ESIA REPORT

FOR

THE PROPOSED 76KM NATURAL GAS PIPELINE PROJECT

FROM

AGPC FACILITY IN OHAJI/EGBEMA LGA, IMO STATE TO INDORAMA COMPLEX IN ELEME LGA, RIVERS STATE

BY

INDORAMA FERTILIZER FZE
INDORAMA FREE ZONE, ELEME LGA,
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FEDERAL MINISTRY OF ENVIRONMENT (FMEnv)
APPROVED ESIA UPDATED WITH SECOND SEASON BASELINE DATA FOR AfDB SUBMISSION

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ABBREVIATIONS

AoI	Project Area of Influence
%	Percentage
µg/m3	Microgram per cubic metre
0C	Degrees Celsius
AfDB	African Development Bank
AIP	alien invasive plant
ANSI	American National Standards Institute
AoI	Area of Influence
APC	All-Progressives Congress
AGPC	Anoh Gas Processing Company
AQS	Air Quality Standards
ASME	American Society of Mechanical Engineers
BCF	Bill Cubic Feet
BOD	Biochemical Oxygen Demand
CAGR	Compound Annual Growth Rate
CCRA	Climate Change Risk Assessment
CDC	Community Development Committee
CDT	Climate Data Tool
Cm	Centimetre
CO	Carbon monoxide
CO2	Carbon dioxide
COD	Chemical Oxygen Demand
COP	Conference of the parties
CPUE	Catch Per Unit Effort
CR&D	Community Relations and Development Department
CSR	Cooperate Social Responsibility
dB	Decibel
dBA	Decibel
DD	Data Deficient
E&S	Environment and Social
EAD	Environmental Assessment Department
EAE	Environment Agency for England
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPC	Engineering Procurement Construction
EPFI	Equator Principle Founding Institute
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FEPA	Federal Environmental Protection Agency

FGD	Focus Group Discussions
FMEnv	Federal Ministry of Environment
GBVH	Gender Based Violence and Harassment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIIP	Global International Industry Practice
GMP	Grievance Management Procedure
GPHC	Greater Port Harcourt City
GPS	Global Positioning System
H+	Hydrogen ion
Ha	Hectares
HR	Human Resources
HSE	Health, Safety and Environment
HUB	Hydrocarbon utilising Bacteria
HUF	Hydrocarbon utilising Fungi
IFF	Indorama Eleme Fertilizer and Chemicals Limited
IEPL	Indorama Eleme Petrochemical Limited
IFC	International Finance Cooperation
IPCC	Inter-Governmental Panel on Climate Change
IPs	Indigenous Peoples
IR	Industrial Relations
IUCN	International Union for Conservation of Nature
kg/cm2	Kilogram force per square centimetre
kg/ha	Kilogram Per Hectare
kg/hr	Kilogram Per Hour
KIIs	Key Informant Interviews
KL	Kilolitres
KPI	Key Performance Indicator
KTA	Kilo Ton Per Annum
kWh	Kilowatt per Hour
LC	Least Concern
LFN	Laws of the Federation of Nigeria
LGA	Eleme Local Government Area
lt/day	Litre Per Day
m3	Cubic Meters
m3/hr	Cubic Meter Per Hours
mamsl	Metres above mean sea level
mbar	Millibar
mbgl	Meter below ground level
MDEA	Methyl diethanolamine
mg/l	Milligram Per Litre
mg/Nm3	Milligrams Per Cubic meter
Mm	Millimetre
MMBTU/MT	Million Metric British Thermal Unit/Metric Ton

MMSCF	Million Standard Cubic Feet
MMSCFD	Million Standard Cubic Feet Per day
MMTPA	Million Metric Tonne Per Annum
MoU	Memorandum of Understanding
MSDS	Material Safety data Sheet
MTPD	Metric Tons Per Day
MW	Megawatt
MWH	Megawatt Per Hour
N_2O	Nitrous oxide
NACE	National Association of Corrosion Engineers
NCCC	National Council on Climate Change
NE	Not Evaluated
NESREA	National Environmental Standards and Regulations Enforcement Agency
NG	Natural gas
NGFCP	Nigerian Gas Flare Commercialization Program
NGOs	Non-Governmental Organisations
NH3	Ammonia
NIMET	Nigerian Meteorological Agency
NMDPRA	Nigerian Midstream and Downstream Petroleum Regulatory Authority
NNPC	Nigerian National Petroleum Cooperation
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NPK	Nitrogen (N), Phosphorus (P) and Potassium (K).
NSDWQ	Nigerian Standard for Drinking Water Quality
NSITF	Nigeria Social Insurance Trust Fund
NSR	Noise Sensitive Receptor
NT	Near Threatened
O&M	Operation and Maintenance
OS	Operational Safeguard
OSH	Occupational Safety and Health
PM	Particulate Matter
PM10	Particulate Matter of 10 diameter
PM2.5	Particulate Matter of 2.5 diameter
PPE	Personal Protective Equipment
ppm	Part per million
PS	Performance Standards
RH	Relative humidity
RIWAMA	Rivers State Waste Management Agency
RoW	Right of Way
RSMENV	Rivers State Ministry of Environment
S	South
SDG	Sustainable Development Goal
SE	Southeast
SED	Socio-Economic Development

SED01	Sediment Station One
SEP	Stakeholder Engagement Plan
SIA	Social Impact Assessment
SO2	Sulphur Dioxide
SON	Standard Organization
SOP	Standard Operating Procedures
SPSS	Statistical Package for the Social Sciences
SW	Surface Water
TDS	Total Dissolved Solids
THB	Total Heterotrophic Bacteria
THF	Total heterotrophic Fungi
ToR	Terms of Reference
UNFCCC	United Nation Framework Convention on Climate Change
USD	United State Dollar
UV	Ultraviolet
VAPP	Violence against Persons (Prohibition) Act
VOCs	Volatile organic compounds
WBG	World Bank Group
WHO	World Health Organization
WMP	Waste Management Plan
WRI/ WBCSD	World Resources Institute/World Business Council for Sustainable Development
wt	Weight

SAFESPACE ESIA TEAM

PERSONNEL	Qualification	COMPONENT
Engr. Olu Andah Wai-Ogosu	MSc Environmental system management (Engineering Option)	Project Leader
Dr. Solomon Nwachukwu	MSc Soil Science, PhD Environmental Soil Science	Project Coordinator Soil Chemistry/Report Compilation
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Dr. Yorkor Banadornwi	PhD Public Health Engineering	Noise and Vibration
Prof. Erema Daka	PhD Marine Biology (Ecotoxicology)	Aquatic Ecology
Engr. Iniabe Eezor	MSc Natural Resources and Environmental Management, PhD (In-view)	Surface Water Resources/Sediment
Dr. Chimezie Ekeke	PhD Plant Biosystematics and Taxonomy	Terrestrial Ecology (Incl. Wetlands)
Engr. Paul Mogaba	MSc Petroleum Geology	Geology/Hydrogeology
Dr. Richard Obinna	MSc Public Health, PhD Public Health	Social-Economic/Public Health
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The management of Indorama Eleme Fertilizer & Chemicals Limited (IFF) wishes to acknowledge with thanks, the opportunity granted by the Government of Federal Republic of Nigeria through the Federal Ministry of Environment (FMEnv) and the Rivers State Ministry of Environment (RSMEnv) and Imo State Ministry of Environment (ISMEnv) to carry out this Environmental and Social Impact Assessment Study (ESIA) for the proposed "IFF-20" x 11 and 24" x 65km Natural Gas Pipeline Project".

In view of the Indorama's business continuity and future development, after due technical review of future natural gas requirement, management has decided to increase diameter from 20" to 24" of the phase two 65km pipeline which will be constructed. Furthermore, this addendum ESIA report covers the aspects of increased diameter of 65km pipeline and wet season data collected during August 2026.

IFF appreciate the cordial working relationships had with the Federal Ministry of Environment, the Rivers State Ministry of Environment, and Imo State Ministry of Environment during ESIA study. IFF acknowledge the support of the CLOs, Royal Chiefs, Clan Heads, Women and Youth Groups, NGOs, Individual and other community-based organizations for their support during this study especially during the stakeholder's engagement.

IFF also acknowledge and appreciate the support of others, who extended their services and support to help in executing this ESIA study.

Thank you,

Management of IFF

EXECUTIVE SUMMARY

Indorama Eleme Fertilizer & Chemicals Limited (IFF) is a leading manufacturer and supplier of Urea fertilizer based in Eleme LGA, Rivers State, Nigeria. The company is a subsidiary of Indorama Corporation, a global conglomerate with diverse business interests including petrochemicals, textiles, and fertilizers. IFF as a leading industrial player in Nigeria, intends to construct a 76km Natural Gas pipeline from a nearby gas supplier (AGPC) in Asa North of Ohaji/Egbema LGA in Imo state to Indorama complex in Eleme LGA, Rivers State.

This Executive Summary has been prepared as a standalone summary of the updated Environmental and Social Impact Assessment (ESIA) of the 76 km natural gas pipeline, in line with Section B and Annex 2 of the AfDB Borrower Guidance Note on Operational Safeguard 1 (OS1). Each section below summarises the findings, plans and commitments of the corresponding chapter of the report (Chapters 1 to 9) — including the key tables — so that decision-makers, lenders, regulators and the public can understand the Project, its setting, its principal environmental and social risks and impacts, the mitigation and management commitments and their cost, without reference to the main report.

ES1.0 ESIA Objective

The overall objective of this ESIA study is to proactively identify and evaluate the potential environmental and social (E&S) impacts of the Project; and to put in place appropriate mitigation measures and management actions to address the identified impacts.

The ESIA study involved a number of key activities carried out in a stepwise manner. These included: scoping, literature review, baseline data gathering, stakeholder engagement, impact identification and evaluation, development of mitigation measures and an Environmental, Social Management and Monitoring Plan (ESMMP), and Report writing. Each of these activities/processes is explained in detail in this Report.

ES1.1 Project Overview, Categorisation and Approvals

The key data of the Project, its categorisation and the approvals obtained to date are summarised in Table ES-1.

Table ES-1: Key Project data

Item	Description
Project proponent	Indorama Fertilizer Free Zone Enterprise (IFF), Indorama Free Zone, Eleme LGA, Rivers State, Nigeria (part of the Indorama Eleme Fertilizer & Chemicals Limited complex).
Project	76 km natural gas transmission pipeline from the Anoh Gas Processing Company (AGPC) manifold at Assa, Ohaji/Egbema LGA, Imo State, to the gas receiving facility in the Indorama Complex at Akpajo, Eleme LGA, Rivers State.
Phase 1 (completed)	20-inch x 11 km pipeline from the AGPC manifold to approximately KP17 near Awara, hot-tapped into the existing IFF 18-inch x 83 km pipeline; laid on newly acquired Right-of-Way (RoW) of about 16.5 ha in Assa, Ochia and Awara communities (Imo State); constructed, commissioned and in operation.

Item	Description
Phase 2 (to be constructed)	24-inch x 65 km pipeline from KP17 to the Indorama Complex, laid within the existing NNPC/Oando (NAOC) pipeline RoW, parallel to the existing 18-inch pipeline; no new land acquisition; scheduled October 2026 – September 2028 (contractor mobilisation June 2027, mechanical completion July 2028, handover August 2028).
Key design data	Design pressure 85 bar; flange rating 600#; capacity 300 MMSCFD (20-inch) and 370 MMSCFD (24-inch); API 5L PSL2 X70M carbon-steel line pipe, 3LPE coated, impressed-current cathodic protection; minimum cover 2.0 m (land) and 3.0 m (swamp); line-break valve stations, pig launcher/receiver, metering and emergency shutdown (ESD) systems; design life 30 years.
Location and host area	Two States (Imo and Rivers); five LGAs (Ohaji/Egbema in Imo State; Etche, Ikwerre, Obio/Akpor and Eleme in Rivers State); 22 host communities (5 in Imo State and 17 in Rivers State).
RoW and land take	RoW width 15 m; total RoW footprint about 114 ha, of which about 16.5 ha (11 km section) is newly acquired land and about 97.5 ha (65 km section) lies within the existing pipeline corridor.
Estimated cost	Initial estimate N95 billion (76 km x 20-inch); Phase 2 (24-inch x 65 km) about N90 billion.
Workforce	About 100 personnel at peak construction (skilled, semi-skilled and unskilled), with priority to host-community labour.
ESIA category and approvals	FMEnv Category 1 EIA with one-season baseline (letter FMEnv/EA/EIA/7236/Vol.1/68 of 12 October 2023); Terms of Reference approved by FMEnv letter FMEnv/EA/EIA/7236/Vol.1/170 of 27 October 2023; high-risk (Category 1) project under the AfDB Integrated Safeguards System.
Baseline seasons	Dry season: December 2023. Wet season: 6–9 August 2026 (fieldwork supervised by FMEnv and Rivers State Ministry of Environment; laboratory inspection on 10 August 2026).
Applicable standards	Nigerian EIA Act CAP E12 LFN 2004 and EIA Regulations 2021; PIA 2021 and NMDPRA regulations (2023); AfDB Integrated Safeguards System (2023) OS1–OS10; IFC Performance Standards (2012); WBG General and Onshore Oil & Gas EHS Guidelines; Equator Principles IV.

ES1.2Policy, Regulatory and Administrative Framework.

This ESIA study has been conducted in line with the National EIA Procedural and Sectoral Guidelines, as well as ensuring consideration of relevant best practices, international standards, and guidelines. The Legal and Regulatory Framework provides the basis for the preparation, approval and implementation of the project ESIA. The framework identifies the applicable Federal and State environmental laws, regulations, standards, institutional requirements and international safeguards relevant to the project**.** The key relevant national regulatory framework applicable to Project are:

- Environmental Impact Assessment Act 86 of 1992 (amended by EIA Act CAP E12 LFN 2004) and regulation 2021.
- National Environmental Impact Assessment Procedural and Sectoral Guidelines, 1994
- The Midstream and Downstream Petroleum Environmental Regulation 2023
- The Midstream and Downstream Petroleum Safety Regulation 2023
- Climate Change Act, 2021
- Labour Act, CAP L1 LFN 2004
- Petroleum Industry Act,2021
- Land Use Act CAP L5 LFN, 2004
- Water Resources Act, CAP W2 LFN, 2004

Below are relevant international guidelines and standards

- International Conventions, Protocols and Agreements signed by Nigeria
- Equator Principles (EPIV)
- International Finance Corporation Performance Standards on Environmental and Social Sustainability, 2012 (IFC PSs) African Development Bank's (AfDB) Integrated Safeguard System (ISS) - Operational Safeguards on Environmental and Social Sustainability, 2023 (AfDB OSs)
- The World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines

The effective implementation of the Indorama project will depend on the capacity of the Project Proponent, contractors, government agencies, regulators and host communities to fulfil their respective environmental and social responsibilities. Consequently, the table below outlines the roles and responsibilities of each group, including their institutional and administrative capacity.

