti, O. F	MOUA, Umudike	08036851660	o.oti@mouau.edu.ng	
27.	Umeh Patrick	NSCDC	08056714609	onypatz@yahoo.com	
28.	UTTAH [illegible] U.	ENVIRONMENTAL DPT	0705[illegible]73	[illegible]	
29.	CHARITY ZINAHONE	PRESS	08125414583		
30.	Joyce Nwabueze	press	08140844673	distinguishedlass88@gmail.	
31.					
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ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF PROPOSED REHABILITATION/CONSTRUCTION OF THE EXISTING PORT HARCOURT MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP

AT DMATEL HOTEL, 91 KEN SARO-WIWA ROAD, PORT HARCOURT CITY, RIVERS STATE

ON 13 NOVEMBER, 2020

ATTENDANCE LIST

S/N	NAME	ORGANIZAITON/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
1.	Engr. Nwosu Isaac	Fed. Min of Transport	08033505561	zikyzim@gmail.com	[signature]
2.	NGOZI UGWUANYI	FED MIN. OF ENV	08037398415	reality_mo@yahoo.com	[signature]
3.	ESU (MRS) T.C. EMMANUEL	RAILWAY PROPERTY MGT COMPANY LTD	08033285103	Sophirstone@yahoo.com	[signature]
4.	ENGR. IHUANNE, EVEREST N	RIVERS STATE MIN. OF WORKS	08037465778	nkemjikgeverest@yahoo.co.uk	[signature]
5.	IBIBIA BEAUTY (SC)	NIG. SECURITY AND CIVIL DEFENCE CORPS	08066594738	ellafuro@yahoo.com	[signature]
6.	Epelle Rita	NSCDC PH	08037367555	—	[signature]
7.	IKOMAH F.B	FMENV. PHC	08035662496	bgrieene.env@gmail.com	[signature]
8.	VISAA PETER. B.	GOKANA LGA	08030677064	visaapeter@gmail.com	[signature]
9.	Obi Augusta	FMENV	08032658246	augustaean@yahoo.c	[signature]
10.	Engr Gbenga Ogunwumi	Fed. Min of Transport	08035213281	gbenga10434@yahoo.com	[signature]
11.	Lawal Ajoola Ens G	EISRL	08102591583	Ajoola648@gmail.com	[signature]
12.	Kelvin C. Olizelene	EIBRL	07035055680	kelvinolizelene@yahoo.com	[signature]
13.	Engr. Hamza Usman	FMoT	07067601296	hamzibb@gmail.com	[signature]
14.	Mohammed Ibrahim	NIMASA	08035896899	iro320@hotmail.com	[signature]
15.	AMACHREE DIMABO OTONYE	NIMASA	08036845377	amachree.dimabo@yahoo.com	[signature]
16.	NYENWE REJOICE	Vice Chairman IKWERRE LGA	08137206974	rejoice127.com	[signature]
17.	CHIDUM WUTCHE	R/S Min. of Env.	08052678089	chidumn3@yahoo.com	[signature]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF PROPOSED REHABILITATION AND CONSTRUCTION OF PORT HARCOURT – MAIDUGURI RAILWAY AND ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP
ROYAL HOTEL DAMGRETE, UMUAHIA
ON 12 NOVEMBER 2020

ATTENDANCE REGISTER

SN	NAME	ORGANIZATION/COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
1.	Ifeanyi Echefu	C CECC	08060213393	anyicom@yahoo.com	
2.	Engr. Nwosu Isaac	Fed Min of Transport	08033505561	zikyzim@gmail.com	
3.	Obasi Ikechukwu	DSS	08032659036	belovedapostle2@gmail	
4.	Nwachukwu C. Emmanuella	Min. of Industry, Abia State	07038044960	ndukwechituma[illegible]@gmail.com	
5.	Odunlami Babatunde	FMEnv, Abuja	08033057302	babsodunlami@gmail.com	
6.	Ahunanya Chibuzor	Youth Rep	08036393885	—	
7.	Engr Ohia, Uzoma	Nigerian Society of Engrs Umuahia	07032228874	donbush2@yahoo.com	
8.	Engr, Enyinnaya, Romanus	N.S.E Umuahia branch	07031937981 08140621517	romanus.enyinnaya@gmail.com	
9.	Nwogu Kingsley Obi	NESREA	08034532098	abia@nesrea.gov.ng	
10.	Ekeu, Okezie	NESREA	08032539468	okezieekere@yahoo.com	
11.	Odoh Joseph C.	NRC	07034767746	josephodoh[illegible]@gmail.com	
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ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF PROPOSED REHABILITATION/CONSTRUCTION OF THE EXISTING PORT HARCOURT MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

STAKEHOLDERS' ENGAGEMENT WORKSHOP

AT DMATEL HOTEL, 91 KEN SARO-WIWA ROAD, PORT HARCOURT CITY, RIVERS STATE

ON 13 NOVEMBER, 2020

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ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF PROPOSED

REHABILITATION/CONSTRUCTION OF THE EXISTING PORT HARCOURT MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

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Appendix 1.2: Sample Results

Physicochemical Characteristics of Groundwater Sample

Parameter	Groundwater Samples										Mean	Range	SD	WHO	FMEnv
	GW_1	GW_2	GW_3	GW_4	GW_5	GW_6	GW_7	GW_8	GW_9	GW_{10}					
Color (Pt Co Units NCASI)	3.87	3.63	4.61	2.75	4.56	4.92	4.72	3.68	3.85	4.77	4.136	2.75-4.92	0.69	5-15	-
pH	6.33	5.67	6.38	6.42	5.88	6.45	6.55	6.43	6.44	5.77	6.232	5.67-6.55	0.33	6.5-8.5	6.5-9.0
Temperature (oC)	28.4	29.2	28.7	28.5	29.3	29.1	30.3	29.6	29.2	29.5	29.18	28.4-30.3	0.56	-	-
Turbidity (NTU)	0.34	0.23	0.25	0.32	0.35	0.28	0.25	0.22	0.37	0.33	0.294	0.22-0.37	0.05	5	5
Salinity (ppt)	0.0088	0.0092	0.0084	0.008	0.0074	0.0069	0.0091	0.0069	0.0083	0.0084	0.008	0.0069-0.0092	0	-	-
Hardness (mg/l)	14.23	13.57	10.34	15.11	14.28	14.09	14.32	11.67	12.51	14.18	13.43	10.34-15.11	1.47	250	250
Conductivity (µS/cm)	17.6	18.4	16.8	16.7	14.8	13.8	18.1	13.7	16.5	16.7	16.31	13.7-18.4	1.67	1000	400
DO (mg/l)	0.11	0.13	0.21	0.18	0.11	0.09	0.12	0.16	0.24	0.18	0.153	0.09-0.24	0.05	5	>4.0
BOD (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
COD (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	150
THC (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Phosphate (mg/l)	0.05	0.02	0.11	0.03	0.04	0.02	0.03	0.05	0.06	0.02	0.043	0.02-0.11	0.03	-	-
Sulphate (mg/l)	1.05	2.12	1.21	1.15	2.01	1.18	1.16	1.21	1.22	3.02	1.533	1.05-3.02	0.64	250	250
Nitrate (mg/l)	0.45	0.32	0.28	0.18	0.41	0.36	0.34	0.43	0.26	0.33	0.336	0.18-0.45	0.08	10	10
TDS (mg/l)	8.8	9.2	8.4	8.35	7.4	6.9	9.05	6.85	8.25	8.35	8.155	6.85-9.2	0.84	1000	1000
TSS (mg/l)	0.14	0.1	0.1	0.8	0.15	0.12	0.1	0.09	0.15	0.14	0.189	0.09-0.15	0.22	-	-
Copper (mg/l)	0.012	0.013	0.009	0.017	0.006	0.011	0.012	0.015	0.008	0.014	0.0117	0.008-0.017	0.003	1	0.01
Iron (mg/l)	0.33	0.28	0.35	0.27	0.31	0.24	0.26	0.32	0.24	0.25	0.285	0.24-0.35	0.04	0.36	0.36
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.17	0.08	0.11	0.32	0.18	0.22	0.21	0.33	0.28	0.25	0.215	0.08-0.33	0.08	3	<1.0
Cadmium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<1.0
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	0.05
Potassium (mg/l)	0.09	0.06	0.11	0.08	0.13	0.07	0.05	0.12	0.04	0.14	0.089	0.04-0.14	0.03	-	-
Faecal Coliform (cfu/100ml)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Coliform (cfu/100ml)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THB(cfu/ml)	1.8×10^5	2.0×10^5	1.5×10^5	1.5×10^5	1.1×10^5	2.1×10^5	1.7×10^5	1.3×10^5	1.6×10^5	2.3×10^5	1.7×10^5	$1.1–2.3 \times 10^5$	0.37	100	100

Source: Laboratory Analysis (2020)