Table ES-2: Roles, responsibilities and institutional capacity of Project implementation stakeholders

Institution/Entity	Principal Roles and Responsibilities	Institutional and Administrative Capacity
Indorama Fertilizer Freezone Enterprise (IFF)	Overall responsibility for implementation of the ESMP; provision of financial, human and technical resources; obtaining and maintaining statutory approvals; integrating E&S requirements into project design, procurement and contracts; ensuring contractor compliance; stakeholder engagement; grievance management; environmental and social monitoring; incident reporting; corrective actions; and periodic review of ESMP performance.	Indorama has an established organisational structure, experienced management and technical personnel, and an operational **Environmental and Social Management System (ESMS)** supported by HSE procedures. The existing facility has established systems for environmental monitoring, regulatory compliance, incident management, emergency response, contractor management, stakeholder engagement and reporting. These existing systems provide the institutional foundation for implementing and maintaining the ESMP for the proposed Project. Additional resources will be provided as required during construction and operation.
Project Management Team	Incorporate ESMP requirements into project planning, engineering, procurement, construction and commissioning; coordinate contractors and consultants; ensure that environmental and social commitments are incorporated into work	The Project Management Team will comprise experienced project, engineering, construction, HSE and environmental/social personnel. The team will have defined reporting lines and authority to incorporate E&S requirements into

	packages and contractor obligations.	project decisions, approve work plans, coordinate contractors and track ESMP performance. Project-specific E&S responsibilities will be included in project implementation procedures and work packages.
HSE/Environmental and Social Management Team	Day-to-day implementation and supervision of ESMP measures; environmental monitoring; inspections and audits; waste management; pollution prevention; occupational and community health and safety; biodiversity and resource management; incident investigation; record keeping and regulatory reporting.	Indorama maintains an established HSE and environmental management function with personnel experienced in industrial environmental management, occupational health and safety, environmental monitoring, regulatory compliance and emergency response. The team will be strengthened with additional competent personnel and specialists where required, particularly during peak construction activities. It will have authority to conduct inspections, identify non-conformances, initiate corrective actions and escalate significant issues to management.
Engineering/Operations Department	Ensure that environmental and social controls are incorporated into engineering design, equipment selection, operation and maintenance; implement resource-efficiency, emission-control and pollution-prevention measures.	The Engineering and Operations teams possess technical and operational experience in large-scale pipeline design, construction and operation. Their established maintenance, process-control and operational procedures provide capacity to integrate pollution prevention, energy efficiency, emission controls, waste minimisation and environmental safeguards into project design and operation. Specialist engineering support will be engaged where necessary.
Procurement/Contract Management	Incorporate E&S requirements, performance standards and applicable regulatory obligations into contractor and supplier agreements; monitor contractor performance and enforce contractual corrective actions.	Existing procurement and contract-management procedures provide a mechanism for incorporating HSE, environmental and social requirements into tender documents, contracts and purchase orders. Contractors will be prequalified based on relevant technical and HSE

		competence, and contractual performance requirements will include compliance with the ESMP, applicable legislation and Indorama's HSE requirements.
Contractors/Subcontractors	Implement all applicable ESMP, HSE and environmental requirements within their areas of responsibility; prepare method statements and task-specific plans; provide competent personnel and PPE; undertake monitoring and reporting; manage wastes and hazardous materials; report incidents and implement corrective actions.	Contractors will be required to demonstrate adequate technical, financial, HSE and environmental capacity before mobilisation. Each major contractor will designate competent HSE/environmental personnel and implement project-specific HSE and environmental plans. Contractor performance will be subject to induction, routine inspections, audits, toolbox meetings, monitoring and corrective-action tracking by Indorama.
Federal Ministry of Environment (FMEnv)	Regulatory oversight of the ESIA process and environmental compliance; review and approval of the ESIA/ESMP; monitoring of compliance with approval conditions; inspections and enforcement in accordance with applicable environmental legislation.	FMEnv has the statutory mandate, technical departments and established procedures for ESIA review, environmental compliance monitoring, inspection and enforcement. The Ministry will provide regulatory oversight through review of the ESIA/ESMP, approval conditions, inspections, monitoring and review of compliance reports.
Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)	Regulatory oversight of applicable midstream/downstream petroleum and gas-related activities; review and enforcement of relevant technical, safety, environmental and operational requirements within its statutory mandate.	NMDPRA has specialised regulatory and technical capacity covering applicable gas and petroleum-sector activities, including technical, operational and safety oversight. Its established inspection, permitting, monitoring and enforcement mechanisms will support regulatory compliance for applicable gas-related aspects of the Project.
Rivers State Ministry of Environment / relevant State authorities	State-level environmental oversight, inspections, coordination and monitoring; participation in environmental compliance activities and community-related environmental matters.	The Rivers State environmental authorities provide state-level environmental oversight and have established personnel and administrative structures for environmental monitoring, inspection, stakeholder engagement

		and coordination with federal regulators. The Ministry will support implementation through periodic monitoring, participation in inspections and engagement on state and community-level environmental matters.
Relevant Local Government Authorities	Local administrative coordination, support for stakeholder engagement and community-level implementation of relevant project commitments.	The relevant Local Government Authorities provide an established administrative interface between the Project, host communities and state government. Their capacity will primarily support local coordination, communication, community mobilisation and participation in implementation of relevant community-level commitments.
Host Communities/Community Representatives/CDCs	Participate in consultation, disclosure, grievance management and participatory environmental monitoring; provide community feedback and assist in identifying emerging environmental and social concerns.	Existing community leadership structures, Community Development Committees (CDCs) and community representatives provide an established platform for stakeholder engagement and community participation. Their capacity will be strengthened through regular consultation, environmental awareness, grievance-management procedures and participation in **Participatory Environmental Monitoring (PEM)**.
Consultants/Independent Specialists	Provide specialist environmental and social expertise, baseline studies, monitoring, audits, capacity building and independent technical support where required.	Qualified and appropriately accredited consultants and specialists will be engaged where specialist expertise is not available internally. Consultants will support environmental and social monitoring, audits, technical studies, capacity building and independent verification. Their engagement will be subject to defined scopes of work, competency requirements and quality-control procedures.
Development Finance Institution/AfDB, IFC/WB where applicable	Oversight of applicable environmental and social requirements under the AfDB Integrated Safeguards	Where applicable, AfDB, IFC/WB will provide independent safeguard oversight through review of

	System, including monitoring of implementation of relevant safeguard commitments.	environmental and social documentation, monitoring of ESMP implementation and engagement with the PIE and relevant stakeholders. The PIE will maintain appropriate documentation and reporting mechanisms to demonstrate compliance with applicable AfDB safeguard requirements.

Capacity assessment. In line with Section J and Annex 2 (item 3) of the AfDB Borrower Guidance Note on OS1, the review of the Nigerian environmental and social framework and of the implementing institutions concluded that: (i) the Federal and State regulators (FMEnv, NMDPRA, RSMEnv and ISMEnv) have clear statutory mandates and established EIA review, permitting and inspection procedures, but field monitoring is constrained by logistics and budget, so IFF will facilitate joint monitoring visits; (ii) IFF, as the Project Implementing Entity (PIE), operates an existing ESMS, HSE and Community Relations & Development functions and a grievance mechanism for the existing 83 km pipeline communities, but needs dedicated E&S staffing for Phase 2 construction and specific skills in AfDB OS5 livelihood monitoring, GBV/SEA risk management and contractor E&S supervision; (iii) contractors are required by contract to provide qualified HSE/E&S personnel and a Contractor ESMP; and (iv) community structures (CDCs, cluster heads and CLOs) need training in grievance handling and participatory monitoring. The capacity gaps and the capacity-building programme are summarised in Table ES-3.

Table ES-3: Capacity gaps and capacity-building programme

Stakeholder	Capacity gap identified	Capacity-building measure	Timing	Indicative cost (N million)
IFF (PIE) – E&S/HSE and Community Relations	No dedicated E&S/social safeguards staff for Phase 2; limited OS5 livelihood-monitoring and GBV/SEA experience	Appoint a Project E&S personel and a Social/Community Liaison Officer for Phase 2; training on AfDB ISS OS1–OS10, OS5 monitoring, GBV/SEA and contractor E&S supervision	Before mobilisation; refresher annually	25
EPC and community contractors	Variable HSE/E&S competence of sub-contractors and community contractors	Contractual E&S requirements; Contractor ESMP; E&S induction, toolbox talks and ESMP-specific training; minimum one HSE officer per work front	Pre-mobilisation and throughout construction	6
Cluster heads, CLOs and Grievance Committees	Informal grievance logging and limited record keeping	Training on the Project GRM, grievance registration, resolution timelines and reporting	Before construction; refresher every 6 months	5
Host communities / CDCs, women and youth groups	Limited awareness of pipeline hazards and RoW restrictions;	Pipeline safety and emergency awareness campaigns;	Construction and first year of operation	8
FMEnv, NMDPRA, RSMEnv, ISMEnv and LGAs	Logistics constraints for field monitoring	Facilitation of joint monitoring and inspection visits; sharing of monitoring reports	Six monthly during construction;	12

Stakeholder	Capacity gap identified	Capacity-building measure	Timing	Indicative cost (N million)
			annually in operation	
Emergency services (State Fire Service, SEMA, local health facilities)	Limited familiarity with high-pressure gas pipeline emergencies	Briefing on the pipeline ERP	Before commissioning; annually thereafter	4
Total (indicative)				**60**

Legislative and regulatory requirements for ESMP implementation, and gaps with AfDB requirements. Implementation of the ESMP is anchored on the EIA Act CAP E12 LFN 2004 and the EIA (Procedures and Charges) Regulations 2021 (ESIA approval conditions and compliance monitoring by FMEnv), the Petroleum Industry Act 2021 and the Midstream and Downstream Petroleum Environmental, Safety and Decommissioning & Abandonment Regulations 2023 (NMDPRA licences to construct and operate, and decommissioning approval), the Land Use Act CAP L5 LFN 2004 (land acquisition), the Labour Act and Employee Compensation Act (workers) and State environmental laws of Rivers and Imo States. The applicability of the AfDB Operational Safeguards is summarised in Table ES-4, and the principal gaps between the national framework and AfDB requirements, with the measures adopted by the Project to close them, are summarised in Table ES-5.

Table ES-4: Applicability of AfDB Operational Safeguards (ISS 2023) to the Project

Operational Safeguard	Triggered?	Reason / how addressed
OS1 – Assessment and management of E&S risks and impacts	Yes	Category 1 project; this ESIA and ESMP; IFF ESMS.
OS2 – Labour and working conditions	Yes	About 100 construction workers (direct and contracted); HR policies, worker GRM, OHS plan.
OS3 – Resource efficiency and pollution prevention	Yes	Construction wastes, hydrotest water, fuel use, fugitive methane; waste, spill and LDAR measures; GHG reporting.
OS4 – Community health, safety and security	Yes	High-pressure gas through 22 communities; traffic; labour influx; security; QRA, ERP, community awareness.
OS5 – Land acquisition, restrictions on land use and involuntary resettlement	Yes	16.5 ha new RoW for the 11 km section (economic displacement, no physical displacement); land-use restrictions on the RoW.
OS6 – Habitat and biodiversity conservation	Yes	Clearing of modified habitat, wetland edges; conservation-significant species reported; Biodiversity Management Plan.
OS7 – Vulnerable groups	Not triggered for Indigenous Peoples	No Indigenous Peoples or highly vulnerable rural minorities in the sense of OS7; vulnerable individuals (women, elderly, youth, PAPs) are addressed under OS1, OS5 and OS10.
OS8 – Cultural heritage	Yes	Sacred bush along the Ochia alignment, three graves within the RoW at Ochia, shrines in host communities; chance-finds procedure.
OS9 – Financial intermediaries	No	The Project is financed directly and not through a financial intermediary sub-lending arrangement.
OS10 – Stakeholder engagement and information disclosure	Yes	SEP, GRM, ESIA disclosure and continuous engagement with 22 host communities.

Table ES-5: Key gaps between the national framework and AfDB requirements, and gap-filling measures

Theme	Nigerian requirement	AfDB requirement	Gap-filling measure adopted by the Project
Baseline seasons	FMEnv approved one-season (dry) baseline	Category 1: seasonal variation to be characterised (OS1)	Second (wet) season field campaign, 6–9 August 2026, integrated per component.
Land acquisition and compensation	Land Use Act: compensation for unexhausted improvements (crops, structures); land value not compensated; no livelihood-restoration requirement	OS5: compensation at full replacement cost before land access; livelihood restoration; support to vulnerable PAPs; GRM; monitoring and completion audit	Compensation for land, crops and economic trees paid before entry; GRM; livelihood restoration and vulnerable-person support;
Stakeholder engagement and disclosure	EIA Act: public display for 21 working days and review panel	OS10: continuous, inclusive engagement through the project cycle; SEP; accessible GRM; disclosure in accessible form	SEP updated to include the 11 km communities; GRM; disclosure at LGA and State offices and in host communities.
Labour and working conditions	Labour Act and Employee Compensation Act; limited requirements for contractor workers and worker grievances	OS2: equal application to contracted workers; worker GRM; OHS; no child or forced labour	Contractual labour clauses; worker GRM; IFF HR policies (Section 1.9) applied to contractors; labour audits.
Community health, safety and security	NMDPRA technical and safety regulations	OS4: community risk assessment, emergency preparedness with communities, security personnel conduct, GBV/SEA	QRA, ERP with community component, security code of conduct, GBV/SEA code of conduct and referral pathway.
Biodiversity	Endangered Species Act; no habitat-classification requirement	OS6: habitat classification; no net loss for natural habitat; management of priority species	Habitat classification (modified habitat dominant); pre-clearance surveys; Biodiversity Management Plan.
Cultural heritage	NCMM Act protects antiquities	OS8: includes sacred sites, graves and intangible heritage; chance-finds procedure; consultation	Avoidance of sacred sites; consultation and agreed rites for graves; chance-finds procedure.
GHG emissions	Climate Change Act 2021 (no project-level quantification requirement)	OS3: estimate and report GHG emissions; minimise methane	Construction GHG estimate; leak detection and repair (LDAR); annual reporting of fugitive and vented methane.

ES2.0 Need for the Project

Indorama operates a Petrochemical and Fertilizer manufacturing complex in Nigeria, with facilities producing Urea and Polymers using Natural Gas as feedstock. The Petrochemical plants have been in operation since 2006, and the Fertilizer plants consist of two trains commissioned in 2016 and 2021, with a third train under construction. To support the expansion, Indorama initially planned to construct a 20-inch gas pipeline from Anoh Gas Manifold to their complex in Eleme, with a maximum flowrate of 300mmscfd. The pipeline will deliver natural gas at 85bar pressure to meet the gas requirements for future projects. However, in view of the Indorama's business continuity and future development, after due technical review of future natural gas requirement, management has decided to

increase diameter from 20" to 24" of the phase two 65km pipeline which will be constructed. The 20" x 11km natural gas pipeline has been constructed and in operation.

ES2.1 Project Benefits

The proposed 76 km gas pipeline will provide Indorama projects with a reliable, affordable and secure natural gas supply, supporting increased and sustained fertilizer/methanol production, improved energy and operational efficiency, reduced production costs and improved long-term business viability. The use of natural gas will also support lower emissions intensity, reduced environmental impacts and a potential reduction in associated-gas flaring compared with less efficient or higher-emission alternatives.

The Project will generate significant economic and social benefits through job creation, income generation, skills acquisition and transfer, and contract and procurement opportunities for indigenous contractors and businesses. Host communities are expected to benefit from scholarships, women's grants and support, training, and other community-development initiatives. At the wider level, the Project will strengthen gas and industrial infrastructure, stimulate local economic activity and investment, support Nigeria's fertilizer availability and food-security objectives, reduce dependence on fertilizer imports, and contribute to national economic growth. Overall, the Project will deliver mutually reinforcing economic, social and environmental benefits by strengthening reliable energy supply, fertilizer production, local employment and enterprise development, community well-being, industrialisation, and the long-term sustainability of Indorama's operations.

Section 2.2 of the report identifies eight principal benefits of the Project, summarised below:

- **Increased fertilizer production:** a stable and cost-effective supply of natural gas feedstock will enable Indorama to increase urea output, meet growing domestic demand and reduce the need for fertilizer imports.
- **Energy efficiency:** natural gas is a cleaner and more efficient energy source than alternative fuels, improving the energy efficiency of operations and reducing operating costs.
- **Economic growth:** construction and operation will create jobs, stimulate the regional economy and encourage further investment.
- **Reduction of gas flaring:** utilisation of gas that would otherwise be flared or unutilised supports Nigeria's gas-flaring reduction and GHG commitments.
- **Reliable energy supply:** pipeline supply reduces operational risks from supply interruptions and price volatility.

- **Infrastructure development:** the pipeline strengthens regional gas infrastructure and may attract other industries.
- **Environmental benefits:** cleaner-burning gas reduces air pollution relative to other hydrocarbons.
- **Long-term viability:** the pipeline secures the long-term sustainability of the Indorama operations and their contribution to the Nigerian economy.

ES2.2 Project Value

The initial cost of the proposed 76 km x 20" gas pipeline was estimated at N95 billion, covering materials, construction, personnel, equipment, approvals and corporate social responsibility activities. The first phase has been completed. The second phase 24" x 65km natural gas pipeline cost is estimated approx. 90 billion naira only. A significant portion will benefit the Nigerian economy through contracts, subcontracts, local procurement and employment, while the gas supply will support fertilizer production and power generation at the Indorama complex. The Project will also support gas-flaring and greenhouse-gas reduction. World Bank data indicate that about 600 MMSCF/day of gas was flared globally in 2021. With a fertilizer line consuming approximately 90 MMSCF/day, the Project has the potential to avoid about 2.1 MMTPA of CO_2-equivalent emissions, subject to actual gas availability and operating conditions, while contributing to Nigeria's gas-flaring reduction and climate objectives.

In summary, consistent with Section 2.3 of the report, the value of the Project lies in:

- enhancement of fertilizer production at the Indorama Complex through a secure gas supply of up to 300 MMSCFD (20-inch section) and 370 MMSCFD (24-inch section);
- reduction of gas flaring, by providing a market for associated and non-associated gas in the Anoh area;
- a potential reduction in greenhouse-gas emissions of approximately 2.1 MMTPA CO2-equivalent, subject to actual gas availability and operating conditions; and
- local and national economic value through contracts, local procurement, employment and government revenue.

ES2.3 Envisage Project Sustainability

Environmental Sustainability

The gas pipeline project is environmentally sustainable owing to the implementation of the Environmental and Social Management Plan emanating from the Environmental Impact Assessment (EIA) study. Furthermore, the pipeline will also be constructed in line with green engineering principles, with minimal disturbance to the environment.

Economic Sustainability

The AGPC field has large reserves of natural gas and currently has a gas processing facility of 300 million standard cubic feet per day. Consequently, there are therefore proven reserves of gas that can economically and commercially viable to support the proposed pipeline project and other project operational in Indorama. Thus, revenue will accrue from the sale of gas which would otherwise have been flared for Associated Gas (AG) or unutilized for Non-associated Gas (NAG). There is high demand for natural gas in the local market. The project will therefore contribute substantially to the revenue accruing to Nigeria. The project will definitely stimulate economic activities around the area as long as gas Indorama complex is operational. The execution of the project will ensure increase income to those employed.

Technical Sustainability

The proposed project is expected to be technically sustainable due to the utilization of proven technology for the piping and auxiliary facilities implemented in the existing 83km gas pipeline. Moreover, strict adherence to internationally accepted engineering design and construction standards, as well as codes of practice, will be implemented at all stages of the project to ensure technical sustainability.

Social Sustainability

The project will leverage on existing Social Action Plan from the existing Gas Pipeline project and continue to consult with stakeholders throughout its lifetime. The project is expected to provide jobs, skills training, infrastructural development, grant to women, contracts, and generally improve the well-being of the project host communities. A Grievance Redress Mechanism will be established to prevent conflicts with the local community. Furthermore, the project's social sustainability will be maintained through ongoing consultations with the community, fostering a positive working relationship between Indorama and the project communities.

ES2.4 Project Options

Do-Nothing Option

In Environmental Social Impact Assessment (ESIA), it's important to consider all options, including doing nothing. In this case, not building a gas pipeline would hinder the expansion plans of the Indorama facility in Eleme, leading to missed opportunities for social, economic, and environmental benefits like job creation, revenue generation, and crime reduction. Ultimately, the Do-Nothing option was rejected because it didn't maximize benefits for both the people and the nation.

The Delay Option

This option suggests postponing a project to a later date, usually because conditions are not favorable for implementation. However, in this case, the social, economic, and political environment strongly support the project. Delaying it would make all previous work and costs wasted, potentially leading to increased costs and discouraging investors. Therefore, the Delayed Project option is not a viable or appealing choice.

Go-Ahead Option

This option was chosen as the best one to help the Train 3 Fertilizer plant and other industrial activities run smoothly at the Indorama Complex in Port Harcourt, Rivers State, Nigeria.

ES2.5 Project Alternatives

Project screening is a crucial process that aims to assess the potential environmental impacts of a proposed project. Consequently, the following alternatives were thoroughly screened against the benefits and dis-benefit on the environment and its natural resources.

- Transportation Alternative
- Route alternative
- Pipe size alternatives

In considering transportation alternatives, the options of Road Trucking and Pipeline were looked at. The Pipeline option was favored because of its safety benefits over Road Trucking, which has a higher risk of gas explosions and increased emissions. However, the Pipeline system does have a few negative impacts, such as loss of biodiversity and vandalism. These issues can be addressed with proper mitigation measures and technology. The following options were considered

Table ES-6: Route options considered

Route Options	Length of Route (Km)	Physical Structure/Settlements	Length of River/Creeks /Creeklets Crossings (Km)	Area of route to be required acquired
Option 1	78	Route acquisition shall result in substantial physical displacement of people living along the route. Impact on livelihood and residential and industrial assets very high.	No river crossing, Major wetlands	100% of route
Option 2	76	14% new route acquisition with minimal physical displacement of people. Route deliberately chosen to avoid physical settlements. Impact on	No river crossing, Few wetlands	Only 14% of route (ie 11 km) will be newly acquired, while 65 km will be on the existing

Route Options	Length of Route (Km)	Physical Structure/Settlements	Length of River/Creeks /Creeklets Crossings (Km)	Area of route to be required acquired
		livelihood low relative to options 1 & 3		83km pipeline RoW To Indorama complex
Option 3	79	Route acquisition shall result in substantial physical displacement of people living along the route. Impact on livelihood and residential assets relatively higher than option 2	No river crossing, Major wetlands	100% of route

Route Option 2 was identified as the preferred route for the project based on its comparatively lower environmental and social impacts, as well as its technical and economic advantages. The option requires acquisition of approximately 11 km of new Right-of-Way (RoW), thereby minimising land acquisition, physical displacement and potential disruption to existing settlements. It is also expected to result in comparatively lower impacts on local livelihoods and economic activities. From an engineering and economic perspective, Route Option 2 was considered more favourable and practicable than Route Options 1 and 3, and was therefore selected as the preferred route. The second phase 65km natural gas pipeline will be constructed within existing RoW

The transportation and pipe-size alternatives considered are summarised in Table ES-7.

Table ES-7: Transportation and pipe-size alternatives

Alternative	Key considerations	Outcome
Road trucking (CNG/LNG)	High-pressure or cryogenic transport; specialised trucks, storage and refuelling infrastructure; road-traffic and explosion risk; higher emissions; poor road infrastructure	Not recommended
Pipeline	Continuous, weather-independent, high-volume transport; lowest energy use and safest mode; impacts limited to RoW clearing and vandalism risk, minimised by use of existing RoW and surveillance	Recommended
12-inch and 18-inch pipe (300 MMSCFD)	Higher pressure drop and energy use; no capacity for future demand	Rejected
20-inch pipe (300 MMSCFD)	Adequate for initial demand	Selected for Phase 1 (11 km)
24-inch pipe (370 MMSCFD)	Lower pressure drop; capacity for future gas demand and supply security	Selected for Phase 2 (65 km)

Different options for pipe sizes were considered in order to deliver the necessary amount of gas to the Indorama complex.

- 12”x 76km pipeline to deliver 300mmscf/d
- 18” x 76km pipeline to deliver 300mmscf/d

- 20'' x 76km pipeline to deliver 300mmscf/d
- 24'' x 76km pipeline to deliver 370mmscf/d

Overall, the benefits of a 20-inch and 24-inch pipe diameter over other pipe diameters were significant and as such have a significant impact on its overrall performance, efficiency, and cost-effectiveness of a piping system and consequently **"was selected"**. However, in view of the Indorama's business continuity and future development, after due technical review of future natural gas requirement, it has been decided to increase diameter from 20" to 24" of the phase two 65km pipeline which will be constructed. The increase pipeline diameter will be able to deliver 370mmscf/d natural gas which will ensure continuous supply to the operations, and enhance the reliability as Indorama has different gas supplies in different gas producing zones.

ES3.0 Project Description

A 20-inch pipeline is planned to connect the ANOH gas processing plant in Assa Imo state to the Indorama facility, delivering natural gas at high pressure. The pipeline will utilise an existing Right-of-Way (RoW) for approximately 65 km, while approximately 11 km will require acquisition of a new RoW. The pipeline will maintain a uniform 24-inch diameter throughout the 65km alignment to ensure consistent and efficient gas flow and 20 inch at 11km. The newly acquired 11 km RoW follow a "plan–consult–identify–value–compensate–restore–monitor" approach. The key principle is to acquire only the land necessary for the project, minimise displacement, ensure transparent valuation and compensation, protect vulnerable persons and maintain meaningful engagement with affected communities throughout the process. This approach is consistent with AfDB OS5, IFC PS5 and international good practice, which emphasise avoidance and minimisation of displacement, meaningful consultation, appropriate compensation, livelihood restoration and monitoring of outcomes.

The pipeline project will be implemented in two phases:

- Phase 1: Construction of a new 20-inch pipeline from the ANOH Gas Processing Plant (AGPC) to approximately KP17, where it will connect to the existing 18-inch × 83 km IFF pipeline through a hot-tapping arrangement. This section will traverse approximately 11 km of newly acquired RoW, generally running parallel to the existing RoW.
- Phase 2: Construction of the new 24-inch pipeline start from the KP17 (connection point near Awara Community), on the existing NNPC/Oando RoW at approximately 65km. The pipeline will then turn and continue within the existing corridor, running

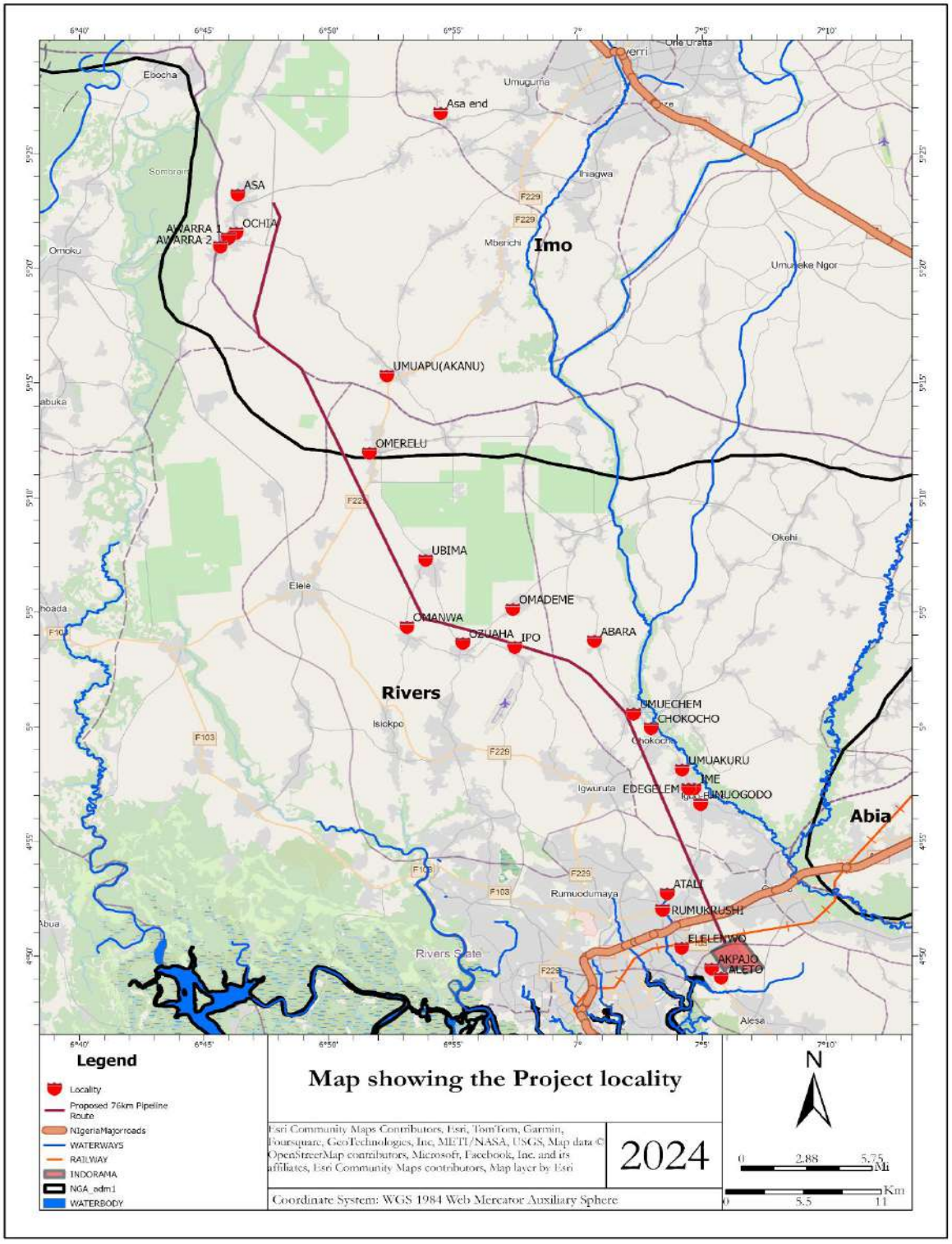
parallel to the existing 18-inch × 83 km pipeline until it reaches the Indorama Complex.

Right-of-Way dimensions and land take. The total length of the RoW is 76 km and the RoW width is 15 m. The 11 km Phase 1 section therefore occupies approximately 16.5 ha (11,000 m x 15 m = 165,000 m²) of newly acquired land, while the 65 km Phase 2 section will be constructed within the existing NNPC/Oando (NAOC) pipeline corridor, where the 15 m working strip corresponds to approximately 97.5 ha (65,000 m x 15 m) of land already held as pipeline RoW and requiring no new acquisition. The total RoW footprint of the 76 km pipeline is therefore approximately 114 ha (1,140,000 m²), of which only about 16.5 ha (14%) is new land take.

The main permanent and temporary components of the Project are listed in Table ES-8.

Table ES-8: Permanent and temporary Project components

Permanent components	Temporary components (construction only)
20-inch x 11 km pipeline, AGPC manifold to KP17 24-inch x 65 km pipeline, KP17 to the IFF gas receiving facility Manifold with ultrasonic custody-transfer metering at the AGPC tie-in Corrosion-inhibitor injection system Pig launching and receiving stations (AGPC, KP17, Indorama) Two line-break valve stations and one valve station along the RoW Gas receiving facility with gas chromatograph, slug catcher, knock-out drum, ESD valves and metering station at the Indorama Complex	Temporary site office facilities Laydown, pre-fabrication and construction warehouse areas within the RoW Temporary pipe storage yards (no workers' camps along the RoW; workers housed in existing accommodation)



Right of Way with communities hosting the pipeline

The initial scope of work covers Engineering, Procurement, construction, testing and commissioning of the 20" X 76km from AGPC to Indorama Natural Gas pipeline. However, in view of the Indorama's business continuity and future development, after due technical review of future natural gas requirement, it is decided to increase diameter from 20" to 24" of the phase two 65km pipeline which will be constructed. The 11 km 20" natural gas

pipeline construction has completed and currently in operation. The construction and operation of 24" x 65km natural gas pipeline scope covers the following:

Pre-Construction

The activities in this phase are essentially desktop works involving feasibility, technical and financial investigations/considerations. Pre-construction activities during this phase include:

- Engineering design
- Procurement of materials/equipment
- Permit to re-survey existing ROW.
- Gas Pipeline Route survey
- Environment & Social Impact Assessment (ESIA)
- Acquisition of land for new 11km RoW
- Oil Pipeline License (OPLL)
- Survey verification and boundary re-opening
- Mobilization of equipment and personnel to site

At the end of the design phase, the proposed 20-inch x 11 km and 24 inch x 65km pipelines will be dimensionally correct, such that all the main components of the Project can be fully described. It is during this phase that the outcomes of the ESIA will influence how the proposed Project develops.