Parameter	Groundwater Samples										Mean	Range	SD	WHO	FMEnv
	GW$_{11}$	GW$_{12}$	GW$_{13}$	GW$_{14}$	GW$_{15}$	GW$_{16}$	GW$_{17}$	GW$_{18}$	GW$_{19}$	GW$_{20}$					
Color (Pt Co Units NCASI)	3.41	2.25	3.18	3.21	3.24	2.28	2.44	3.09	2.16	2.12	2.738	2.12-3.24	0.53	5-15	-
pH	6.21	6.17	6.34	5.78	5.83	6.43	5.75	6.35	6.28	6.38	6.152	5.75-6.43	0.26	6.5-8.5	6.5-9.0
Temperature (oC)	31.4	30.8	31.4	29.7	29.8	30.7	31.3	31.4	31.4	30.8	30.87	29.7-31.4	0.65	-	-
Turbidity (NTU)	0.22	0.42	0.23	0.35	0.32	0.26	0.37	0.28	0.24	0.41	0.31	0.22-0.42	0.07	5	5
Salinity (ppt)	0.0094	0.0088	0.0076	0.0092	0.009	0.0092	0.008	0.0083	0.0089	0.0087	0.009	0.0076-0.0094	0	-	-
Hardness (mg/l)	23.4	18.6	24.1	23.6	19.5	20.7	23.3	22.7	17.7	21.3	21.49	17.7-24.1	2.28	250	250
Conductivity (µS/cm)	18.7	17.6	15.2	18.3	17.9	18.3	15.9	16.5	17.7	17.4	17.35	15.2-18.7	1.13	1000	400
DO (mg/l)	0.14	0.21	0.16	0.11	0.08	0.12	0.15	0.18	0.13	0.17	0.145	0.08-0.21	0.04	5	>4.0
BOD (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
COD (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	150
THC (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Phosphate (mg/l)	0.08	0.11	0.06	0.11	0.05	0.12	0.05	0.04	0.09	0.05	0.076	0.04-0.12	0.03	-	-
Sulphate (mg/l)	2.08	2.44	2.16	1.56	1.66	2.39	1.72	2.28	2.33	2.07	2.069	1.56-2.44	0.32	250	250
Nitrate (mg/l)	0.32	0.21	0.25	0.23	0.15	0.13	0.25	0.25	0.12	0.17	0.208	0.12-0.32	0.06	10	10
TDS (mg/l)	9.35	8.8	7.6	9.15	8.95	9.15	7.95	8.25	8.85	8.7	8.675	7.6-9.35	0.57	1000	1000
TSS (mg/l)	0.09	0.18	0.1	0.15	0.13	0.11	0.15	0.12	0.1	0.17	0.13	0.09-0.18	0.03	-	-
Copper (mg/l)	0.002	0.011	0.003	0.004	0.008	0.006	0.013	0.001	0.003	0.005	0.006	0.001-0.013	0.004	1	0.01
Iron (mg/l)	0.33	0.35	0.37	0.26	0.28	0.25	0.34	0.24	0.28	0.22	0.292	0.22-0.37	0.05	0.36	0.36
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.22	0.28	0.32	0.25	0.33	0.27	0.26	0.31	0.29	0.31	0.284	0.22-0.33	0.03	3	<1.0
Cadmium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<1.0
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	0.05
Potassium (mg/l)	0.05	0.04	0.04	0.06	0.02	0.03	0.03	0.03	0.03	0.03	0.036	0.02-0.06	0.01	-	-
Faecal Coliform (cfu/100ml)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Coliform (cfu/100ml)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THB(cfu/ml)	1.1×10^5	1.2×10^5	1.6×10^5	1.4×10^5	1.7×10^5	1.1×10^5	1.4×10^5	1.3×10^5	1.4×10^5	1.2×10^5	1.3×10^4	$1.1 – 1.7 \times 10^4$	0.2	100	100

Source: Laboratory Analysis (2020)

Physicochemical Properties of Surface Water Samples

Parameter	SW_1		SW_2		SW_3		SW_4		SW_5		SW_6		SW_7		SW_8		Mean	Range	SD	WHO	FMEnv
	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS					
Color (Pt Co Units NCASI)	15.16	15.33	14.57	15.09	13.55	14.28	15.26	15.34	15.21	15.27	14.14	14.22	13.27	13.32	15.02	15.17	14.638	13.27-15.34	0.75	5-15	-
pH	6.13	5.77	6.23	6.43	5.73	5.58	6.27	6.24	6.33	7.02	7.12	7.23	6.23	6.45	6.42	6.48	6.354	5.58-7.23	0.47	6.5-8.5	6.5-9.0
Temperature (oC)	35.3	35.5	35.5	36.2	34.5	34.7	34.4	34.7	35.1	35.4	35.3	35.6	32.6	32.4	33.6	33.8	34.663	32.4-36.2	1.08	-	-
Turbidity (NTU)	3.22	2.21	3.23	4.15	3.08	4.25	3.08	4.16	1.23	3.34	3.13	2.32	4.08	3.24	1.28	4.02	3.68	1.23-4.25	3.72	5	5
Salinity (ppt)	0.077	0.079	0.069	0.07	0.074	0.08	0.083	0.084	0.065	0.067	0.08	0.081	0.075	0.075	0.079	0.08	0.076	0.065-0.084	0.01	-	-
Hardness (mg/l)	360.1	361.2	420.5	422.4	275.4	275.8	388.3	388.7	625.1	626.3	310.2	313.3	225.4	235.1	418.2	418.7	379.044	225.4-626.3	116.63	250	250
Conductivity (µS/cm)	110.3	112.4	98.5	99.6	105.5	114.3	118.3	120.7	92.7	95.6	114.4	115.2	107.2	107.8	113.5	114.1	108.756	92.7-120.7	8.32	1000	400
DO (mg/l)	7.23	7.27	6.58	6.64	7.05	7.12	7.41	7.55	6.45	6.47	7.02	7.15	6.75	6.81	7.22	7.25	6.998	6.45-7.55	0.34	5	>4.0
BOD (mg/l)	1.12	1.24	1.21	1.32	1.31	1.36	1.28	1.33	1.07	1.11	1.24	1.27	1.03	1.08	1.22	1.24	1.214	1.03-1.36	0.1	-	-
COD (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	150
THC (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Phosphate (mg/l)	0.57	0.62	0.42	0.46	0.54	0.57	0.43	0.47	0.38	0.41	0.42	0.46	0.51	0.53	0.33	0.37	0.468	0.33-0.67	0.08	-	-
Sulphate (mg/l)	4.02	4.15	3.54	3.57	4.11	4.07	3.26	3.33	4.05	4.12	4.21	4.25	3.52	3.56	3.22	3.25	3.764	3.22-4.21	0.39	250	250
Nitrate (mg/l)	3.14	3.23	2.42	2.44	2.54	2.57	2.34	2.38	2.12	2.16	2.21	2.24	3.27	3.31	3.08	3.13	2.661	2.12-3.23	0.45	10	10
TDS (mg/l)	17.21	28.68	18.95	19.72	23.85	20.01	12.81	14.49	24.89	16.92	20.08	18.64	15.04	15.46	19.45	20.05	18.129	12.81-28.68	5.82	1000	1000
TSS (mg/l)	11.01	14.25	22.1	16.73	17.12	20.02	18.78	18.82	21.35	21.39	14.22	14.3	20.53	17.6	19.7	20.01	16.31	11.01-21.35	4.57	-	-
Copper (mg/l)	0.234	0.237	0.314	0.321	0.213	0.218	0.333	0.337	0.225	0.229	0.211	0.215	0.305	0.311	0.325	0.327	0.272	0.211-0.337	0.05	1	0.01
Iron (mg/l)	2.36	2.44	1.05	1.13	2.18	2.24	2.08	2.13	2.05	2.11	1.57	1.61	1.24	1.27	1.03	1.11	1.725	1.03-2.44	0.52	0.36	0.36
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.34	0.37	0.43	0.54	0.45	0.49	0.52	0.58	0.55	0.59	0.43	0.47	0.38	0.42	0.33	0.35	0.453	0.33-0.59	0.09	3	<1.0
Cadmium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.003	<1.0
Chromium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.05
Potassium (mg/l)	0.23	0.29	0.24	0.27	0.31	0.34	0.33	0.36	0.25	0.27	0.29	0.31	0.22	0.25	0.18	0.22	0.273	0.18-0.36	0.05	-	-
Faecal Coliform (cfu/100ml)	11	14	6	7	4	7	3	8	6	9	7	8	10	12	8	11	8.188	3.0-14.0	2.9	0	0
Total Coliform (cfu/100ml)	13	15	8	12	9	13	11	14	10	15	11	15	8	10	7	9	11.25	7.0-15.0	2.7	0	0
THB(cfu/ml)	2.4×10^5	2.8×10^5	1.3×10^5	1.9×10^5	2.2×10^5	2.5×10^5	1.8×10^5	2.3×10^5	2.1×10^5	2.3×10^5	1.1×10^5	1.4×10^5	2.2×10^5	2.6×10^5	2.4×10^5	2.7×10^5	2.1×10^5	$1.1\text{-}2.8 \times 10^5$	0.54	100	100

Source: Laboratory Analysis (2020)