Project planning, decision-making and refinement of the Project will continue throughout the design phase, as a result of continued engineering studies, as well as per the findings of this ESIA and associated ESMMP, and through further post-ESIA environmental and social studies.

Pipeline design data

S/No	DESIGN PARAMETERS	11km pipeline	65km pipeline
1	Nominal pipe diameter (inches)	20	24
2	Length of pipeline, km	11	65
3	Flange pressure rating	600#	600#
4	Design pressure	85bar	85bar
5	Capacity at maximum operating pressure	300mmscfd	370mmscfd
6	Minimum pipe wall thickness	12.7mm	15.9mm
7	Coating for external corrosion protection	3LPE	3LPE
8	Depth of burial (swamp)	Minimum cover of 3.0m	Minimum cover of 3.0m

S/No	DESIGN PARAMETERS	11km pipeline	65km pipeline
9	Depth of burial (land)	2.0m	2.0m

Construction of the proposed pipeline will require carbon-steel line pipes, valves, fittings, flanges, welding and coating materials, construction aggregates, concrete and reinforcement materials, cathodic-protection components, hydrostatic-testing materials, pigging/commissioning materials, erosion-control materials and general construction consumables. The principal permanent material will be approximately 11 km of 20-inch with wall thickness 12.7mm and 65km of 24 inch carbon-steel line pipe with a minimum wall thickness of 15.9 mm and 3LPE external corrosion protection. Materials will be sourced from qualified and approved local and international manufacturers/suppliers, subject to applicable Nigerian regulatory and local-content requirements. Final quantities will be established through the detailed engineering Material Take-Off (MTO) and procurement schedule.

Current Design

The 20-inch x 11 and 24 inch x 65 km pipeline Project will follow the pattern of the 18-inch x 83 km pipeline except for the pipeline size and length, as the equipment design, process flow sheets, layout, etc. IFF shall engage competent Engineering, Procurement and Construction (EPC) Contractors for the Project. For the purposes of this ESIA, the following regarding the Project is important to note:

- Project design is such that the Project will have an operational lifespan of 30 years., with a planned shutdown for pigging purpose every 5 years.

Construction phase

Construction of the gas pipeline will be executed in accordance with a standard engineering/planning framework to ensure maximum efficiency in construction, minimum adverse environmental and health impact, earliest completion time, and compliance with regulatory requirements. This involves the following:

- Material Procurement and Transportation
- Bush clearing within ROW.
- Excavation/Trenching
- Construction (Tie-in Points and Receiving Gas Station)
- Pipe laying (pipe stringing/welding, hydrostatic testing Non-destructive Weld Inspection, Lowering and Backfilling and cathodic protection).
- Commissioning and Handover

For gas transportation projects, 3LPE coated steel line pipes are used, with a factory-applied external polyethylene coating for corrosion protection. The pipeline will be buried with a minimum soil cover of 2.0 meters, with the pipe laying process varying depending

on the environment. In normal ground, the ditch is excavated with clear sides and backfilled with granular material. In swamps, the ditch is excavated with side sloping and the pipe is laid with a concrete weight coating to prevent flotation. The trench must be free from objects that may damage the pipe or coating, with backfill material of silt or sand.

Resources, wastes, manpower and schedule. Trenching will generate about 136,076 m³ of excavated soil (17,776 m³ for Phase 1 and 118,300 m³ for Phase 2), of which about 75% will be re-used as backfill. Construction will consume about 248,000 litres of diesel. The main waste streams and estimated quantities are summarised in Table ES-11. Approximately 100 personnel will be engaged at peak construction (indicatively 25 skilled, 30 semi-skilled and 45 unskilled), with a target of at least 50% of the workforce, and all unskilled positions where available, recruited from the host communities. Phase 1 (11 km) was implemented between October 2024 and March 2026 and is in operation; Phase 2 (65 km) is scheduled from October 2026 to September 2028, with contractor mobilisation in June 2027, pipeline laying from July 2027 to June 2028, mechanical completion (pre-commissioning) in July 2028 and handover in August 2028.

Table ES-11: Main waste streams and estimated quantities

Phase	Waste stream	Estimated quantity	Classification	Management
Construction	Excavated subsoil	136,076 m³	Non-hazardous	Backfilling and reinstatement
Construction	Vegetation / clearing waste	3,000–8,000 m³	Non-hazardous	Mulching / controlled disposal
Construction	Scrap metal and pipe off-cuts	30–80 t	Non-hazardous	Segregation and recycling
Construction	Hydrotest water	8,000–15,000 m³	Liquid waste	Testing, treatment and controlled discharge
Construction	Drilling mud / cuttings (HDD, thrust boring)	1,000–5,000 m³	Special waste	Dewatering, re-use or approved disposal
Construction	Used oils / lubricants	10,000–25,000 L	Hazardous	Bunded storage; licensed recovery
Construction	Domestic / general waste	150–300 t	Non-hazardous	Segregation; approved disposal
Operation	Pigging waste	5–30 t per pigging event	Potentially hazardous	Characterisation; incineration at the Indorama Complex
Operation	Condensate / liquid hydrocarbons	1,000–10,000 L per event	Hazardous	Recovery and controlled disposal
Operation	Used oils, filters, absorbents, batteries	~1,000–3,000 L/yr; 1–4 t/yr	Hazardous	Licensed hazardous-waste contractor
Operation	RoW vegetation maintenance waste	500–2,000 m³/yr	Non-hazardous	Mulching / re-use

Land acquisition

Land acquisition for the approximately 11 km new Right-of-Way (RoW), covering an estimated 16.5 hectares (165,000 m²) was acquired from three (3) communities namely Assa, Ochia and Awarra. The process followed a participatory and transparent process aimed at avoiding or minimizing physical and economic displacement. Affected landowners, land users and communities were consulted, while affected assets were identified and valued to guide fair compensation. Final engagement with affected landowners was held on 18 June 2025, with compensation, livelihood restoration and additional support for vulnerable persons addressed in line with applicable agreements and identified needs. A Grievance Redress Mechanism (GRM) was established to facilitate the timely resolution of concerns. The approach is aligned with AfDB Operational Safeguard 5 (OS5) and IFC Performance Standard 5 (PS5). A gazette notification was published in Imo State Gazette No 13, Volume 49 indicating the purpose of the land acquisition, and giving a 19 days window for any objection related to valuation; payment of appropriate compensation and overall acquisition process. The public hearing under the supervision of Imo State ministry of lands survey, housing and urban planning and Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) was conducted on 18th of June 2025 with no objection.

The land acquisition process for the 11 km RoW is summarised in Table ES-10.

Table ES-10: Summary of land acquisition for the 11 km new RoW

Aspect	Details
Extent	About 11 km x 15 m = 16.5 ha (165,000 m²), Ohaji/Egbema LGA, Imo State.
Affected communities	Assa, Ochia and Awara.
Ownership / tenure	Customary land held by individuals, extended families and communities (land vested in the Governor under the Land Use Act 1978; customary rights of occupancy).
Land use affected	Farmland, bush fallow and secondary vegetation, crops and economic trees; sacred bush along the Ochia alignment and three graves within the RoW at Ochia.
Physical / economic displacement	No physical displacement (route selected to avoid settlements and structures); economic displacement through loss of crops and economic trees and permanent restriction of incompatible land uses on the RoW.
Acquisition process	Route selection to avoid settlements → RoW survey and pegging → identification and verification of landowners, land users and assets → valuation of land, crops and economic trees → gazette notification in Imo State Gazette No. 13, Vol. 49 (19-day objection window) → public hearing supervised by the Imo State Ministry of Lands, Survey, Housing and Urban Planning and NMDPRA on 18 June 2025 (no objection) → final engagement with affected landowners on 18 June 2025 → payment of compensation before land entry → livelihood restoration and vulnerable-person support → monitoring.

ES4.0 ESIA Study Methods

The study used national and international methods outlined in the Federal Ministry of Environment (FMEnv) Green Book, Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) 2018, and International Finance Corporation (IFC) Environmental, Health and Safety (EHS) guidelines to conduct an Environmental

and Social Impact Assessment (ESIA) for a proposed pipeline project from Anoh Gas Processing Company (AGPC) in Asa to Indorama in Eleme. The study reviewed relevant laws and guidelines related to IFF activities to ensure compliance. Additionally, field data was gathered during the dry season in December 2023 and wet season in August 2026 within 2.0km on both sides of the Right of Way (RoW), with controls sampled at about 4 km beyond the starting and ending points of the RoW. Regardless of the one-season data approval from FMEnv, the IFF conducted a wet season baseline data gathering which took place 6-9th of August 2026 with officials of Federal and State Ministry of Environment including laboratory inspection on 10th of August 2026 as part quality assurance and control procedure. The sample analysis was done by Anal Concept Laboratory during dry season and Adopt International during wet season 2026, accredited laboratories in Port Harcourt. The socio-economic and health baseline study used a combination of primary and secondary data collection. Primary data was obtained through household questionnaires, key informant interviews, focus group discussions, community consultations and direct observations across communities within the project area of influence

The sampling design applied in both seasons is summarised in Table ES-12.

Table ES-12: Baseline sampling design (dry season December 2023 and wet season August 2026)

Component	Sampling effort (each season)	Key parameters
Climate / meteorology	Field weather station near Ipo plus 30-year regional data (1990–2020)	Temperature, relative humidity, wind speed/direction, pressure, cloud cover, solar radiation, rainfall
Air quality and noise	40 stations along the RoW, including 2 control stations	SO2, NO2, CO, O3, SPM, PM10, PM2.5, VOC, NH3, CxHy; LAeq noise
Soil quality	40 positions at two depths (0–15 cm and 15–30 cm)	Physico-chemistry, nutrients, heavy metals, THC/TPH/PAH/BTEX, microbiology
Geology, resistivity and geotechnics	Trial pits (1.5 m) and auger holes (3.0 m); 70 resistivity stations	Lithology, soil corrosivity, thermal conductivity, geotechnical properties
Groundwater	Existing community boreholes along the RoW (22 + 2 controls)	Physico-chemistry, major ions, heavy metals, microbiology
Surface water and sediment	3 stations: Okulu Stream (SW1), Otamiri–Chokocho (SW2), Egbeda Stream (SW3)	Physico-chemistry, heavy metals, hydrocarbons, microbiology
Aquatic biology	Same 3 stations (12–13 Dec 2023; 6–7 Aug 2026)	Phytoplankton, zooplankton, benthos, fisheries
Vegetation and wildlife	8 transects (T1–T8) with quadrats	Floristic composition, IUCN status, fauna by direct observation, calls, signs and interviews
Socio-economics and health	22 communities; 440 households (20 per community); FGDs, KIIs, participatory appraisal; health-facility records; MUAC of 200 children	Demography, livelihoods, income, infrastructure, perceptions, health status and services
Cultural heritage	Community survey and literature review	Shrines, sacred forests, graves, festivals and intangible heritage

ES4.1 Baseline Environment

ES4.1.1 Climate/ Meteorology

The study observed seven microclimatic parameters in the project environment: ambient temperature, relative humidity, wind speed, atmospheric pressure, cloud cover, dominant wind direction, and solar insolation. The average measurements for these parameters for the dry and wet seasons were 29.2 oC, 73.6%, 1.5 m/s, 1009.5 mbar, 5.4 oktas, and 220 W/m2 as well as 27.1 oC, 82.3%, 3.1 m/s, 1008.1 mbar, 6.2 oktas, and 183.2 W/m2 respectively. The weather analysis showed a mix of wet maritime and dry continental air masses, creating conditional instability. The main rainy periods for the environment were from June to October, with average monthly rainfall exceeding 300 mm, while the dry season had rainfall below 20 mm. The highest maximum temperature was in February, and the lowest was in July. The prevalent wind direction varied between north-easterly and south-westerly depending on the season. Solar insolation also varied with the season, with higher levels during the dry season.

ES4.1.2 Air quality

As a part of the environmental assessment study, to establish the baseline ambient air quality of proposed project environs, the monitoring of various criteria quality parameters was done at 40 locations. The air quality baseline study of the proposed Project environs has shown that the average ground level concentrations of various criteria quality parameters, within and outside proposed project sites for the dry and wet seasons respectively: SO_2 (4.10 µg/m^3); NO_2 (26.51 µg/m^3); CO (5.07 µg/m^3); O_3 (14.45 µg/m^3); SPM (104.62 µg/m^3); PM_{10} (61.13 µg/m^3) and $PM_{2.5}$ (32.91 µg/m^3) as well as SO_2 (3.96 µg/m^3); NO_2 (30.68 µg/m^3); CO (10.20 µg/m^3); O_3 (32.96 µg/m^3); SPM (60.39 µg/m^3); PM_{10} (30.23 µg/m^3) and $PM_{2.5}$ (19.51 µg/m^3). Other parameters such as C_xH_y, VOC and NH_3 were below detection limit (BDL) for both seasons. All monitored values were below acceptable limits set by concerned regulators across all sampled stations.

ES4.1.2 Noise

To establish the baseline, an ambient noise survey was undertaken within the project environment as part of the assessment study for the proposed project. Ambient noise was monitored at forty (40) stations, including two (2) control stations. Ambient noise levels in the monitored environment during the field survey for the dry and wet seasons ranged from 50.3 dB(A) to 63.2 dB(A) and from 49.1 dB(A) to 67.1 dB(A), respectively. Details of the noise level measurements captured during fieldwork are provided in Tables 4.9 and 4.9a. It is shown that, for the dry and wet seasons, about 90% and 72.5% of noise observations for the sample environment fell within 50-53 dB(A) for the period of monitoring, respectively, while 10% and 7.5% of overall observations were 55 dB(A) and above. Higher noise levels were recorded during daytime hours due to anthropogenic

activities, and vice versa. Generally, ambient noise levels for the project environment did not exceed the IFC standards of 70 dB(A) for the entire monitored periods.

Table ES-13: Ambient air quality and noise – seasonal means and applicable limits

Parameter	Dry season (Dec 2023)	Wet season (Aug 2026)	Applicable limit	Remark
SO2 (µg/m³)	4.10	3.96	WHO/IFC 24-h: 50 (IT-2)	Within limit
NO2 (µg/m³)	26.51	30.68	Nigeria 24-h: 120; 1-h: 200	Within limit
CO (µg/m³)	5.07	10.20	WHO 8-h: 10,000	Within limit
O3 (µg/m³)	14.45	32.96	WHO 8-h: 100	Within limit
PM10 (µg/m³)	61.13	30.23	Nigeria 24-h: 150	Within limit
PM2.5 (µg/m³)	32.91	19.51	Nigeria 24-h: 40	Within limit
VOC, NH3, CxHy	BDL	BDL	–	Below detection
Noise, LAeq dB(A)	50.3–63.2	49.1–67.1	IFC daytime: 55 (residential), 70 (industrial)	Mostly below 55 dB(A); higher values near roads and markets

Source: Chapter 4, Tables 4.8, 4.8a, 4.9 and 4.9a.

ES4.1.3 Geology

Regionally, the Project Area is situated within the greater Niger Delta. The formation of the present-day Niger Delta started in the early Paleocene era and resulted in the build-up of fine-grained sediments eroded and transported by River Niger and its tributaries.

Locally, the lithologies identified in the study area are predominantly sandy clay, clay, clayey sand and minor sand from the surface to a maximum investigation depth of 3.0m. Sandy clay accounts for over 70% of the lithologies encountered based on soil auger holes' data.

ES4.1.4 Soil Quality

Soil quality assessment was considered a critical aspect of the ESIA of the proposed 76km Natural Gas Pipeline with the objective to document soil condition along RoW and to aid impact assessment with respect to proposed project activities on the soil ecosystem. Consequently, soil samples were collected along the pipeline RoW with a control station collected about 10km away from the starting and ending point of the RoW at two depths (0-15 and 15-30cm) using hand auger according to national and international standards. Soil samples were subjected to laboratory analysis in an FMEnv/NMDPRA accredited laboratory and discussed under soil section of the ESIA report. Physical observation during the field data gathering revealed that the study area is relatively flat, with wetlands. Soil of the area are derived from geologic parent material of coastal plain sands friable when dry and slightly stick when wet. They are moderately deep, weakly structured with coarse texture to fine particle in the surface while the subsurface soils have clay accumulation. The pH (H_20) of the air-dried for topsoil ranged from 4.1 to 6.7 and 3.59 to 5.70 for dry and wet season respectively, while subsoil pH ranged 4.3 to 6.3 and 3.48 to 5.78 for dry

and wet seasons respectively. organic carbon present in topsoil of the study area ranged from 0.936 to 2.262% and 1.014 to 2.901% for dry and wet season respectively, while for subsurface soil organic carbon ranged between 0.758 to 2.108% and 0.819 to 2.212% for dry and wet seasons respectively. Heavy metal level depicts bedrock characteristics of the study area with iron showing the highest concentration with mean value of 279.49 and 296.9mg/kg topsoil; 319.49 and 325.6mg/kg subsoil, followed by copper 16.30 and 15.36mg/kg topsoil 16.06mg/kg and 16.86mg/kg subsoil, zinc 9.54 and 10.46mg/kg topsoil 8.64mg/kg and 8.77mk/kg, Nickel 8.36 and 7.59mg/kg topsoil, 62mg/kg and 6.86mg/kg subsoil, Lead 3.14 and 2.77mg/kg topsoil, 3.29 and 3.55mg/kg subsoil, chromium 2.29 and 2.21mg/kg topsoil,1.48 and 1.31mg/kg subsoil and Arsenic 0.15 and 0.12mg/kg topsoil, 0.15mg/kg and 0.19mg/kg subsoil all for dry and wet season respectively., the soil quality assessment has given an insight of the soil condition within the proposed pipeline RoW for better management approach during the project implementation.

ES 4.1.5 Hydrogeology

The bulk of groundwater in the Niger Delta is contained in very thick and extensive sediments of the Benin Formation. In general, the hydrogeological data in the upland areas of the Niger Delta have very broad similarities not only on the sub surface lithology but also in the overall aquifer characteristics. The exploited aquifers in the Niger Delta including the Greater Port Harcourt are derived from the Benin Formation (The Coastal Plain Sands). Basically, the Benin Formation is unconsolidated and consists of very thick sediment over 2000meters thick. Groundwater was not in any trial pits dug and any soil auger hole. The maximum depth for each trial hole is 1.5m and 3.0m for the soil auger holes. This suggest that groundwater occurs at depths beyond 3.0m across the site. Water tables in unconfined aquifers varies with season. The groundwater level, although not measured, is a known fact that it mimics the surface topography to a large degree. Hence, groundwater flows from the northwest towards the southeastern part of the area. This trend is expected since surface topography is highest towards the northwest and lowest towards the southeastern part of the project site. The major source of aquifer recharge in the project area is surface precipitation (rainfall). With rainfall varying from 2000 mm inland of the Delta to 3600mm at the coastline.

ES 4.1.5.1 Groundwater Quality

Groundwater quality assessment was undertaken along the proposed 76 km pipeline RoW during the dry and wet seasons to establish baseline conditions for future environmental monitoring. Groundwater was generally clear, with low turbidity, TDS and electrical conductivity, indicating low dissolved mineral loading. The groundwater was predominantly slightly acidic, with mean pH values of 6.27 in the dry season and 6.12 in

the wet season, with several samples below the stated potable-water guideline range. The waters were generally soft, with low hardness and low concentrations of major ions and nutrients. Oil and grease, cyanide and ammonia were below detection limits, while salinity remained very low, indicating no significant evidence of saline intrusion. Dissolved oxygen, BOD and COD were generally low, although the wet-season maximum COD slightly exceeded the stated WHO guideline, warranting continued monitoring. Heavy metals were generally low, with arsenic, chromium, lead, mercury, nickel and cadmium below detection limits; wet-season manganese showed some elevation relative to the stated WHO value. Microbiological results showed no faecal coliform contamination, although total coliforms were detected at some locations and increased slightly during the wet season. The groundwater baseline indicates generally low dissolved and microbial loading, but groundwater acidity, seasonal changes in selected metals and occasional elevated COD should be retained as key parameters for subsequent monitoring and environmental management.

ES4.1.6 Surface water

Surface water samples were collected from three (3) predetermined sampling stations: Okulu Stream (SW1), Otamiri Stream (SW2) and Egbeda Stream (SW3) in the study area. Okulu Stream is a brackish water body, while Otamiri Stream and Egbeda Stream are freshwater bodies. Samples from both the dry and wet seasons were analysed in an FMEnv-approved laboratory. Seasonal comparison showed that surface-water pH remained near neutral to slightly alkaline, increasing from a dry-season mean of 7.56 ± 0.06 to 7.76 ± 0.06 in the wet season. Mean temperature decreased from 28.63 ± 2.35°C in the dry season to 26.47 ± 0.62°C in the wet season. Electrical conductivity (EC) and total dissolved solids (TDS) showed marked spatial and seasonal variability. Mean EC decreased from 2,591.67 ± 4,441.28 µS/cm in the dry season to 1,769.33 ± 2,471.11 µS/cm in the wet season, while mean TDS decreased from 1,306.67 ± 2,237.24 mg/l in the dry season to 887.53 ± 1,239.89 mg/l in the wet season. The variability is consistent with differences in ionic strength and the influence of freshwater dilution, particularly during the wet season. Turbidity and TSS were higher in the wet season, with mean turbidity increasing from 4.97 ± 0.57 NTU to 9.60 ± 2.69 NTU and mean TSS increasing from 3.77 ± 0.65 mg/l to 5.60 ± 1.07 mg/l. Among the major ions, sodium remained the predominant cation, with the general cation order of Na > Ca > Mg > K. Mean concentrations of sodium, calcium and magnesium decreased during the wet season, while potassium increased slightly. Heavy-metal concentrations were generally low. Silver, cobalt, vanadium, nickel, chromium, lead, mercury, cadmium and arsenic were below detection limits in both seasons. Manganese, iron, copper and zinc were detected. Microbial counts were generally of the order of 10^2 CFU/ml but were higher during the wet season. Mean Total Heterotrophic Bacteria (THB) increased from 2.17×10^2 CFU/ml in the

dry season to 5.03 × 10² CFU/ml in the wet season, while Total Heterotrophic Fungi (THF) increased from 1.30 × 10² CFU/ml to 2.00 × 10² CFU/ml. Total coliforms increased from a mean of 29.33 to 47.33 MPN/100 ml, while faecal coliforms increased from 12.67 to 21.33 MPN/100 ml. The seasonal increase in microbial and coliform counts indicates increased microbial loading during the wet season and suggests probable faecal contamination associated with activities within the study area. Summarily, the results indicate a surface-water system with generally acceptable pH, dissolved oxygen and low detectable oil and grease, but with seasonal and spatial variability in ionic parameters, elevated BOD5/COD, chloride and copper relative to the stated NESREA limits, and increased microbial indicators during the wet season.

ES4.1.7 Sediment

The classes of sediment encountered in the study area was sandy loam. The particle size distribution shows that sand particles predominate followed by clay particles and silt. Sediment pH during the dry season ranged from 5.00 to 5.30, with a mean of 5.17 ± 0.15, indicating slightly acidic sediment conditions. During the wet season, pH ranged from 4.69 to 5.79, with a mean of 5.15 ± 0.57. The dry-season EC ranged from 141 to 858 µS/cm, with a mean of 424 µS/cm, whereas the wet-season values ranged from 108 to 525 µS/cm, with a mean of 293 µS/cm. The reduction in mean EC during the wet season may be associated with dilution arising from increased rainfall and freshwater inflow, which can reduce the concentration of dissolved ionic constituents in the sediment-water interface. Sediment sulphate concentrations decreased from a dry-season mean of 16.00 mg/kg to a wet-season mean of 11.00 mg/kg, with corresponding ranges of 10–25 mg/kg and 6–18 mg/kg, respectively. The seasonal reduction may reflect dilution, hydrological flushing and differences in organic matter decomposition processes between the two seasons. The organic matter indicators showed slight seasonal differences. Total Organic Carbon (TOC) increased from a dry-season mean of 2.55% to 4.14% during the wet season, while Total Organic Matter (TOM) increased from 4.41% to 7.14%. Ammonia also increased from a mean of 0.38 mg/kg in the dry season to 0.95 mg/kg during the wet season. Sodium decreased from a dry-season mean of 54.48 mg/kg to 46.15 mg/kg during the wet season. This reduction may partly reflect increased freshwater input and dilution during the wet season. Magnesium remained relatively stable, decreasing only slightly from a dry-season mean 20.79 mg/kg to 20.53 mg/kg during the wet season. Calcium remained below the detection limit in both seasons. Iron decreased slightly in mean concentration from 49.16 mg/kg during the dry season to 39.67 mg/kg during the wet season, although the wet-season range was wider, extending from 5.83 to 74.05 mg/kg. Iron and manganese are natural constituents of sedimentary materials, and the concentrations recorded were within ranges for Niger Delta sediments. Hydrocarbon concentrations in the sediments were generally low during both seasons. Dry-season Total Hydrocarbon Content (THC)

ranged from 2.12 to 3.51 mg/kg, with a mean of 2.77 mg/kg, while the wet-season values ranged from 3.42 to 4.16 mg/kg, with a mean of 3.77 mg/kg. During the dry season, hydrocarbon-utilising bacteria (HUB) ranged from 0.8 × 10^3 to 1.3 × 10^3 CFU/g, with a mean of 0.97 × 10^3 CFU/g, while hydrocarbon-utilising fungi (HUF) ranged from 0.3 × 10^3 to 0.9 × 10^3 CFU/g, with a mean of 0.60 × 10^3 CFU/g.

ES4.1.8 Vegetation Characteristics

The terrestrial plant survey assessed floristic composition, vegetation structure, habitat characteristics, spatial distribution and seasonal variation across eight sampling transects (T1–T8). The study area comprises a heterogeneous and predominantly modified vegetation landscape consisting of secondary forests, bush fallows, farmlands, plantations, built-up/homestead vegetation and localized wetland or seasonal swamp habitats. Despite anthropogenic pressures from agriculture, vegetation clearing and settlement development, native and secondary-forest vegetation persists in several locations.

A total of 254 plant species belonging to 179 genera, and 56 families were identified in wet and dry seasons. Species richness varied substantially among transects, with T8 recording the highest richness (111 species), followed by T7 (83), T4 (79) and T6 (71), while T3 recorded the lowest (36 species). Spatial turnover was considerable, with 136 taxa (53.54%) occurring at only one sampling location, while only four species occurred across all eight locations. *Alchornea cordifolia*, *Chromolaena odorata*, *Rauvolfia vomitoria* and *Sida acuta* were among the widely distributed species.

Floristic similarity was highest between T1 and T3 (Jaccard = 0.854; Sørensen = 92.1%) and lowest between T1 and T8 (Jaccard = 0.079; Sørensen = 14.6%). Seasonal differences were also evident. Wet-season vegetation generally supported more luxuriant herbs, climbers, cultivated plants and moisture-associated species, whereas dry-season vegetation showed greater prominence of grasses, drought-tolerant herbs and disturbance-associated plants. Approximately 75% of transects exhibited moderate-to-high or high seasonal variation.

The survey recorded important indigenous forest species, including *Milicia excelsa*, *Alstonia boonei*, *Nauclea diderrichii*, *Treculia africana*, *Baphia nitida* and *Myrianthus arboreus*, alongside invasive or disturbance-associated species such as *Chromolaena odorata*, *Mimosa diplotricha*, *Mimosa invisa* and *Lantana camara*. Regarding IUCN status, 88.94% were Not Evaluated, 9.36% Least Concern, 1.28% Near Threatened and 0.43% Vulnerable. The area represents a dynamic mosaic of modified habitats, but the persistence of native vegetation provides opportunities for biodiversity conservation, restoration and invasive-species management.

ES4.1.9 Wildlife Characteristics

A total of 113 wildlife species were recorded or reported across six major taxonomic groups. Insects were the most species-rich group, with 40 species (35.40%), followed by birds with 31 (27.43%), mammals with 24 (21.24%), reptiles with 9 (7.96%), amphibians with 6 (5.31%), and molluscs with 3 (2.65%). The high insect diversity reflects the availability of varied vegetation structures and microhabitats, while the prominence of birds reflects their mobility and detectability across the heterogeneous landscape.

Birds were the most conspicuous vertebrate group, comprising 31 species, 29 genera and 21 families. *Poicephalus senegalus* was recorded only during the wet season, indicating seasonal variation. Two conservation-significant vultures, *Gyps africanus* and *Necrosyrtes monachus*, both classified as Critically Endangered (CR), were reported from adjoining forest areas but were not directly observed. These records should therefore be regarded as secondary records requiring further verification. The mammalian assemblage comprised 24 species, including primates, antelopes, rodents, squirrels, bats and shrews. Notable species included *Cercopithecus erythrogaster*, *C. mona*, *Chlorocebus tantalus*, *Philantomba maxwelli*, *Tragelaphus spekii* and *Neotragus batesi*. Conservation-significant mammals included the Endangered (EN) *C. erythrogaster*, Near Threatened (NT) *C. mona* and *Eidolon helvum*, and Vulnerable (VU) *Genetta cristata*. Several records were based on hunter photographs or interviews and should be distinguished from direct observations. Nine reptile species were recorded or reported, including *Bitis gabonica* (VU), *Python regius* (NT), *Python sebae* (NT), *Kinixys erosa* (NT) and *K. homeana* (CR). Recent reports of *B. gabonica* and *P. sebae* suggest continued occurrence in the wider landscape, while older records of *K. erosa* and *K. homeana* may indicate local rarity. Amphibians comprised six species (5.31%), mainly associated with wetlands and other moist habitats. *Afrixalus fulvovittatus* was recorded only during the wet season. The insect assemblage included butterflies, dragonflies, grasshoppers, termites, beetles, bees, wasps, flies, ants and spiders, with greater wet-season representation associated with increased vegetation growth and moisture. Although no formally designated biodiversity hotspot or Important Bird Area was identified within the immediate study area, the occurrence of conservation-significant species demonstrates that the modified landscape retains biodiversity value. Forest remnants, wetlands and other semi-natural habitats may function as refugia, feeding areas and movement corridors. Maintaining these habitats, reducing wildlife mortality and implementing periodic biodiversity monitoring will be important for sustaining the ecological and conservation value of the study area.