Parameter	SW_9		SW_{10}		SW_{11}		SW_{12}		SW_{13}		SW_{14}		SW_{15}		SW_{16}		Mean	Range	SD	WHO	FMEnv
	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS					
Color (Pt Co Units NCASI)	15.19	15.23	14.12	14.18	12.67	12.71	15.09	15.12	14.55	14.62	14.14	14.23	14.05	14.08	14.11	14.13	14.264	12.67-15.23	0.75	15.19	15.23
pH	6.32	6.44	5.76	5.82	5.25	5.33	6.22	6.27	6.54	6.55	6.41	6.43	6.37	6.41	6.46	6.47	6.191	5.25-6.55	0.42	6.32	6.44
Temperature (oC)	34.5	34.7	35.2	35.5	35.6	35.8	34.7	35.1	34.3	34.6	33.6	33.8	34.2	34.6	34.5	35.2	34.744	33.6-35.8	0.62	34.5	34.7
Turbidity (NTU)	3.12	1.81	3.23	4.20	3.08	4.25	3.08	4.16	1.23	3.34	3.13	2.32	4.08	3.24	1.28	4.02	3.94	1.81-4.25	3.28	5	5
Salinity (ppt)	0.076	0.0762	0.09	0.091	0.07	0.0701	0.081	0.083	0.065	0.066	0.071	0.071	0.078	0.079	0.086	0.088	0.078	0.065-0.091	0.01	0.076	0.0762
Hardness (mg/l)	330.3	331.1	277.5	277.9	489.1	489.6	340.2	344.1	321.4	322.4	522.2	524.3	378.3	378.5	290.3	295.2	369.525	277.5-524.3	87.13	330.3	331.1
Conductivity (µS/cm)	108.8	108.9	128.3	130.1	99.6	100.2	116.4	118.2	92.7	94.3	101.3	101.5	111.1	113.5	123.4	125.3	110.85	92.7-130.1	12.01	108.8	108.9
DO (mg/l)	6.33	6.37	7.28	7.31	5.58	5.62	5.78	5.82	7.14	7.17	7.22	7.27	6.62	6.68	7.06	7.12	6.648	5.58-7.31	0.65	6.33	6.37
BOD (mg/l)	1.19	1.21	1.08	1.12	1.27	1.31	1.33	1.35	1.13	1.17	1.24	1.26	1.11	1.15	1.02	1.05	1.187	1.02-1.35	0.1	1.19	1.21
COD (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THC (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphate (mg/l)	1.23	1.25	1.06	1.08	1.18	1.22	1.34	1.38	1.27	1.31	1.25	1.27	1.33	1.36	1.41	1.44	1.274	1.06-1.44	0.11	1.23	1.25
Sulphate (mg/l)	4.02	4.06	3.11	3.16	3.03	3.11	3.23	3.24	3.21	3.25	2.67	2.68	3.32	3.38	4.01	4.04	3.345	2.67-4.06	0.45	4.02	4.06
Nitrate (mg/l)	2.37	2.51	2.25	2.33	3.07	3.11	2.45	2.51	2.44	2.46	2.28	2.34	2.17	2.22	2.08	2.13	2.42	2.08-3.11	0.29	2.37	2.51
TDS (mg/l)	17.21	22.68	19.95	20.52	23.85	20.01	12.81	14.49	24.89	16.92	20.08	18.64	15.04	15.46	19.45	20.05	14.12	12.81-24.89	5.82	1000	1000
TSS (mg/l)	11.01	14.25	22.1	16.73	17.12	20.02	18.78	18.82	21.35	21.39	14.22	14.3	20.53	17.6	19.7	20.01	16.31				
Copper (mg/l)	0.223	0.226	0.188	0.191	0.251	0.255	0.167	0.172	0.154	0.155	0.201	0.207	0.155	0.157	0.135	0.138	0.186	0.135-0.255	0.04	0.223	0.226
Iron (mg/l)	1.38	1.43	1.32	1.35	1.28	1.32	1.25	1.27	1.33	1.36	1.41	1.44	1.31	1.33	1.26	1.29	1.333	1.25-1.44	0.06	1.38	1.43
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (mg/l)	0.56	0.58	0.62	0.64	0.38	0.42	0.54	0.57	0.46	0.47	0.68	0.71	0.73	0.59	0.64	0.66	0.578	0.38-0.73	0.1	0.56	0.58
Cadmium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Potassium (mg/l)	0.11	0.13	0.08	0.12	0.13	0.15	0.24	0.27	0.22	0.26	0.17	0.21	0.16	0.18	0.23	0.27	0.183	0.08-0.27	0.06	0.11	0.13
Faecal Coliform (cfu/100ml)	6	10	8	9	6	7	4	5	8	11	7	11	6	10	8	10	7.875	4.0-11.0	2.16	6	10
Total Coliform (cfu/100ml)	9	11	14	17	10	21	20	11	15	23	11	10	9	12	12	16	13.813	9.0-23.0	4.45	9	11
THB(cfu/ml)	2.5×10^5	2.7×10^5	2.2×10^5	2.8×10^5	1.7×10^5	2.1×10^5	2.8×10^5	3.3×10^5	2.3×10^5	2.5×10^5	2.3×10^5	2.8×10^5	1.8×10^5	2.1×10^5	2.3×10^5	2.7×10^5	2.4×10^5	$1.7\text{-}3.3 \times 10^5$	0.41	2.5×10^5	2.7×10^5

Source: Laboratory Analysis (2020)

Physicochemical Properties of Sediment Samples

Parameter	Sed$_1$		Sed$_2$		Sed$_3$		Sed$_4$		Sed$_5$		Sed$_6$		Sed$_7$		Sed$_8$		Mean	Range	SD
	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS			
pH	7.31	7.44	6.89	7.05	7.28	7.36	7.11	7.13	6.94	6.98	7.35	7.41	7.27	7.32	7.22	7.26	7.208	6.89-7.44	0.17
EC (µS/cm)	282.4	287.1	301.5	302.2	311.4	313.5	308.2	312.1	323.4	325.3	289.3	290.2	275.4	275.8	293.5	294.4	299.106	275.4-325.3	15.62
TOC (%)	22.2	23.4	21.3	23.2	26.6	27.2	30.5	31.2	27.6	28.3	26.8	27.4	21.6	22.3	27.7	28.1	25.963	21.3-31.2	3.17
Av. P (mg/kg)	4.68	5.05	5.24	5.27	5.33	5.35	6.11	6.14	5.44	5.46	5.09	5.12	6.13	6.15	6.23	6.27	5.566	4.68-6.27	0.52
NO_3^- (mg/kg)	7.44	7.51	7.23	7.27	7.34	7.38	8.41	8.47	9.06	9.11	10.21	10.24	10.08	10.12	12.11	12.14	9.008	7.23-12.14	1.67
SO_4^{2-} (mg/kg)	0.57	0.62	2.06	0.87	0.65	0.71	0.45	0.48	2.11	2.17	0.37	0.44	0.46	0.47	0.36	0.41	0.825	0.36-2.17	0.65
Na (meq/100g)	5.33	5.35	2.06	7.11	7.16	7.21	4.88	4.91	2.66	2.68	6.75	6.77	5.75	5.78	7.12	7.14	5.541	2.06-7.21	1.74
K (meq/100g)	8.15	8.17	10.11	10.14	7.88	7.91	8.35	8.42	9.44	9.47	8.55	8.57	10.23	10.27	9.57	9.62	9.053	7.88-10.27	0.88
Ca (meq/100g)	22.43	22.45	20.35	20.37	25.09	25.12	19.27	19.33	27.19	27.21	22.37	22.44	18.45	18.47	18.05	18.13	21.67	18.05-25.12	3.14
Mg (meq/100g)	2.32	2.37	2.62	2.77	1.78	1.81	2.54	2.57	3.18	3.23	2.37	2.43	2.53	2.57	2.51	2.55	2.509	1.78-3.23	0.38
Fe (mg/kg)	2.77	2.80	3.17	3.23	3.22	3.27	2.46	2.49	3.44	3.47	2.35	2.38	2.76	2.82	2.45	2.48	2.848	2.38-3.47	0.4
Mn (mg/kg)	4.41	4.44	3.08	3.17	4.48	4.51	3.28	3.32	4.42	4.55	4.28	4.35	3.54	3.61	4.27	4.32	4.002	3.08-4.55	0.55
Zn (mg/kg)	3.24	3.28	3.27	3.34	2.57	3.01	3.18	3.21	3.33	3.35	2.66	2.68	3.31	3.37	2.56	2.61	3.061	2.56-3.35	0.32
Cu (mg/kg)	1.09	1.11	0.58	0.63	0.71	0.73	1.23	1.28	0.83	0.87	1.15	1.21	0.57	0.64	1.14	1.18	0.934	0.57-1.28	0.26
Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cd (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
V (mg/kg)	0.023	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameter	Sed$_9$		Sed$_{20}$		Sed$_{11}$		Sed$_{12}$		Sed$_{13}$		Sed$_{14}$		Sed$_{15}$		Sed$_{16}$		Mean	Range	SD
	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS			
pH	7.36	7.48	7.43	7.45	7.58	7.62	7.17	7.23	7.44	7.48	7.53	7.55	7.17	7.22	7.28	7.31	**7.394**	**7.17-7.62**	**0.148**
EC (µS/cm)	362.5	363.1	271.5	272.3	288.6	288.7	318.7	319.2	328.2	330.4	265.7	266.2	305.3	305.7	311.5	313.4	**306.938**	**265.7-363.1**	**30.64**
TOC (%)	28.3	29.4	24.6	25.2	27.5	27.7	32.3	32.8	25.8	26.2	33.3	33.7	23.7	24.1	29.5	30.2	**28.394**	**24.1-33.3**	**3.37**
Av. P (mg/kg)	5.21	5.25	5.55	6.01	5.76	5.79	6.23	6.27	6.42	6.47	5.13	5.17	5.87	6.05	5.99	6.04	**5.826**	**5.13-6.47**	**0.45**
NO_3^- (mg/kg)	9.32	9.37	9.13	9.17	10.57	10.62	10.23	10.28	9.55	9.58	10.44	10.47	9.26	9.29	10.77	11.04	**9.943**	**9.13-11.04**	**0.66**
SO_4^{2-} (mg/kg)	0.65	0.67	2.16	0.57	0.44	0.47	0.55	0.57	2.23	2.27	0.43	0.48	0.52	0.55	0.38	0.44	**0.836**	**0.38-2.27**	**0.69**
Na (meq/100g)	5.35	5.38	2.16	7.17	7.26	7.28	5.08	5.11	3.23	3.28	5.88	5.91	6.54	6.58	5.06	5.14	**5.401**	**2.16-7.26**	**1.49**
K (meq/100g)	9.15	9.17	12.11	12.16	8.88	9.01	9.45	9.47	10.47	10.52	9.51	9.53	11.03	11.07	10.27	10.32	**10.133**	**8.88-12.16**	**1.05**
Ca (meq/100g)	28.13	28.15	22.14	22.17	20.03	20.08	23.11	23.13	20.15	20.22	23.34	23.37	28.05	28.07	20.15	20.18	**23.154**	**20.03-28.15**	**3.21**
Mg (meq/100g)	2.33	2.39	3.42	3.47	2.66	2.68	3.55	3.57	3.22	3.27	3.47	3.51	3.34	3.39	2.82	2.85	**3.121**	**2.33-3.57**	**0.43**
Fe (mg/kg)	3.18	3.22	3.42	3.46	3.35	3.41	3.66	3.68	2.78	2.81	2.48	2.52	3.26	3.28	2.65	2.71	**3.117**	**2.48-3.68**	**0.4**
Mn (mg/kg)	5.45	5.48	4.28	4.32	3.51	3.56	4.18	4.22	5.09	5.11	3.31	3.33	4.24	4.27	3.55	3.57	**4.217**	**3.31-5.48**	**0.73**
Zn (mg/kg)	2.44	2.48	2.53	2.57	3.61	3.63	2.48	2.51	3.45	3.49	3.26	3.28	3.36	3.39	3.16	3.21	**3.053**	**2.44-3.63**	**0.46**
Cu (mg/kg)	1.22	1.27	1.25	1.28	1.08	1.13	1.25	1.29	0.55	0.57	1.45	1.47	0.72	0.75	1.27	1.31	**1.116**	**0.55-1.47**	**0.3**