ES4.1.10 Aquatic Biology

The Phytoplankton consisted of five genera of bacillariophyeae (diatoms) in the dry season and six genera in the wet season, as well as two genera of chlorophyceae (green algae) in both seasons. Diatoms accounted for 62 % (SW2) to 87 % (SW1) in the dry season,

and 71% (SW2) to 84% (SW1). However, the green algae were marginally higher at SW 3 with 51 % during the dry season. *Cyclotella, Nitzschia* and *Synedra* were the most widely distributed diatoms in both seasons. Amongst the green algae, *Spyrogyra* was found in all the stations *while Rivularia* and *Closterium* were found in one station each during the dry and wet seasons respectively. Copepods were the most dominant Zooplankton during the dry season with 100% in SW1 and SW2 but were not observed in SW3 where Cladocera (75%) and Rotifera (25). Only copepod naupli were found in SW1 and SW2 whilea bundance of cladocera in SW3 was in the order *Bosmina longirostris, Daphnia rosea, Diaphanosoma* sp, *Moina wierzejskii.* In the wet season, copepoda accounted for 72% at SW3 to 100% at SW2, while Cladocera was 25% and 28 % at SW1 and SW2 respectively. Copepod nauplii was the most widely distributed followed by *Senecella calanoides*. *Daphnia* sp was observed at SW1 and SW3. The composition and abundance of benthic organisms in the study area was very low. No organism was recovered as SW2 in both seasons and SW3 in the wet season. While one genus of polychaeta (*Streblospio*) and one unidentified genus of Oligochaeta were recorded at SW1 and SW3 respectively in the dry season, one genus each of polychaeta (*Nereis*), oligochaeta (*Ophidonais)* and Mollusca (*Loripinus*) were recorded at SW1 during the wet season. The continuous sand mining at SW2 might be responsible for the zero-benthos count in both seasons. Also, a crude oil spill incident a few months before the dry season sampling may have led to benthic faunal obliteration, while wet season low abundance values were due to sand mining.

There is minimal fishing activity in the Okulu stream and Chokocho River, mostly at subsistence levels. A checklist of fishes in Okulu stream compiled from the biodiversity studies showed that black-chin tilapia *Sarotherodon melanotheron* is the dominant species in the Okulu Stream. The flathead grey mullet *Mugil cephalus, Neochelon facipinnis and Coptodon guineensis* were common*, Sardinella maderensis, Monodactylus sebae* and *Eucinostomus melanopterus were* occasional and all other species observed are rare. The bagrid catfish *Chrysichthys nigrodigitatus* and *Clarias gariepinus* were reported from Otmiri River. The three water bodies within the spatial boundaries of the study (Okulu Stream Chokocho River and Egbeda Stream) do not fall within any national legally protected area or an internationally recognized area. It is not an aquatic critical or sensitive fish habitat. There are no endemic species, and the IUCN status of the fish were mostly Least Concern or Data Deficient (except *Megalops atlanticus and Sardinella maderensis* is listed as vulnerable globally).

The mining/dredging of sand in Okulu and the Otaminri River at Chokocho constitute major threats to aquatic biodiversity. Run-off from other land-based activities such as

agriculture, abattoir; and wastes from domestic and commercial activities also enters the water bodies.

ES4.1.11 Ecosystem Services

The ecosystems surrounding the Project environment provide habitats for various species of animals and plants. Some, like riparian and freshwater swamp forests, are losing their natural attributes due to human alterations. Secondary forests and Guinea savanna offer resources like shade, cover, and food for wildlife. Anthropogenic activities such as logging, hunting, sand extraction, and infrastructural development are causing degradation in the area. Ecosystem services include provisioning (timber, wild food, medicinal plants), supporting (habitat for fishes, nursery grounds), and regulating (nutrient cycle, erosion control).

ES4.1.12 Socio-economic

The study covered 22 communities in Rivers and Imo States: 17 communities in Rivers State and 5 communities in Imo State. The various social variables including population distribution, demographic composition, education levels, and age distribution. The table below present the breakdown of project environment

Table ES-14: Host communities by LGA, cluster and State

S/N	Community	Local Government Area (LGA)	Cluster	State
1.	Akpajo	Eleme	1	Rivers
2.	Elenwo	Obio/Akpor		
3.	Rumuokwurusi			
4.	Atali			
5.	Chokocho	Etche	2	
6.	Abara			
7.	Omuogodo			
8.	Umuakuru			
9.	Ime			
10.	Edegelem			
11.	Omuechem			
12.	Ipo	Ikwerre	3	
13.	Omademe			
14.	Ozuaha			
15.	Omuanwa			
16.	Ubima			

S/N	Community	Local Government Area (LGA)	Cluster	State
17.	Omerelu			
18.	Omuapu (Akanu)	Ohaji/Egbema	5	Imo
19.	Awara 1			
20.	Awara 2			
21.	Ochia			
22.	Asa			

Population and households. The 1991 census population of the host communities, projected to 2024 at the National Population Commission growth rate of 2.4% per year (with field estimates where census data were unavailable), and the household sampling frame are presented community by community in Table ES-15. The 22 communities have a projected 2024 population of about 605,295 in about 100,874 households; the most populous are Ubima, Rumuokwurusi, Elelenwo and Omerelu, while the five Imo State communities on the 11 km section are smaller rural settlements of about 6,000–15,500 people each.

Table ES-15: Population and households of the 22 host communities

Community	LGA	State	1991 census	Projected 2024	Households	Households surveyed
Akpajo	Eleme	Rivers	5,196	35,124	5,854	20
Elelenwo	Obio/Akpor	Rivers	8,645	58,440	9,740	20
Rumuokwurusi	Obio/Akpor	Rivers	11,476	77,577	12,929	20
Atali	Obio/Akpor	Rivers	2,428	16,413	2,735	20
Chokocho	Etche	Rivers	3,463	23,409	3,901	20
Abara	Etche	Rivers	1,866	12,614	2,102	20
Omuodogo	Etche	Rivers	-	9,877	1,646	20
Umuakuru	Etche	Rivers	1,736	11,735	1,955	20
Ime	Etche	Rivers	2,781	18,799	3,133	20
Edegelem	Etche	Rivers	2,378	16,075	2,679	20
Umuechem	Etche	Rivers	4,593	31,048	5,174	20
Ipo	Ikwerre	Rivers	2,125	14,365	2,394	20
Omademe	Ikwerre	Rivers	4,267	28,844	4,807	20
Ozuaha	Ikwerre	Rivers	4,742	32,055	5,342	20
Omuanwa	Ikwerre	Rivers	5,019	33,928	5,654	20
Ubima	Ikwerre	Rivers	13,491	91,199	15,199	20
Omerelu	Ikwerre	Rivers	7,530	50,902	8,483	20
Omuapu (Akanu)	Ohaji/Egbema	Imo	-	15,433*	2,572	20
Awara I	Ohaji/Egbema	Imo	-	7,423*	1,237	20
Awara II	Ohaji/Egbema	Imo	-	6,344*	1,057	20
Ochia	Ohaji/Egbema	Imo	-	6,056*	1,009	20
Asa	Ohaji/Egbema	Imo	-	7,635*	1,272	20
Total				**605,295**	**100,874**	**440**

** Field estimate (December 2023) where 1991 census figures were not available. Source: Chapter 4, Tables 4.33 and 4.35.*

Oral Tradition and Traditional Governance

The communities have diverse origins but similar traditional governance systems, headed by Paramount Rulers and Councils of Chiefs, with support from CDCs, youth and women groups. These institutions oversee community affairs, conflict resolution, peace and development.

Social Organization

Men and women are organized into age groups and associations that support community development, cultural activities, security, sanitation and traditional governance. Community discipline is maintained through traditional rewards and sanctions, including titles for distinguished members and fines, legal referral or ostracism for misconduct.

Land Practices

Land in the study area is predominantly held by individuals, extended families and communities, generally through inheritance and customary arrangements. Land may be sold, leased or mortgaged subject to local customary requirements, while residential development may occur on individual, family or communal land. Non-indigenes can generally acquire land through purchase or community/family arrangements. Agricultural land is increasingly constrained by urbanisation, industrialisation, population growth and competing economic activities, resulting in declining fallow periods. Fallow periods range from about 2–10 years, depending on location and land availability, but have generally reduced to approximately 3–5 years or less in several communities. Land values vary considerably by location. At the time of the survey, a standard plot (approximately 100 ft × 50 ft or 30 m × 15 m) ranged from about N400,000 to N15 million, with the highest values recorded around the more urbanised and industrialised areas of Rumuokwurusi, Elelenwo and Akpajo. The substantial increase in land values over the preceding five years reflects growing urbanisation and development pressure.

Human Rights

Nigeria was classified as "Partly Free" in the 2022 Freedom in the World Index. The study area is influenced by broader national issues relating to governance, security, corruption and socio-economic vulnerability. These factors are relevant to project planning, stakeholder engagement, labour practices and community relations.

Crime and Vices

The main social concerns identified include land-related disputes, conflicts, kidnapping and other anti-social activities. However, reported levels of crime within the study area were considered comparatively low relative to broader national trends. Appropriate security, community engagement and conflict-management measures will therefore be important during project implementation.

Demography

The Project traverses Rivers and Imo States, covering five LGAs and 22 communities, of which four LGAs and 17 communities are in Rivers State, while Ohaji/Egbema LGA and five communities are in Imo State. The available 1991 census data, supplemented by field estimates for communities without census figures and projected at an annual growth rate of 2.4%, indicate a 2024 projected population of approximately 605,295 within the study area. The population is concentrated particularly in the more urbanised communities, including Rumuokwurusi, Elelenwo and Ubima.

Age-Sex Distribution

The study population comprises 6,796 surveyed persons, with males accounting for 48.26% and females 51.64%. The population structure is generally youthful, with a relatively large proportion below 15 years, although the proportion of the working-age population (15–64 years) is higher than the national average. The dependency ratio is 86:100, similar to the national figure, while the sex ratio is 93.5 males per 100 females, below the national ratio of 102:100. The demographic structure indicates a substantial working-age population alongside a significant dependent population.

The key socio-economic indicators of the study area, compared with national values where available, are summarised in Table ES-16.

Table ES-16: Key socio-economic indicators of the study area

Indicator	Study area	Remark / national comparison
Surveyed household population	6,796 persons (48.26% male, 51.64% female)	440 households in 22 communities
Age structure	27.8% under 15 years; 63.2% aged 15–64 years	Nigeria: 41.7% and 55%
Dependency ratio / sex ratio	86:100 / 93.5 males per 100 females	Nigeria: 86:100 / 102:100
Literacy (male / female / total)	79.5% / 76.9% / 78.3%	Nigeria: 71.3% / 52.7% / 62%
Educational attainment	Secondary completed 20.5% (modal); tertiary completed 11.7%; no formal education 1.5%	Relatively high human-capital base
Unemployment (male / female / total)	67.2% / 76.7% / 72%	Very high; job creation is the top community expectation
Primary occupation	Farming 34.2%; business 14.6%; senior private-sector worker 14.5%; trading 13.4%; artisans 6.6%; hunting 5.2%; fishing 3.8%	Agriculture-based rural economy, diversifying near Port Harcourt
Household income	Mean N71,472 per month (about US$1.60 per day); modal N100,000	Below the US$2.15/day poverty line
Housing	Bungalows 36.7%, wagon-type rooming houses 27.3%; block walls 77.3%; 38.5% need major repair	Overcrowding not significant
Household energy	Firewood/charcoal 46.3%; kerosene 32.8%; gas 14.8%; electricity 6.1%	Grid supply unreliable
Water supply	Boreholes 67.3%; mono-pumps 23%; other 9.7%	Many communal schemes moribund
Sanitation	Water closet 56.6%; pit latrine 23.6%; holes 6.5%; open defecation 11.4%	Open defecation mainly in rural communities

Indicator	Study area	Remark / national comparison
Household refuse	Family dumpsites 61%; street corners 11.6%; burying 9%; burning 6.7%; private collectors 5.8%	No organised collection in rural areas
Farm holdings and fallow	About 0.25 ha per farmer; fallow reduced from up to 7 years to 3–5 years or less	Increasing pressure on farmland
Land value (one plot, 30 m x 15 m)	N0.4–2 million (Ohaji/Egbema and Ikwerre clusters); N1–4 million (Etche); N6–15 million (Akpajo, Elelenwo, Rumuokwurusi)	Rapid increase over the past five years

Source: Chapter 4, Section 4.6 (Field Survey, December 2023).

Education

Educational attainment in the study area is relatively favourable, with secondary school completion representing the modal educational level at 20.5% of the population. Approximately 11.7% had completed tertiary education, while only 1.5% had no formal education. Literacy rates were 79.5% for males, 76.9% for females and 78.3% overall, exceeding the reported national averages of 71.3%, 52.7% and 62%, respectively. The relatively high literacy level indicates a reasonable availability of human resources for formal employment, skills development and project-related training.

Employment Status

The study recorded substantial unemployment, with reported unemployment rates of approximately 67.2% for males, 76.7% for females and 72% for the overall population. Female unemployment was particularly high, while household participation in employment was also affected by full-time domestic responsibilities. The findings indicate a significant local employment gap and highlight the importance of local recruitment, skills development, vocational training and livelihood enhancement as part of the Project's social investment and impact-management measures.

Occupation

Agriculture is the dominant occupation, accounting for 34.2% of the surveyed population, followed by business (14.6%) and trading (13.4%). Fishing, hunting, artisan activities and private/public-sector employment also contribute to household livelihoods. The dominance of agriculture reflects the largely rural character of much of the study area, although urbanisation and industrial development are increasingly encouraging diversification into trading, services, small businesses and wage employment.

Income

The reported mean monthly household income was approximately N71,472, with N100,000 as the modal income. Income levels indicate significant economic vulnerability, with many households dependent on low and irregular earnings from agriculture, trading and other informal activities. The findings demonstrate the importance of employment creation, local procurement, livelihood restoration/enhancement and community-development initiatives in maximising the socioeconomic benefits of the Project.

Facilities, Infrastructure and Services

Classification of Infrastructure

Infrastructure in the study area comprises physical, social and institutional infrastructure. Physical infrastructure includes roads, bridges, culverts, transportation and utilities; social infrastructure includes housing, education, healthcare, water, sanitation and recreational facilities; while institutional infrastructure includes financial institutions, cooperatives, agricultural extension services, security and administrative institutions.

Availability of Infrastructure

Physical Infrastructure – Transportation

The study area benefits from major transport corridors, including the East-West Road, Port Harcourt–Aba Highway and Port Harcourt–Owerri Road, which are generally tarred and in good condition. However, several intra- and inter-community roads remain untarred, poorly maintained or in fair condition. The survey identified one jetty, four bridges and 11 culverts, with transport infrastructure generally better developed in the more urbanised areas.

Social Infrastructure – Recreation

There are no major organised recreational facilities in the study area. Recreation is primarily provided through community playgrounds, open spaces, school fields and spaces associated with religious institutions.

Housing

The dominant housing type is the bungalow (36.7%), followed by wagon-type rooming houses (27.3%) and multi-family blocks of flats (17.2%). Block walls (77.3%), corrugated iron roofing (65.5%) and strip foundations (87%) are the predominant construction characteristics. Most houses were assessed as fairly good (42.6%), although 38.5% were classified as requiring major repairs. Firewood/charcoal remained the major household energy source (46.3%), followed by kerosene (32.8%), gas (14.8%) and electricity (6.1%). Overcrowding was generally not considered significant.

Education, Religious and Health Facilities

The study area has a network of nursery, primary and secondary schools, although higher educational facilities are limited. Religious infrastructure is predominantly Christian, with numerous churches and a small number of Islamic facilities. Healthcare infrastructure comprises hospitals, maternity facilities, health centres, clinics, patent medicine stores and traditional healing centres. Patent medicine stores are particularly widespread, indicating reliance on primary and informal healthcare services.