Parameter	Sed$_9$		Sed$_{20}$		Sed$_{11}$		Sed$_{12}$		Sed$_{13}$		Sed$_{14}$		Sed$_{15}$		Sed$_{16}$		Mean	Range	SD
	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS			
Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cd (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
V (mg/kg)	0.023	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: Laboratory Analysis (2020)

Physicochemical Characteristics of Soil Samples

Parameter	SS$_1$	SS$_2$	SS$_3$	SS$_4$	SS$_5$	SS$_6$	SS$_7$	SS$_8$	SS$_9$	SS$_{10}$	SS$_{11}$	SS$_{12}$	Mean	Range	SD
Physical Characteristics															
Permeability (%)	39.5	40.3	38.6	39.6	41.4	40.6	39.4	39.5	40.7	41.7	42.3	41.6	40.433	38.6-42.3	1.14
Porosity (%)	38.7	42.4	40.4	42.6	42.5	39.6	47.3	46.7	47.4	49.2	47.6	48.3	44.392	38.7-49.2	3.74
Bulk Density (mg/kg)	1.2	1.4	1.1	1.5	1.3	1.5	1.4	1.6	1.8	1.5	1.3	1.4	1.417	1.1-1.8	0.19
Particle Size Distribution															
% Sand	78	75	70	69	70	65	77	67	82	72	73	80	73.167	65-82	5.31
% Clay	15	18	23	25	24	26	14	25	10	21	18	14	19.417	10.0-26.0	5.33
% Silt	7	7	7	6	6	9	9	8	8	7	9	6	7.417	6.0-9.0	1.16
Chemical Characteristics															
pH	6.87	6.75	6.88	7.23	7.15	7.21	6.73	6.82	6.84	7.13	7.08	7.18	6.989	6.73-7.23	0.19
Moisture Content (%)	42.3	40.3	40.7	41.4	39.7	38.5	38.8	41.5	42.3	40.3	39.9	40.4	40.508	38.5-42.3	1.22
Nitrate (mg/kg)	10.2	9.7	9.5	10.4	10.2	9.8	9.5	9.7	11.1	11.3	10.5	10.4	10.192	9.5-11.3	0.59
Phosphate (mg/kg)	2.67	2.54	4.07	4.23	4.21	2.71	3.45	3.63	5.02	4.66	3.82	3.65	3.722	2.54-5.02	0.79
Sulphate (mg/kg)	3.05	3.45	2.72	2.61	2.43	3.44	3.11	3.28	4.02	4.11	3.44	3.47	3.261	2.43-4.11	0.51
Calcium (mg/kg)	39.8	50.6	47.3	55.2	38.3	52.9	53.4	47.4	44.5	50.7	51.4	53.8	48.775	38.3-55.2	5.49
Magnesium (mg/kg)	6.6	5.9	7.1	7.4	8.2	6.5	8.1	7.3	7.2	7.5	8.3	8.5	7.383	5.9-8.5	0.8
Potassium (mg/kg)	0.32	0.27	0.33	0.49	0.52	0.44	0.37	0.42	0.51	0.35	0.46	0.47	0.413	0.27-0.52	0.08
Sodium (mg/kg)	0.56	0.76	0.45	3.25	3.08	2.85	0.65	0.54	0.23	2.73	3.11	2.63	1.737	0.23-3.25	1.28
THC(mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron (mg/kg)	12.23	11.65	10.54	10.48	9.77	9.82	12.08	12.50	11.21	10.46	9.58	9.71	10.836	9.58-12.50	1.06
Lead (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (mg/kg)	1.05	0.84	0.57	1.17	0.55	1.29	1.31	0.76	0.79	1.03	1.31	1.22	0.991	0.55-1.31	0.28
Zinc (mg/kg)	6.25	4.78	5.55	5.62	6.23	6.28	4.68	4.91	4.77	5.49	6.11	6.02	5.558	4.68-6.28	0.63

Source: Laboratory Analysis (2020)

Parameter	SS$_{13}$	SS$_{14}$	SS$_{15}$	SS$_{16}$	SS$_{17}$	SS$_{18}$	SS$_{19}$	SS$_{20}$	SS$_{21}$	SS$_{22}$	SS$_{23}$	SS$_{24}$	Mean	Range	SD
Physical Characteristics															
Permeability (%)	40.8	41.3	43.3	40.2	42.2	41.1	40.6	41.4	41.5	42.2	40.7	41.1	41.367	40.2-43.3	0.85
Porosity (%)	44.2	39.9	39.5	40.3	38.8	40.5	42.4	41.5	42.1	39.5	39.4	37.8	40.492	37.8-44.2	1.77

Parameter	SS$_{13}$	SS$_{14}$	SS$_{15}$	SS$_{16}$	SS$_{17}$	SS$_{18}$	SS$_{19}$	SS$_{20}$	SS$_{21}$	SS$_{22}$	SS$_{23}$	SS$_{24}$	Mean	Range	SD
Bulk Density (mg/kg)	1.6	1.5	1.3	1.7	1.4	1.6	1.5	1.7	1.5	1.6	1.2	1.3	1.49	1.2-1.7	0.16
Particle Size Distribution															
% Sand	72	70	65	72	67	70	75	65	78	70	68	76	70.667	65-78	4.16
% Clay	23	22	27	18	25	22	16	27	13	22	24	20	21.583	13.0-27.0	4.25
% Silt	5	8	8	10	8	8	9	8	9	8	8	4	7.75	4.0-10	1.66
Chemical Characteristics															
pH	6.92	6.95	7.09	6.88	6.85	7.16	6.89	6.88	6.91	7.22	6.79	6.68	6.935	6.68-7.22	0.15
Moisture Content (%)	39.8	42.4	39.3	40.7	40.8	41.1	42.4	39.9	41.7	40.6	41.4	39.5	40.8	39.3-42.4	1.05
Nitrate (mg/kg)	11.8	10.6	12.0	9.5	10.7	10.3	12.3	10.5	9.7	9.4	11.6	11.4	10.817	9.4-12.3	1
Phosphate (mg/kg)	4.11	3.45	2.65	2.57	4.44	3.51	3.66	4.09	4.47	3.58	3.24	2.67	3.537	2.65-4.47	0.67
Sulphate (mg/kg)	4.24	4.18	3.11	3.45	4.12	2.71	4.09	2.55	3.27	3.72	2.57	2.38	3.366	2.38-4.24	0.7
Calcium (mg/kg)	48.5	52.6	50.2	49.9	46.7	39.7	38.8	49.3	52.7	47.3	39.2	39.6	46.208	38.8-52.7	5.38
Magnesium (mg/kg)	7.8	6.7	8.5	8.3	7.4	7.9	7.1	8.3	8.6	8.8	6.5	6.2	7.675	6.2-8.8	0.88
Potassium (mg/kg)	0.44	0.38	0.24	0.53	0.45	0.39	0.47	0.35	0.42	0.55	0.34	0.51	0.423	0.24-0.55	0.09
Sodium (mg/kg)	0.41	0.39	2.33	0.45	0.36	3.05	0.62	0.57	0.54	2.58	0.48	0.67	1.038	0.36-3.05	0.99
THC(mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron (mg/kg)	10.08	9.54	9.63	12.11	10.27	10.23	10.12	12.42	10.29	9.67	10.14	10.34	10.403	9.54-12.42	0.91
Lead (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (mg/kg)	0.65	1.21	1.34	0.45	1.24	0.73	0.66	1.18	1.22	0.43	0.51	0.63	0.854	0.43-1.34	0.35
Zinc (mg/kg)	5.55	5.67	4.44	6.34	5.41	5.67	5.88	5.35	5.46	6.32	5.76	5.78	5.636	4.44-6.34	0.49