Table ES-17: Distribution of key social infrastructure by host community

Community	Nursery	Primary	Secondary	Hospital	Maternity	Health centre / clinic	Patent medicine stores	Churches
Akpajo	3	3	2	2	4	4	15	33

Community	Nursery	Primary	Secondary	Hospital	Maternity	Health centre / clinic	Patent medicine stores	Churches
Elelenwo	0	0	0	0	0	0	0	43
Rumuokwurusi	0	3	1	0	2	1	0	97
Atali	1	1	0	0	0	3	33	35
Chokocho	13	13	11	0	0	4	33	24
Abara	7	1	3	1	4	4	8	8
Omuodogo	0	1	1	0	0	0	16	0
Umuakuru	4	0	0	0	0	0	3	11
Ime	4	5	2	5	10	1	20	9
Edegelem	6	1	1	0	5	2	15	12
Umuechem	4	6	1	0	0	1	0	23
Ipo	8	1	0	0	2	1	9	22
Omademe	7	3	3	0	3	1	12	18
Ozuaha	3	2	1	0	0	1	10	0
Omuanwa	9	11	4	0	0	2	8	0
Ubima	6	8	5	1	1	1	30	0
Omerelu	8	8	1	0	2	1	28	0
Omuapu	3	3	2	1	1	1	26	21
Awara I	6	2	1	0	0	4	18	30
Awara II	5	3	1	0	0	1	5	0
Ochia	5	2	2	0	1	1	0	0
Asa	6	7	1	0	0	1	13	0
Total	**108**	**84**	**43**	**10**	**35**	**35**	**386**	**386**

Source: Chapter 4, Table 4.45 (Field Survey, December 2023).

Institutional Infrastructure

Institutional infrastructure is limited. The study identified farmers' cooperatives, banks, post offices, police posts/stations and agricultural extension services, but no significant presence of courts, agricultural research stations or similar higher-level institutional facilities.

Household Refuse Disposal

The predominant method of household waste disposal is disposal at family-designated temporary dumpsites (61%). Other methods include disposal at street corners (11.6%), burying (9%), burning at designated locations (6.7%) and private waste collection (5.8%). No respondents reported disposal directly into rivers or streams. The findings indicate the need for improved organised waste collection, segregation, disposal and environmental sanitation.

Human Waste Disposal

The water closet system is the dominant sanitation method (56.6%). However, pit latrines (23.6%), holes in the ground (6.5%) and open defecation (11.4%) remain prevalent, particularly in rural communities. The situation highlights the need for improved sanitation facilities and hygiene awareness.

Public Utilities

Most communities have access to the national electricity grid; however, electricity supply is generally unreliable, with some communities experiencing prolonged outages due to damaged transformers and electricity infrastructure. Water supply is also inadequate. Several communal water schemes have become moribund, while urban communities rely largely on private/commercial boreholes and water vendors. Functional communal water systems are mainly limited to some rural areas, particularly mono-pump schemes.

The Economy

Basic and Non-Basic Sectors

The non-basic/local sector dominates the study-area economy, with subsistence agriculture forming the principal economic activity. Household livelihoods are supplemented by trading, services, fishing, forestry and other informal activities.

Agriculture

Agriculture is predominantly subsistence-based and labour-intensive, using simple tools such as machetes, hoes and iron rods. Mechanised agriculture is largely absent, and average farm holdings are approximately 0.25 hectares per farmer.

Crop Farming

Crop production is based mainly on rotational bush fallow and mixed cropping. Major crops include cassava, yam, cocoyam, maize, vegetables, plantain and banana. Fallow periods have declined from historically longer periods of up to seven years to approximately five years or less, due mainly to population growth, urbanisation and declining farmland availability.

Agricultural production is constrained by poor roads, limited financing, inadequate extension services and fertilizer shortages. Reported farm income of about N120,000 per harvest season is generally insufficient to sustain households throughout the year, encouraging livelihood diversification.

Lumbering

Lumbering is practised in forested areas, with species including iroko, mahogany, afara and other timber trees. Timber is used locally for construction and furniture and marketed within and outside the communities. Timber residues are also used for charcoal and firewood.

Fishing

Fishing occurs in rivers, streams and ponds using nets, hooks, traps, baskets and spears, with dug-out canoes commonly used. Major species include catfish, tilapia and crayfish. Fish is marketed fresh, smoked or dried. Fishing is largely subsistence or supplementary, although small-scale aquaculture, particularly catfish production, is also practised. Reported fishing income ranges from approximately N50,000–N150,000 per month.

Livestock Farming

Small-scale livestock production is common, particularly the rearing of goats, sheep and poultry. Livestock is kept primarily for household consumption, income generation and cultural purposes.

Non-Timber Forest Products (NTFPs)

Hunting

Hunting remains an important rural livelihood activity, involving species such as grasscutter, duiker, antelope and bush pig. Products are consumed or sold locally.

Palm Oil Production

Palm oil extraction is practised throughout the year through small, privately owned processing mills. Production varies seasonally, with substantially higher yields during the dry season. The activity generates income and employment but faces constraints including labour shortages, declining availability of skilled palm climbers and occupational safety risks.

Other NTFPs

Rural communities also collect medicinal herbs, edible leaves, snails and fruits such as ogbono. Forest loss, population growth, development and the increasing use of modern medicine have reduced the availability and importance of some of these resources.

Rural Non-Farm Activities

Rural non-farm activities provide important supplementary livelihoods and include grocery stores, trading, restaurants, hairdressing/barbing, tailoring, welding/fabrication, carpentry/furniture making and mechanical workshops. Most enterprises are small-scale, individually owned and provide employment or apprenticeship opportunities. Common food commodities include garri, vegetables, plantain, banana and palm oil, reflecting the continued importance of agriculture and local trading within the study-area economy.

The perception of respondents during the ESIA field sampling regarding benefits and impacts is presented in the table below:

Overall, about 60% of respondents were very or somewhat pleased with the proposed Project, 17.3% were indifferent and about 23% expressed displeasure; the main reasons given for displeasure were the perceived lack of employment of indigenes (25.8%), lack of internal community roads (16.7%) and lack of electricity (15.2%). Employment was the dominant expected benefit (74.5% of first mentions), followed by social infrastructure/development and contracting opportunities, while the risk of explosion and fire (66.1% of first mentions), air pollution and destruction of crops during construction were the main perceived adverse effects (Tables ES-18 and ES-19).

Table ES-18: Perceived Benefits (Percentage Distribution of First, Second & Third Mentions)

S/No	Benefits	First Mention		Second Mention		Third Mention	
		N	%	N	%	N	%
1.	Employment Opportunity	269	74.5	33	9.6	0	0
2.	Opportunity For Contracting	4	1.1	120	34.9	9	3.7
3.	Social Infrastructure /Development	70	16.6	106	30.8	118	48.8
4.	Skills Acquisition by Youths	0	0	13	3.8	36	14.9
5.	Promote God Relationship with Indorama	0	0	5	1.5	22	9.1
6.	It Would Attract Other Companies	0	0	7	2.0	0	0
7.	Construction of Football Field/Stadium	0	0	4	1.2	0	0
8.	Economic Growth	0	0	27	7.8	34	14.0
9.	Scholarship For Youths	0	0	3	0.9	0	0
10.	Reduction In Youth Restiveness	0	0	6	1.7	3	1.2
11.	It Would Help Reduce Flaring	0	0	3	0.9	0	0
12.	Good Roads, Water and Light	10	2.8	7	20	0	0
13.	Boost Education of Youths	0	0	10	2.9	0	0
14.	Solar Street Light	18	5.0	0	0	0	0
15.	It would foster women empowerment	0	0	0	0	13	5.4
16.	Building of Market	0	0	0	0	4	1.7
17.	It would attract more CSR Projects	0	0	0	0	3	1.2
Total		**361**	**100**	**344**	**100**	**242**	**100**

Table ES-19: Perceived Adverse Effects (% Distribution of First, Second & Third Mentions)

S/No	Adverse Effects	First Mention		Second Mention		Third Mention	
		N	%	N	%	N	%
1.	Risk of Explosion and Fire	211	66.1	18	5.9	7	2.8
2.	Air Pollution	30	9.4	224	73.2	15	6.0
3.	Destruction of Crops During Construction	36	11.3	10	3.3	122	48.8
4.	Conflict Within Community	4	1.3	17	5.6	51	20.4
5.	Ground Water Pollution	10	3.1	14	4.6	4	1.6
6.	Perpetual Loss of Farmland Land	7	2.2	0	0	0	0

S/No	Adverse Effects	First Mention		Second Mention		Third Mention	
		N	%	N	%	N	%
7.	Influx of People into the Community	11	3.4	0	0	13	5.2
8.	Decrease in Crop Production	4	1.3	9	2.9	10	4.0
9.	Vandalism of Pipeline and its attendant destruction of farmland	6	1.9	0	0	0	0
10.	Increase in vices due to influx of strangers	0	0	14	4.6	0	0
11.	Damage to roads	0	0	0	0	15	6.0
12.	Displacement of wildlife	0	0	0	0	13	5.2
Total		**319**	**100**	**306**	**100**	**190**	**100**

Generally, the study area is characterized by a mixed rural–urban socioeconomic system, with agriculture remaining the principal livelihood in rural communities while trading, business, wage employment and informal enterprises are increasingly important in urbanized areas. The population is relatively young, literacy is comparatively high, but unemployment, low household incomes, declining agricultural land, inadequate utilities and infrastructure deficits remain key socioeconomic vulnerabilities. These conditions provide opportunities for the Project to generate positive impacts through local employment, skills development, indigenous contracting, local procurement, improved infrastructure and targeted community-development programmes, while requiring appropriate measures to manage land access, livelihood disruption, community health and safety, and other potential socioeconomic impacts.

ES4.1.13 Community Health

Data Collection Methods

Health data were collected across the 22 communities using questionnaires, health-facility records, focus group discussions, key-informant interviews and direct observations, supported by NPC demographic data and field surveys.

Housing Conditions

Housing conditions were generally fairly good, with over 42% of houses rated good or fairly good. About 78% had cemented or tiled floors, while 22% had earth/mud floors.

Access to Safe Drinking Water

The main water sources were private/communal boreholes (67.3%), mono-pumps (23%) and other sources (9.7%). Most households reportedly accessed about 20–40 litres of water daily.

Human Waste Disposal

The main sanitation facilities were flush toilets/septic tanks (49.5%) and pit latrines (20.7%). Open defecation and disposal in holes accounted for smaller proportions, indicating generally improved sanitation, although rural areas still face sanitation challenges.

Pest/Vector Control

Common vectors include mosquitoes, houseflies, tsetse flies and sandflies. Control measures include insecticides, treated mosquito nets and household sanitation. While malaria awareness was high, 78% of respondents had limited knowledge of other vector-borne diseases.

Non-Human Waste Management

Family-designated dumping sites were the dominant waste disposal method (59.1%). Urban communities also used government dumpsites, private waste vendors and burning, indicating the need for improved organised waste management.

Nutrition and Food Security

Staple foods include garri, rice, beans, yam, plantain and cocoyam, with meat and other animal products providing protein. Assessment of 200 children aged 6–59 months indicated that over 16% had MUAC below 12.5 cm, while only about 55% of households were considered food secure, suggesting nutritional vulnerability.

Risky Behaviours

Awareness of HIV/AIDS and STIs was generally adequate, but alcohol and tobacco use remain common. Drug abuse among youths was identified as a concern, while risky sexual practices, multiple partnerships and low condom use were also reported.

Disease Burden

The major reported health conditions were malaria, typhoid, hypertension, eye diseases and diabetes.

Mortality Patterns

Reported maternal mortality was zero, while infant mortality was estimated at 3.8 per 1,000 live births. Major childhood health risks include malaria, gastroenteritis, anaemia, febrile illnesses and vaccine-preventable diseases. Participatory assessment indicated life expectancy of approximately 60 years for men and 65 years for women.

Immunization:

Approximately 89% of children under five had received some childhood immunization. Routine and National Immunization Day campaigns contribute to relatively good vaccination uptake.

Health Infrastructure and Personnel

The study area has relatively good access to primary healthcare, particularly in Rivers State, where Model Primary Health Centres are generally available within about 3 km of

communities. However, shortages of healthcare personnel and equipment remain challenges, with serious cases referred to secondary and tertiary facilities.

The key community health indicators of the study area are summarised in Table ES-20; the distribution of health facilities by community is shown in Table ES-17.

Table ES-20: Summary of community health baseline

Health determinant / indicator	Baseline finding	Relevance to the Project
Drinking water	Boreholes 67.3%, mono-pumps 23%, other 9.7%; 20–40 litres per person per day	Protect boreholes and water sources from construction run-off and spills
Sanitation	Flush toilet/septic tank 49.5%; pit latrine 20.7%; bush 6.1%; holes 5.7%	Provide sanitation for workers; avoid faecal contamination of water
Vector-borne disease	Mosquitoes, houseflies, tsetse and sandflies; 78% unaware of diseases other than malaria	Avoid stagnant water in trenches/borrow areas; malaria prevention
Nutrition and food security	Over 16% of 200 children (6–59 months) with MUAC below 12.5 cm; about 55% of households food secure	Avoid loss of farmland/crops without compensation; livelihood restoration
Risky behaviours	High alcohol and tobacco use; drug abuse among youths; multiple sexual partners and low condom use	Labour-influx risks: STI/HIV, GBV/SEA; worker code of conduct and awareness
Disease burden	Malaria, typhoid, hypertension, eye diseases and diabetes most common	Worker health screening; community health awareness
Mortality	Maternal mortality nil reported; infant mortality 3.8 per 1,000 live births; life expectancy about 60 years (men) and 65 years (women)	Baseline for monitoring
Immunisation	About 89% of under-fives received some immunisation	Baseline for monitoring
Health infrastructure	10 hospitals, 35 maternity homes, 21 health centres, 14 clinics, 386 patent medicine stores and 47 traditional healing centres; Model PHCs within ~3 km in Rivers State; shortages of staff and equipment	Site clinic for workers to avoid pressure on local facilities; emergency referral arrangements

Source: Chapter 4, Section 4.6 (Community Health Aspects).

ES4.1.14 Community Stakeholder Consultation

A comprehensive stakeholder engagement and consultation programme was successfully undertaken by IFF in collaboration with Safespace Resources Limited, the ESIA consulting firm. The engagement process covered both institutional and community-level consultations and was implemented throughout the ESIA process.

The engagements held for the ESIA, the land acquisition and the wet-season baseline are summarised in Table ES-21.

Table ES-21: Summary of stakeholder engagements

Date	Venue	Stakeholders	Purpose / key topics	Attendees
21 Sept 2023	Project site (RoW)	FMEnv and Rivers State Ministry of Environment	Site verification for Project categorisation	8
19 Oct 2023	Golden Tulip Hotel, Port Harcourt	FMEnv, ISMEnv, RSMEnv, LGAs, paramount rulers and chiefs, women, youth, NGOs/CSOs,	Scoping workshop: ToR, project scope, potential impacts and community expectations	145

Date	Venue	Stakeholders	Purpose / key topics	Attendees
		farmers, traders, fishers, students		
9 Dec 2023	Indorama, Eleme	Cluster heads	Project scope and roles of cluster heads	4
14 Dec 2023	Cluster 2 communities (Etche)	Paramount rulers, CDC chairmen, youth and women groups, community members	Project scope, impacts, mitigation and expectations	87
15 Dec 2023	Cluster 1 communities (Eleme, Obio/Akpor)	As above	As above	53
19 Dec 2023	Cluster 4 communities (Ohaji/Egbema)	As above, including fishermen and hunters	As above	91
20 Dec 2023	Cluster 3 communities (Ikwerre)	As above	As above	135
2025 (gazette); 18 June 2025	Imo State (Ohaji/Egbema)	Affected landowners of Assa, Ochia and Awara; Imo State Ministry of Lands, Survey, Housing and Urban Planning; NMDPRA	Gazette notice (Imo State Gazette No. 13, Vol. 49; 19-day objection window); public hearing and final engagement on land acquisition and compensation – no objection	40
6–10 Aug 2026	RoW communities and laboratory, Port Harcourt	FMEnv, RSMEnv, community representatives	Wet-season baseline fieldwork and laboratory inspection	16

Source: Chapter 4, Table 4.57; Chapter 3, Section 3.5.1.1; Annexure 4.11 (Stakeholder Engagement Report).