Source: Laboratory Analysis (2020)

Parameter	SS$_{25}$	SS$_{26}$	SS$_{27}$	SS$_{28}$	SS$_{29}$	SS$_{30}$	SS$_{31}$	SS$_{32}$	SS$_{33}$	SS$_{34}$	SS$_{35}$	Mean	Range	SD
Permeability (%)	39.3	39.7	40.8	41.5	39.5	40.4	41.7	39.6	42.6	40.4	38.4	40.375	38.4-41.7	1.17
Porosity (%)	40.5	40.1	42.7	38.9	39.4	42.3	41.5	40.2	39.9	44.1	41.3	40.925	38.9-44.1	1.51
Bulk Density (mg/kg)	1.4	1.3	1.6	1.1	1.5	1.3	1.4	1.8	1.3	1.2	1.6	1.433	1.1-1.8	0.21
% Sand	66	65	70	70	75	64	70	65	72	68	70	68.917	64-75	3.37
% Clay	27	26	24	23	20	27	25	28	20	25	23	24.083	20.0-28.0	2.746
% Silt	7	9	6	7	5	9	5	7	8	7	7	7	5.0-9.0	1.28
pH	7.14	6.76	6.84	7.28	7.08	6.79	6.81	6.74	6.77	6.81	6.67	6.906	6.67-7.28	0.2
Moisture Content (%)	40.5	41.3	40.8	38.4	42.2	39.4	39.6	40.3	39.7	41.3	40.5	40.308	38.4-42.2	1.03
Nitrate (mg/kg)	9.2	9.4	9.7	10.6	12.5	11.7	12.1	9.4	10.2	11.1	9.7	10.425	9.2-12.5	1.16
Phosphate (mg/kg)	2.54	2.36	4.71	4.74	3.23	2.57	2.42	3.19	3.33	2.61	2.66	3.143	2.36-4.74	0.82
Sulphate (mg/kg)	0.39	3.42	4.07	0.44	1.55	3.27	3.34	3.22	4.01	2.88	3.18	2.543	0.39-4.07	1.37
Calcium (mg/kg)	60.3	60.1	45.4	50.8	52.2	47.7	46.2	51.1	39.5	50.9	43.8	49.475	39.5-60.3	6.18
Magnesium (mg/kg)	6.7	7.7	6.8	6.2	8.1	8.3	8.8	6.4	6.6	7.6	7.3	7.392	6.2-8.8	0.85
Potassium (mg/kg)	0.37	0.42	0.33	0.40	0.39	0.44	0.52	0.58	0.48	0.35	0.47	0.433	0.33-0.58	0.07
Sodium (mg/kg)	3.33	0.21	0.46	4.28	5.36	1.16	0.39	0.24	0.48	0.47	0.27	1.599	0.21-5.36	1.81
THC(mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameter	SS_{25}	SS_{26}	SS_{27}	SS_{28}	SS_{29}	SS_{30}	SS_{31}	SS_{32}	SS_{33}	SS_{34}	SS_{35}	Mean	Range	SD
Vanadium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron (mg/kg)	8.34	10.21	10.27	10.33	9.65	9.72	9.41	11.21	12.08	11.35	9.77	10.178	8.34-12.08	0.99
Lead (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (mg/kg)	0.37	0.41	0.44	1.03	0.32	1.12	1.24	0.55	0.48	1.13	1.09	0.769	0.32-1.24	0.36
Zinc (mg/kg)	6.22	6.25	6.08	4.76	4.77	4.56	6.14	6.18	6.33	5.45	4.67	5.494	4.52-6.33	0.77

source: Laboratory Analysis (2020)

Appendix 1.3: A Check list of the Fauna species in the study area

S/N	Family/ Order	Common Names	Zoological Names	Abundance	2016 IUCN Status
1	Rodentia	Red-legged sun squirrel	*Helioscius rufobrachium*	4	LC
2		Pygmy striped squirrel	*Myosciurus pumilio*	*	LC
3		Crested porcupine	*Hystrix cristata*	*	LC
4		Grass-cutter	*Thryonomys swinderianus*	4	LC
5		Giant rat	*Cricetomys gambiannus*	4	DD
6		Bush tailed porcupine	*Atherurus africanus*	*	LC
7		Marsh cane-rat	*Thryonomis spp*	1	LC
8		Green squirrel	*Paraxerus poensis*	1	LC
9		Bush rat	*Rattu rattus*	3	LC
10		common rat	*Rattus norvegicus*	6	LC
11		Bush rat	*Rattus fuscipes*	2	LC
12	**Pongidae**	Robust chimpanzee	*Pan troglodytes*		
13	**Manidae**	Giant pangolin	*Manis gigantea*	-	VU
14		Ground pangolin	*Smutsia gigantea*	*	VU
15	**Canidae**	Pale fox	*Vulpes pallid*	*	LC
16	**Bovidae**	Congo forest buffalo	*Syncerus caffer nanus*	*	NE
17	**Molossidae**	Giant pangolin	*Manis gigantea*	-	VU
18		Ground pangolin	*Smutsia gigantea*	*	VU
19	**Primata**	white throated monkey	*Cercopithecus erythrogaster*	*	Vu
20		black throated colored monkey	*Cercopithecus roloway*	*	EN
21		Blue Monkey	*Cercopithecus mitis*	*	LC
22		Old world monkey	*Mandrillus leucophaeus*	*	**EN**
23		Mona monkey	*Cercopithecus mona*	*	LC
24	**Viverridae**	Blotched genet	*Genetta tigrine*	*	LC
25		African civet	*Civettictis civetta*	*	LC
26		African palm civet	*Nandinia binotata*	*	LC
27		Cape clawless otter	*Aonyx capensis*	*	NT
28		Small Indian *Mongoose*	*Herpestes auropunctatus*	1	NA
29	**Artiodactyla**	Bush pig	*Potamochoerus porcus*	*	LC
30		Sitatunga or marshbuck	*Tragelaphus spekii*	1	LC
31		Water chevrotain	*Hyemoschus aquaticus*	-	LC
32		Blue duiker	*Cephalophus monticola*	1	LC
33		Red-flanked duiker	*Cephalophus rufilatus*	*	LC
34		Bush duck	*Tragelaphus scriptus*	1	LC
35	**Accipitridae**	Back kite	*Milvus migrans*	4	LC
36		Hooded vulture	*Necrosyrtes monachus*	2	CR
37		African harrier hawk	*Polyboroides typus*	2	LC
38	**Rallidae**	African rail	*Rallus caerulescens*	2	LC
39	***Phasianidae***	Double-spurred Francolin	*Francolinus bicalcaratus*	4	**LC**

S/N	Family/ Order	Common Names	Zoological Names	Abundance	2016 IUCN Status
40	**Apodidae**	African palm swift	*Cypsiurus parvus*	1	LC
41		Little swift	*Apus affinis*	3	LC
42	**Tytonidae**	**Barn owl**	*Tyto alba*	4	LC
43		Owl	*Strix alba*	2	LC
44	**Muscicapidae**	Cassins flycatcher	*Muscicapa cassini*	*	LC
45		Rusty-tailed Flycatcher	*Muscicaparuficauda*	1	LC
46	**Columbidae**	Red eyed dove	*Streptopelia semitorquata*	4	LC
47		Blue headed wood dove	*Turtur brehmeri*	5	LC
48		African green fruit pigeon	*Treron calvus*	1	LC
49	**Numididae**	Guinea fowl	*Numida meleagris*	9	LC
50	**Anatidae**	Bush duck fowl	*Nettapus auratus*	3	LC
51		African black duck	*Anas sparsa*	4	LC
52	Agamidae	Common rainbow lizard	*Agama agama*	*	LC
53	Boidae	Boa	*Boa constrictor*	-	LC
54	Scinidae	Skink	*Mabuya cochonaev*	6	LC
55		West African dwarf crocodile	*Osteolaemus tetraspis*	*	Vu
56		Rock python	*Python bivittatus*	*	LC
57		Spitting cobra	*Naja nigricollis*	1	LC
58		Nile monitor	*Varanus niloticus*	1	LC
59		Alligator	*Alligator sinensis*	*	CR

Source: PGM Survey, 2020

Asterisk (*) indicate species sighted indirectly, minus Asterisk (-) indicates absence, **LC** = Least Concern, **Vu** = Vulnerable, **CR** = Critically Endangered, **NT** = Near Threatened, **EN** = Endangered, **DD** = Data deficient**,** **NA**= Not Assessed.

Appendix 2: Projected Population of the Project Affected States

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2,017	2018	2019	2020
Rivers	5,198,605	5354563	5515200	5680656	5851076	6026608	6207406	6393628	6585437	6783000	6986490	7196085	7411968	7634327	7863356
Abia	2,845,380	2930741	3018664	3109224	3202500	3298575	3397533	3499458	3604442	3712576	3823953	3938671	4056832	4178536	4303892
Ebonyi	2,176,947	2242255	2309523	2378809	2450173	2523678	2599389	2677370	2757691	2840422	2925635	3013404	3103806	3196920	3292827
Enugu	3,267,837	3365872	3466848	3570854	3677979	3788319	3901968	4019027	4139598	4263786	4391700	4523451	4659154	4798929	4942896
Benue	4,253,641	4381250	4512688	4648068	4787510	4931136	5079070	5231442	5388385	5550037	5716538	5888034	6064675	6246615	6434013
Nasarawa	1,869,377	1925458	1983222	2042719	2104000	2167120	2232134	2299098	2368071	2439113	2512286	2587655	2665285	2745243	2827600
Kaduna	6,113,503	6296908	6485815	6680390	6880801	7087226	7299842	7518838	7744403	7976735	8216037	8462518	8716393	8977885	9247221
Plateau	3,206,531	3302727	3401809	3503863	3608979	3717248	3828766	3943629	4061938	4183796	4309310	4438589	4571746	4708899	4850165
Bauchi	4,653,066	4792658	4936438	5084531	5237067	5394179	5556004	5722684	5894365	6071196	6253332	6440932	6634160	6833184	7038179
Gombe	2,365,040	2435991	2509071	2584343	2661873	2741730	2823981	2908701	2995962	3085841	3178416	3273768	3371982	3473141	3577335
Yobe	2,321,339	2390979	2462709	2536590	2612687	2691068	2771800	2854954	2940603	3028821	3119686	3213276	3309674	3408965	3511233
Borno	4,171,104	4296237	4425124	4557878	4694614	4835453	4980516	5129932	5283830	5442345	5605615	5773783	5946997	6125407	6309169

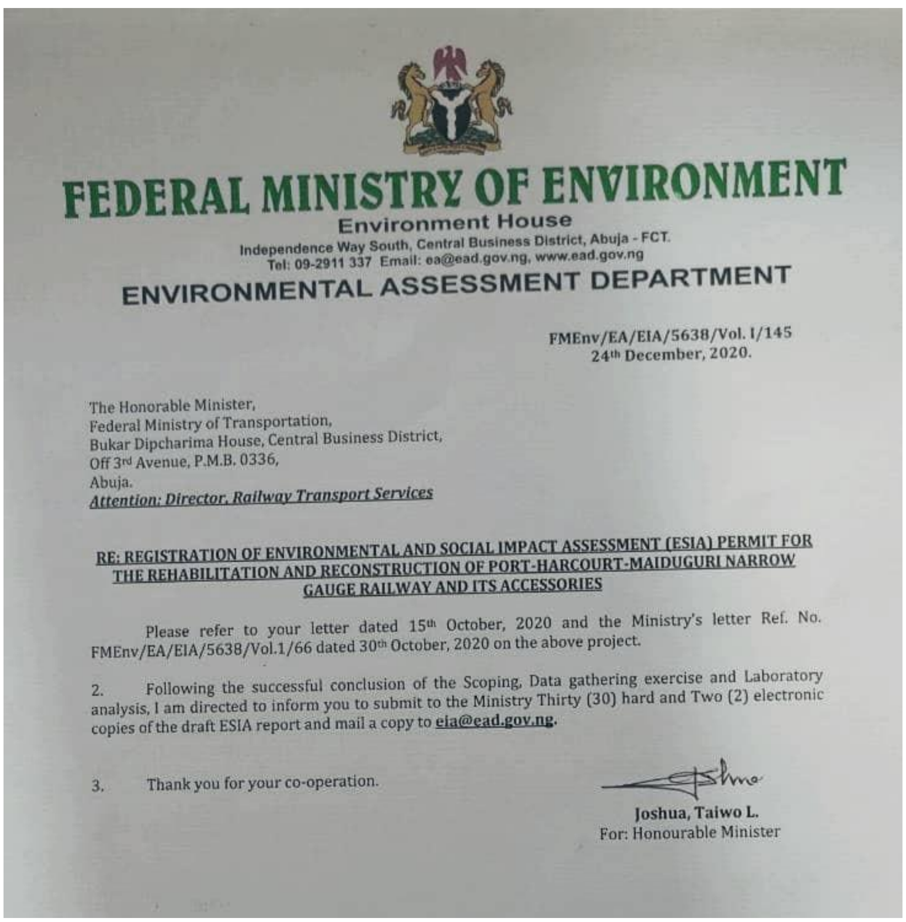
Source: 2006 NPC census figure and PGM Nigeria Limited's population projection using 3.0% Nigeria annual population growth.

Appendix 3: Stakeholders Engagement Pictures



Appendix 4: ESIA CATEGORIZATION AND TOR APPROVAL LETTERS



FEDERAL MINISTRY OF ENVIRONMENT
Environment House
Independence Way South, Central Business District, Abuja - FCT.
Tel: 09-2911 337 Email: ea@ead.gov.ng, www.ead.gov.ng

ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMEnv/EA/EIA/5638/Vol. I/145
24th December, 2020.

The Honorable Minister,
Federal Ministry of Transportation,
Bukar Dipcharima House, Central Business District,
Off 3rd Avenue, P.M.B. 0336,
Abuja.
Attention: Director, Railway Transport Services

RE: REGISTRATION OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) PERMIT FOR THE REHABILITATION AND RECONSTRUCTION OF PORT-HARCOURT-MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

Please refer to your letter dated 15th October, 2020 and the Ministry's letter Ref. No. FMEnv/EA/EIA/5638/Vol.1/66 dated 30th October, 2020 on the above project.

2. Following the successful conclusion of the Scoping, Data gathering exercise and Laboratory analysis, I am directed to inform you to submit to the Ministry Thirty (30) hard and Two (2) electronic copies of the draft ESIA report and mail a copy to **eia@ead.gov.ng**.

3. Thank you for your co-operation.

Joshua, Taiwo L.
For: Honourable Minister

FEDERAL MINISTRY OF ENVIRONMENT

Environment House
Independence Way South, Central Business District, Abuja - FCT.
Tel: 09-2911 337 Email:ea@ead.gov.ng, www.ead.gov.ng

ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMEnv/EA/EIA/5638/Vol. I/144
18th December, 2020.

The Honorable Minister,
Federal Ministry of Transportation,
Bukar Dipcharima House, Central Business District,
Off 3rd Avenue, P.M.B. 0336,
Abuja.
Attention: Director, Railway Transport Services

RE: REGISTRATION OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) PERMIT FOR THE REHABILITATION AND RECONSTRUCTION OF PORT-HARCOURT-MAIDUGURI NARROW GAUGE RAILWAY AND ITS ACCESSORIES

Please refer to your letter dated 15th October, 2020 and the Ministry's letter Ref. No. FMEnv/EA/EIA/5638/Vol.1/66 dated 30th October, 2020 on the above project.

2. Following the conclusion of the site verification exercise, the Ministry has placed the proposed project in Category One (1) with One (1) season baseline data gathering exercise. In line with International Best practices, secondary data may be sourced from approved relevant EIA report within zone of influence of the proposed project.

3. Also, you are requested to incorporate all significant issues raised during the scoping workshop and submit to the Ministry the report of the scoping workshop and a revised Terms of Reference (ToR) detailing project scope & spatial boundary of the proposed study area for approval.

4. The laboratory analysis of the samples must be carried out in a FMEnv accredited Laboratory and witnessed by Officials of the Ministry. You are to ensure full Quality Assurance /Quality Control (QA/QC) measures for the laboratory analysis in line with standard practices.
The following should be forwarded to the Ministry of Environment before submission of the draft EIA report.

- Evidence of accreditation of the Federal Ministry of Environment for the Laboratory where the sample analysis would be carried out.
- Chain of Custody.
- Certificate of Analysis duly stamped and signed by the Laboratory Manager.
- Evidence of Laboratory witnessing by the Federal Ministry of Environment.

5. Upon completion of the EIA studies, You are to submit Thirty (30) hard and Two (2) electronic copies of the draft ESIA report to the Ministry and mail a copy to eia@ead.gov.ng.

6. You may wish to contact the undersigned on GSM number 08055270104 to confirm the receipt of this letter and for any clarification, please.

7. Thank you for your co-operation.

Joshua, Taiwo L.
For: Honourable Minister

Appendix 5: Evidence of Laboratory Accreditation, Witnessing and Quality Assurance

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FEDERAL MINISTRY OF ENVIRONMENT

Environment House

Independence Way South, Central Business District, Abuja - FCT.

Tel: 09-2911 337 www.environment.gov.ng, ea-environment.org

ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMENV/EA/LTS/29/ Vo1/50

6th March, 2018.

The Honourable Commissioner,
Ministry of Science and Technology,
Research and Development Laboratory,
Uyo.
Akwa Ibom State.

REVALIDATION OF THE ACCREDITATION OF ENVIRONMENTAL LABORATORY

Please refer to your application for revalidation of the accreditation of your Environmental Laboratory and the inspection exercise conducted by officials of the Ministry.

2. I am directed to inform you that following the satisfactory completion of the inspection, the revalidation of the accreditation of your Environmental Laboratory located at No.84 Obio Imo Street Uyo has been **approved.**

3. Your certificate would be forwarded to you as soon as it is ready and it is valid for a period of Five (5) years.

4. Congratulations.

Dr. L. P. Eyo-Essien
For : Honourable Minister

REVENUE COLLECTOR'S RECEIPT

Treasury Book No. 6A

Z 10727487

NIGERIA

RRR No. 3401-7460-6840

STATION ABuja

MDA NOSDRA

HEAD/SUB-HEAD

DATE 3/8/17

R.V.No.

Received from AKWA IBOM STATE MINISTRY OF SCIENCE AND TECHNOLOGY, UYO

the sum of ONE HUNDRED THOUSAND NAIRA ONLY

Naira kobo

being (description of payment)* ACCREDITATION FEE (AS LABORATORY CONSULTANT)

ORIGINAL

*If space is insufficient further particulars must be inserted on the back of receipt.

SIGNATURE OR MARK OF PAYER

SIGNATURE OF REVENUE COLLECTOR

₦ 100,000

OCCUPATION OF WITNESS

WITNESS TO MARK

MST - RDL ATTENDANCE SHEET

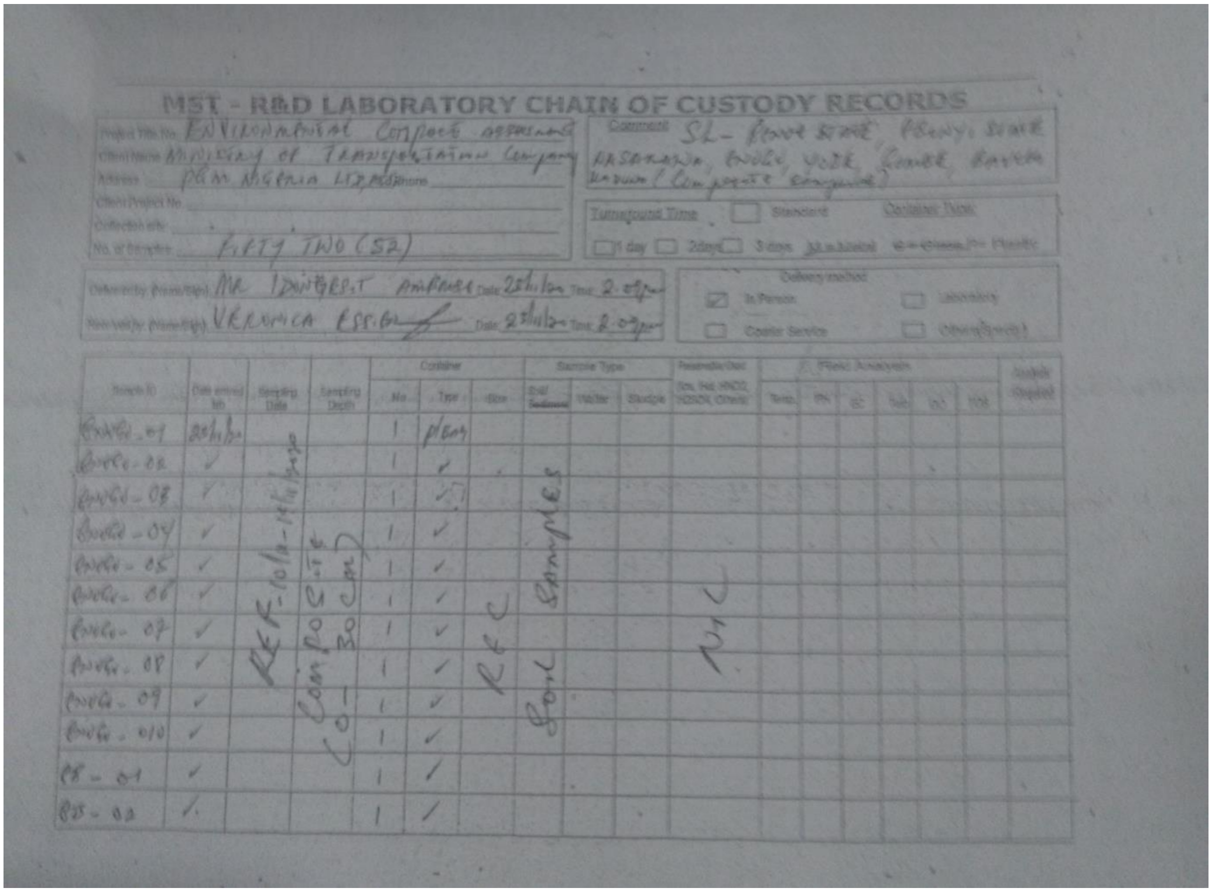
DATE 17-12-2020

NATURE OF VISIT/METTING LABORATORY INSPECTION BY FMENV

S/NO	NAME	COMPANY	PHONE	SIGNATURE
1.	Joan Aniefie Ekong	MST, Dir. of Science	08083772781	
2	Dr Sunday S. Ntoidem	CONTROLLER, FMENV, UYO	08027776660	
3	Ekpo, E. Effiong	MST Manager	08023612224	
4	[illegible]	Rep. PGM	08761518756	
5	[illegible] Peter P.	Safety Officer MST	08137805607	
6	[illegible], Martha B	Chief Scientific Officer MST	08027272294	
7	Ufot, Ime J	PRIN. LAB TECHNOLOGIST	07029008032	
8	Victor James	Scientific officer II	08038698941	
9	Aneela [illegible]	Lab. Superintendent (MST)	08060497356	
10	Esbiet, Veronica	Sample Administrator	07061372728	
11	Etteng Bassey Otuyo	Laboratory Technology	09062137928	

MST R&D LABORATORY CHAIN OF CUSTODY RECORD

Sample ID	Sampling Depth	Sampling date	Date Arrived Lab	Container			Sample Type			Preservative Used	Field Analysis						Analysis Required
				No	Type	Size	Soil/ Sediment	Water	Sludge	(ICE, HCl, HNO_3, H_2SO_4, others)	Temp	pH	EC	Turb	DO	TDS	
OTUKPO			25/11/20	1	Plastic	[illegible]				[illegible]							
GOMBE			✓	1	✓												
BAUCHI			✓	1	✓												
[illegible]			✓	1	✓												



MST - R&D LABORATORY CHAIN OF CUSTODY RECORDS

Project Title No.: ENVIRONMENTAL COMPACT ASSESSMENT
Client Name: MINISTRY OF TRANSPORTATION Company
Address: PGM NIGERIA LTD Phone
Client Project No.:
Collection site:
No. of Samples: FIFTY TWO (52)

Comment: SL- RIVER STATE, ABIA STATE, NASARAWA, ENUGU, YOLA, GOMBE, BAUCHI KADUNA (Composite Sampling)

Turnaround Time: Standard — 1 day, 2days, 3 days
Container Type:

Delivered by (Name/Sign): MR IDONGESIT AMPANA Date: 25/11/20 Time: 2.05pm
Received by (Name/Sign): VERONICA ESSIEN Date: 25/11/20 Time: 2.05pm

Delivery method: ☑ In Person ☐ Laboratory ☐ Courier Service ☐ Others(Specify)

Sample ID	Date arrived lab	Sampling Date	Sampling Depth	Container No.	Container Type	Container Size	Sample Type Soil/Sediment	Water	Sludge	Preservative Used	Temp.	pH	EC	Sal	DO	TDS	Analysis Required
ENVG-01	25/11/20	REF: 10/11-14/11/2020	Composite (0-30 cm)	1	P/Bag	RFC	Soil Samples			N/C							
ENVG-02	✓			1	✓												
ENVG-03	✓			1	✓												
ENVG-04	✓			1	✓												
ENVG-05	✓			1	✓												
ENVG-06	✓			1	✓												
ENVG-07	✓			1	✓												
ENVG-08	✓			1	✓												
ENVG-09	✓			1	✓												
ENVG-010	✓			1	✓												
BS-01	✓			1	✓												
BS-02	✓			1	✓												

MST R&D LABORATORY CHAIN OF CUSTODY RECORD

Sample ID	Sampling Depth	Sampling date	Date Arrived Lab	Container			Sample Type			Preservative Used (ICE, HCl, HNO_3, H_2SO_4, others)	Field Analysis						Analysis Required
				No	Type	Size	Soil/ Sediment	Water	Sludge		Temp	pH	EC	Turb	DO	TDS	
GB - 03																	
GB - 04																	
GB - 05																	
GB - 06																	
GB - 07																	
Lafia - 01																	
Lafia - 02																	
AGYARAGU - 01																	
AGYARAGU - 02																	
AGYARAGU - 03																	
GUDI - 01																	
GUDI - 02																	
TARAKU - 01																	
TARAKU - 02																	
TARAKU - 03																	
OTUKPO - 01																	
OTUKPO - 02																	
MAKURDI - 01																	
MAKURDI - 02																	
MAKURDI - 03																	

MST - R&D LABORATORY CHAIN OF CUSTODY RECORDS

Project Title No. ENVIRONMENTAL IMPACT ASSESSMENT
Client Name: MINISTRY OF TRANSPORTATION COMPANY
Address: Plan HQ. ABUJA Phone:
Client Project No.
Collection site:
No. of Samples: SIXTEEN (16)

Comment: ... BENUE STATE, EBONYI STATE, NASARAWA, ENUGU, YOBE, GOMBE, BAUCHI, KADUNA

Turnaround Time: Standard; 1 day; 2 days; 3 days. Container Type: M = Metal, G = Glass, P = Plastic

Delivered by: (Name/Sign): Mr IDONGESIT AMBROSE Date: 23/11/20 Time: 2:09pm
Received by: (Name/Sign): VERONICA ESSIEN Date: 23/11/20 Time: 2:09pm

Delivery method: ☑ In Person; Courier Service; Laboratory; Others (Specify)

Sample ID	Date arrived lab	Sampling Date	Sampling Depth	Container No.	Container Type	Container Size	Sample Type: Soil/Sediment	Sample Type: Water	Sample Type: Sludge	Preservative Used (Ice, Hcl, HNO3, H2SO4, Others)	Field Analysis: Temp	PH	EC	Turb	DO	TDS	Analysis Required
ENUGU UP	23/11/20	10/11-19/11/2020		1	P	500ml		SURFACE WATER		ICE							
ENUGU DOWN	✓			1	P	500ml											
MADA 01	✓			1	P	500ml											
RIVER BENUE	✓			1	P	500ml											
YOBE	✓			1	P	500ml											
EBONYI	✓			1	P	500ml											
GASHUA	✓			1	P	500ml											
KAFANCHAN	✓			1	P	500ml											
LAFIA	✓			1	P	500ml											
DAMATURU	✓			1	P	500ml											
GOMBE	✓			1	P	500ml											
MAKURDI	✓			1	P	500ml											

MST R&D LABORATORY CHAIN OF CUSTODY RECORD

Sample ID	Sampling Depth	Sampling date	Date Arrived Lab	Container			Sample Type			Preservative Used (ICE, HCl, HNO_3, H_2SO_4, others)	Field Analysis						Analysis Required
				No	Type	Size	Soil/ Sediment	Water	Sludge		Temp	pH	EC	Turb	DO	TDS	
[illegible]		[illegible]	25/10/20	1	P	500ml		Surface water		Ice							
Bauchi Station			✓	1	P	500ml											
Bauchi Rail Station			✓	1	P	500ml											
[illegible]			✓	1	P	500ml											

MST - R&D LABORATORY CHAIN OF CUSTODY RECORDS

Project Title No: ENVIRONMENTAL IMPACT ASSESSMENT
Client Name: MINISTRY OF TRANSPORTATION COMPANY
Address: PHM N.G. ABUJA Phone:
Client Project No:
Collection site:
No. of Samples: NINETEEN (19)

Comment: SL-ABOUT STATE EBONYI STATE NASARAWA, BENUE, YOBE, GOMBE, BAUCHI KADUNA

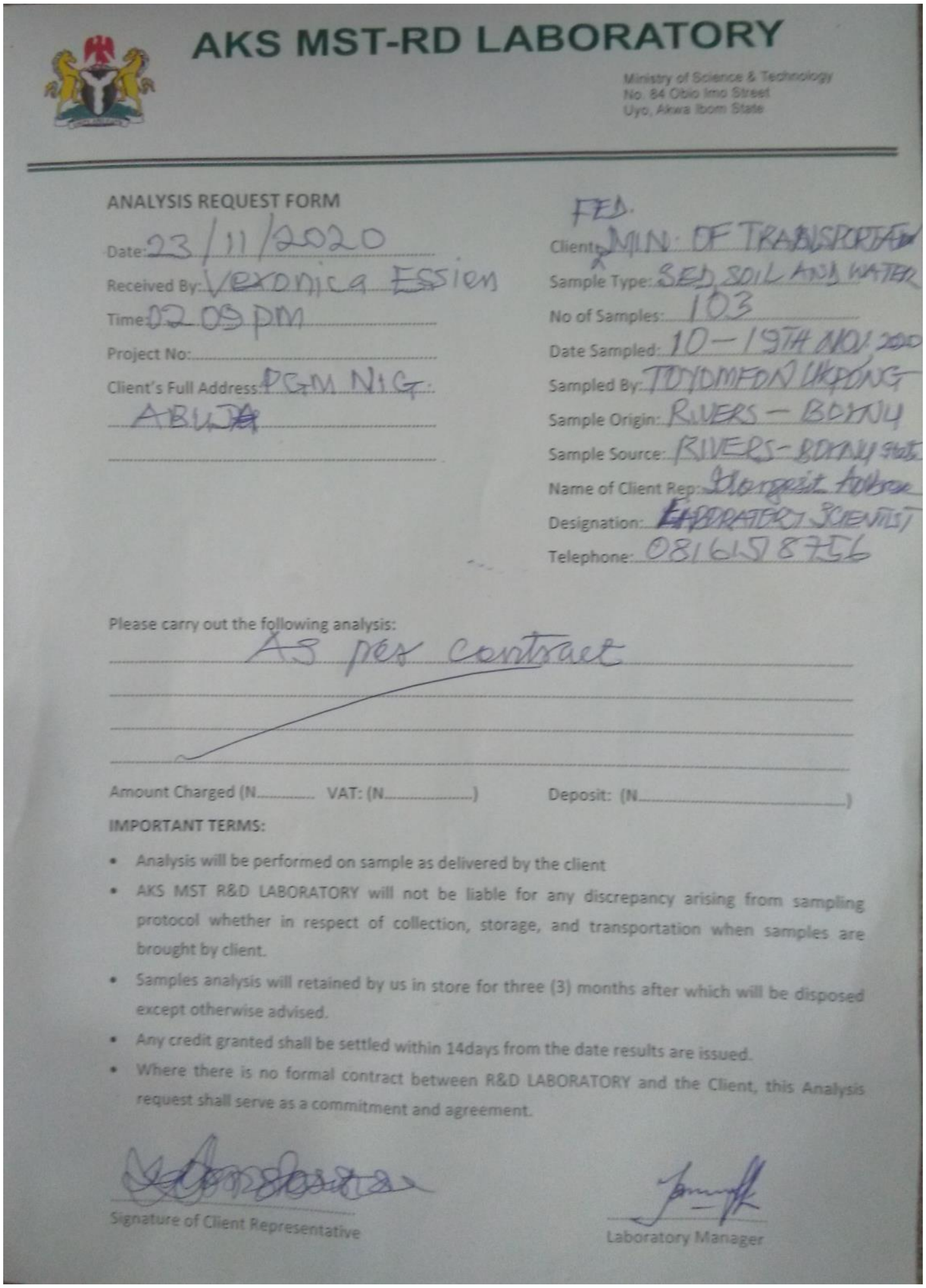
Turnaround Time: ☐ Standard ☐ 1 day ☐ 2days ☐ 3 days

Container Type: ~~M = Metal~~ ~~G = Glass~~ P= Plastic

Delivered by: (Name/Sign): MR IDONGESIT AMBROSE Date: 25/11/24 Time: 2.09pm
Received by: (Name/Sign): VERONICA ESS. [illegible] Date: 25/11/24 Time: 2.09pm

Delivery method: ☑ In Person ☐ Laboratory ☐ Courier Service ☐ Others(Specify)

Sample ID	Date arrived lab	Sampling Date	Sampling Depth	Container			Sample Type			Preservative Used (Ice, Hcl, HNO2, H2SO4, Others)	Field Analysis						Analysis Required
				No	Type	Size	Soil/ Sediment	Water	Sludge		Temp	PH	EC	Turb	DO	TDS	
ABBANI BUKA	25/11/24	10/11 – 19/11-2024		1	P	500ml		GROUND WATER		ICE							
OTUKPO 02	✓			1	P	500ml											
MAKURDI	✓			1	P	500ml											
GUDI	✓			1	P	500ml											
DAMATURU 03	✓			1	P	500ml											
AGYARAGU	✓			1	P	500ml											
OHA AMUFU-01	✓			1	P	500ml											
GBONY	✓			1	P	500ml											
GOMBE 02	✓			1	P	500ml											
NDS-BU-01	✓			1	P	500ml											
LAFIA	✓			1	P	500ml											
DAMATURU 04	✓			1	P	500ml											


AKS MST-RD LABORATORY

Ministry of Science & Technology
No. 84 Obio Imo Street
Uyo, Akwa Ibom State

ANALYSIS REQUEST FORM

Date: 23/11/2020

Received By: Veronica Essien

Time: 02 09 pm

Project No:

Client's Full Address: PGM NIG. ABUJA

Client: FED. MIN. OF TRANSPORTATION

Sample Type: SED, SOIL AND WATER

No of Samples: 103

Date Sampled: 10 – 19TH NOV 2020

Sampled By: TOYDMFON UKPONG

Sample Origin: RIVERS – BONNY

Sample Source: RIVERS – BONNY State

Name of Client Rep:

Designation: LABORATORY SCIENTIST

Telephone: 08161587556

Please carry out the following analysis:

As per contract

Amount Charged (N.......... VAT: (N..........) Deposit: (N..........)

IMPORTANT TERMS:

- Analysis will be performed on sample as delivered by the client
- AKS MST R&D LABORATORY will not be liable for any discrepancy arising from sampling protocol whether in respect of collection, storage, and transportation when samples are brought by client.
- Samples analysis will retained by us in store for three (3) months after which will be disposed except otherwise advised.
- Any credit granted shall be settled within 14days from the date results are issued.
- Where there is no formal contract between R&D LABORATORY and the Client, this Analysis request shall serve as a commitment and agreement.

Signature of Client Representative

Laboratory Manager