The main concerns raised by stakeholders and IFF's responses and commitments are summarised in Table ES-22.

Table ES-22: Key concerns raised by stakeholders and IFF responses / commitments

Concern raised	IFF response / commitment
Employment of indigenes (skilled and unskilled)	Local-content and recruitment procedure giving priority to host communities; target of at least 50% of the construction workforce from host communities; transparent recruitment through cluster committees.
Contracts for indigenous contractors and suppliers	RoW clearing, excavation, backfilling and revegetation to be awarded to competent community contractors; Indigenous Suppliers Forum engaged.
Community development (roads, electricity, water, health centres, schools)	Continued implementation of the subsisting MoU with pipeline host communities and CSR programmes (Section 4.9, Annexure 4.12).
Risk of gas explosion and fire	Design to ASME B31.8; QRA; line-break valves and ESD; RoW surveillance; community pipeline-safety awareness and emergency drills.
Destruction of crops and farmland; compensation	Work restricted to the RoW; compensation for land, crops and economic trees before entry; reinstatement; GRM.
Air pollution, dust and noise	Dust suppression, maintained equipment, daytime working, monitoring at sensitive receptors.
Conflicts within communities and youth restiveness	Engagement through traditional rulers, cluster heads and CDCs; MoU transparency; GRM.
Scholarships, skills acquisition, women's grants	Scholarship, skills acquisition, Youth Entrepreneurship Scheme and micro-grants for women under the MoU.

The engagement commenced with consultations with the Federal Ministry of Environment (FMEnv), Abuja, during project registration and submission of the Draft Terms of

Reference. This was followed by the scoping workshop, held at Golden Tulip Hotel, Stadium Road, Elekahia, Port Harcourt, 19th October 2023 prior to commencement of the field surveys. Representatives of the affected communities and relevant institutions participated in the workshop. Subsequently, community-level consultations were conducted across the 22 communities hosting the project Right-of-Way (RoW). The Social and Health Team conducted consultations in situ within the study communities, engaging traditional rulers, chiefs, community leaders, youth and women representatives, relevant government officials, the media and other stakeholders. The engagement cover project description, community support during project execution, possible impacts/risk and mitigation measures to be put in place.

Key issues raised during the consultations included employment opportunities, local economic benefits, community development and Corporate Social Responsibility (CSR) initiatives. While several stakeholders acknowledged and appreciated Indorama's existing contributions to the host communities, participants also expressed interest in additional employment opportunities and further community development initiatives. The engagement process provided an important platform for stakeholders to understand the project, express concerns, identify community priorities and contribute to the ESIA process. The outcomes of the consultations have been incorporated into the impact assessment and the proposed mitigation, enhancement and stakeholder engagement measures.

Engagement on the 11 km land acquisition. Affected landowners, land users and the communities of Assa, Ochia and Awara were engaged throughout the acquisition: identification and verification of landholdings and assets, valuation, a gazette notification giving a 19-day window for objections on valuation, compensation and the acquisition process, and a public hearing supervised by the Imo State Ministry of Lands, Survey, Housing and Urban Planning and NMDPRA on 18 June 2025, at which no objection was raised; the final engagement with affected landowners was held the same day. Compensation, livelihood restoration and support to vulnerable persons were addressed in line with the agreements reached, and concerns can be raised through the Project GRM (see ES3.0, Table ES-10).

Disclosure and continuing engagement. The ESIA will be disclosed at the offices of the five LGAs, the Rivers and Imo State Ministries of Environment and FMEnv, and in the host communities, and the Stakeholder Engagement Plan has been updated to include the 11 km communities. Engagement will continue through all Project phases via the cluster heads/CLOs, with periodic updates on employment, community development, grievances and Project progress (Chapter 4, Table 4.58).

Details of communities' expectations are included in the table below

Table ES-23: Three most important needs/expectations by host community (Key: red = 1st mention, orange = 2nd mention, green = 3rd mention).

S/No.	Community Expectation	Akpajo	Elelenwo	Rumuokwurusi	Atali	Abara	Chokocho	Umuodogo	Umuakuru	Ime	Edegelem	Umuechem	Ipo	Omademe	Ozuaha	Omuanwa	Ubima	Omerelu	Omuapu	Awara I	Awara II	Ochia	Asa
1.	Youth empowerment																						
2.	Skills acquisition with starter packs																						
3.	Internal Roads construction																						
4.	Building of secondary School																						
5.	Electricity supply																						
6.	Health centre																						
7.	Contracts for indigenes																						
8.	Employment of skilled and unskilled workers																						
9.	Scholarship																						
10.	More projects																						
11.	Market																						
12.	Potable drinking water																						
13.	Grant to Women																						
14.	Empowerment of Farmers																						

S/No.	Community Expectation	Akpajo	Elelenwo	Rumuokwurusi	Atali	Abara	Chokocho	Umuodogo	Umuakuru	Ime	Edegelem	Umuechem	Ipo	Omademe	Ozuaha	Omuanwa	Ubima	Omerelu	Omuapu	Awara I	Awara II	Ochia	Asa
15.	Welfare for the elderly																						

Employment of skilled and unskilled workers is the first-ranked need in 11 of the 22 communities (Akpajo, Elelenwo, Rumuokwurusi, Chokocho, Umuakuru, Omademe, Omuanwa, Ubima, Omerelu, Omuapu and Awara II) and is mentioned among the top three needs in 16 communities. Internal road construction is the first need in Umuechem, Ipo, Awara I and Asa; youth empowerment in Abara and Edegelem; a health centre in Omuodogo and Ime; electricity in Ozuaha; contracts for indigenes in Ochia; and scholarships in Atali.

ES4.1.15 Cultural Heritage

Cultural heritage resources identified within the study area comprised mainly sacred bush along the Ochia alignment, as well as a few family shrines and items associated with traditional worship. In addition, three (3) graves were identified within the proposed RoW at Ochia. No significant concentration of archaeological artefacts was observed during the field survey. This is consistent with the generally limited occurrence of surface archaeological artefacts reported within the project area in Rivers and Imo States. However, shrines and sacred forests were very common in all communities in the study area**.** Shrines and sanctuaries were restricted to only the Chief priests and community leaders when occasion demands that they consult the gods and ancestors of the land. It was sacrilegious to farm or defecate in the forests where these shrines and sanctuaries were located, as they were commonly revered and dreaded across the host communities. Heavy penalties are common for trespassers.

The sacred forests and shrines recorded in the study area are listed in Table ES-24. None of these will be disturbed by Phase 2, which lies within the existing RoW. For the 11 km section, the sacred bush along the Ochia alignment and the three graves within the RoW at Ochia are managed through consultation with the families and community leaders, the performance of any customary rites they require, avoidance or relocation only with the agreement of the families, and a chance-finds procedure for any previously unrecorded heritage encountered during works.

Table ES-24: Sacred forests and shrines in the study area

S/No	Name	Location
1	Ogugu Shrine	Ogugu, Akpajo
2	Onumu Sacred Forest	Onumu, Akpajo
3	Atali Shrine	Atali
4	Atali Sacred Forest	Atali
5	Chokocho Shrine	Chokocho
6	Edegelem Shrine	Edegelem
7	Ala Ubi Shrine	Umuechem
8	Ala Otamiri Sacred Forest	Umuechem
9	Ushi Wanti Shrine	Umuechem
10	Omuanwa Shrine	Omuanwa
11	Nkiripo Akatali	Omuanwa
12	Umuokeduru Sacred Forest	Awara I
13	Obor Sacred Forest	Awara I
14	Ijmuobi Shrine / Sacred Forest	Awara II
15	Obech Shrine / Sacred Forest	Awara II
16	Obegwe Shrine / Sacred Forest	Awara II

Source: Chapter 4, Table 4.53.

ES5.0 Impact Assessment

The environmental and social impacts associated with the implementation of the natural gas pipeline project are summarised in this section. The methods adopted include both qualitative and quantitative approaches, including the Leopold matrix.

Impact assessment method. Potential impacts were first identified and scoped by interaction of Project activities in each phase (site preparation, construction, pre-commissioning, operation and decommissioning) with physical, biological and human receptors, informed by the baseline, stakeholder consultations (scoping workshop of 19 October 2023 and community consultations) and experience of the existing 83 km pipeline. Each impact was then characterised using a modified Leopold matrix (Table ES-25) and its significance evaluated against five weighted criteria — legal/regulatory requirement (L), risk (R), frequency (F), importance of the affected component (I) and public perception (P) — scored on a 0/1/3/5 scale adapted from ISO 14001 (Table ES-26). The sum L+R+F+I+P gives a Low (<8), Medium (8–14) or High (≥15) rating; an impact is also rated High where F+I exceeds 6 or public perception scores 5. Beneficial impacts were identified but not scored.

Table ES-25: Impact characterisation criteria

Characteristic	Definition
Adverse / Beneficial	Negative / positive effect on the receptor
Short term / Long term	Impact removed within 3 months / persists more than 3 months after mitigation
Reversible / Irreversible	Receptor can recover / cannot be returned to its original state even after mitigation
Localised / Widespread	Impact within 10 km / beyond 10 km of the source

Table ES-26: Significance criteria, scoring and rating

Criterion	Scores	Rating rule
Legal/regulatory requirement (L)	0 none; 3 requirement exists; 5 requirement and permit	Sum <8: Low
Risk factor (R)	1 low; 3 intermediate; 5 high	Sum 8–14: Medium
Frequency (F)	1 rare; 3 likely; 5 very likely	Sum ≥15: High
Importance of affected component (I)	1 low; 3 medium; 5 high	F+I >6: High
Public perception/interest (P)	1 low; 3 intermediate; 5 high	P = 5: High

Summary of significant (High and Medium) impacts. Before mitigation, the principal adverse impacts, quantified where the assessment allows, are:

- **Vegetation and habitat loss (Medium):** clearing of a 15 m RoW over 76 km (about 114 ha), of which 16.5 ha of new RoW (Phase 1, already cleared) and about 97.5 ha of previously disturbed, maintained corridor (Phase 2). The corridor comprises modified habitat (secondary forest remnants, bush fallow, farmland, plantations and seasonal swamp edges); no protected area, forest reserve or critical habitat is crossed. Of 254 plant species recorded, 3 (1.28%) are Near Threatened and 1 (0.43%) Vulnerable; economic trees such as Milicia excelsa, Nauclea diderrichii and Treculia africana occur along the route.
- **Disturbance of fauna (Medium):** 113 wildlife species recorded or reported; conservation-significant species reported from adjoining forest remnants (Critically

Endangered vultures Gyps africanus and Necrosyrtes monachus — reported but not observed; Endangered Cercopithecus erythrogaster; Vulnerable Bitis gabonica and Genetta cristata) may be displaced temporarily by noise and clearing; risk of hunting by workers.

- **Soil erosion and degradation (Medium):** about 136,076 m³ of excavated soil, exposed in an area of 2,000–3,600 mm annual rainfall on erodible coastal-plain sands; soil inversion and compaction along the working strip.
- **Water quality (Medium):** sediment-laden run-off and accidental spills of fuels/lubricants (about 248,000 litres of diesel used during construction); discharge of 8,000–15,000 m³ of hydrotest water; drilling mud at thrust-bored/HDD crossings.
- **Air quality and noise (Medium):** dust (baseline PM10 61 µg/m³ in the dry season) and exhaust emissions (about 665 t CO2 from construction diesel) and construction noise above the baseline (49–67 dB(A)) at receptors in the 22 communities.
- **Damage to adjacent operating pipelines (Medium):** Phase 2 shares the corridor with operating pipelines; excavation or boring could cause dents, coating damage or rupture, leading to spills, gas release, fire or explosion.
- **Socio-economic and security (High):** third-party agitation and community conflict over employment and contracts (unemployment 72%), social vices linked to influx of workers and followers, kidnapping of workers and socio-cultural conflict; workplace accidents during construction (about 100 workers).
- **Community health (Medium):** increased risk of STI/HIV, malaria and diarrhoeal disease from labour influx, and pressure on local health facilities.
- **Land acquisition and land use (Medium):** economic displacement on 16.5 ha in Assa, Ochia and Awara (crops, economic trees and land use; no physical displacement) and permanent restriction of incompatible land uses on the 114 ha RoW.
- **Cultural heritage (Medium):** sacred bush along the Ochia alignment and three graves within the RoW at Ochia; possible chance finds.
- **Major accident hazards during operation (High):** injuries, fatalities and destruction of assets and property from a gas leak, fire or explosion of the 85 bar pipeline caused by corrosion, equipment failure or third-party interference/vandalism; fugitive methane emissions (Medium); RoW encroachment (Medium).

Beneficial impacts. About 100 jobs at peak construction (target of at least 50% from host communities), contracting and supply opportunities, increased incomes and skills, a

secure gas supply of up to 370 MMSCFD to the Indorama Complex, and a potential reduction in GHG emissions of about 2.1 MMTPA CO2-equivalent through utilisation of otherwise flared gas.

The potential significant impacts of the Project are summarised by phase in Table ES-27; the full impact assessment matrix is presented in Chapter 5 (Table 5.3).

Table ES-27: Potential Significant impacts of the proposed 76km Pipeline

Project phase	Potential/Associated Impacts	Category
Site Preparation	Opportunity for Contracting and Supplies	Positive
	Employment opportunity for skilled and unskilled labour.	Positive
	Opportunity for Skill enhancement/ acquisition	Positive
	Increase in income for individuals and community	Positive
	Removal of vegetation, disruption of riparian habitat along Pipeline ROW	Medium
	Potential for erosion and loss of soil nutrients due to stripping of vegetation cover	Medium
	Deterioration of surface water quality (turbidity) from surface run – off on bare soil at the river	Medium
	Changes in soil characteristics from movement of heavy-duty machinery	Medium
	Increase in noise from operation of machines & equipment	Medium
	Wildlife migration due to disturbance	Medium
	Loss of Vegetation including economic spp.	Medium
	Third party agitation	High
	Influx of laborers and followers (dependents, bounty seekers, CSWs, etc.)	Medium
	Increased risk of prevalence of HIV,	Medium
	Increased risk of malaria, dysentery, and other diseases	Medium
	Increased pressure on existing social amenities/ infrastructure.	Medium
	Loss of biodiversity due to activities of laborers e.g. hunting and fishing.	Medium
	Increase in social vices	High
	Potential for socio-cultural conflict	Medium
	Hydrocarbon contamination of environment from accidental spills e.g. faulty processes of refueling and lubricants use	Medium
	Loss of habitat to soil fauna/loss of soil arability from soil inversion	Medium
	Potential for disruption of ecological balance during site preparation for HDD at wetlands	Medium
	Workplace accidents leading to injury	High
	Potential for socio-cultural conflict	High
	Potential for kidnapping of workers	High
	Waste generation	Medium
	Visual impacts of heavy equipment to farmers	Medium
Construction	Employment opportunity for skilled and unskilled labour.	Positive
	Opportunity for Skill enhancement/ acquisition	Positive
	Increase in income	Positive
	Potential for changes in physico-chemical properties of surface water bodies due to inflow of runoffs bearing excavated soil	Medium
	Increase in SPM during dry season trenching activities	Medium
	Soil compaction and Loss of habitat to soil fauna and flora due to movements of heavy-duty equipment	Medium

Project phase	Potential/Associated Impacts	Category
	Soil strata inversion during back filling with risk to erosion	Medium
	Increased risk of road traffic accident	Medium
	Increase in noise from operation of machines & equipment during trenching, cutting, welding, pipe laying etc.	Medium
	Air pollution from exhaust fumes/greenhouse gases	Medium
	Obstruction of access routes to villages and farmlands	Medium
	Fragmentation of habitat for wildlife	Medium
Construction	Third party agitation	High
	Influx of laborers and followers (defendants, bounty seekers, CSWs, etc.)	Medium
	Increased risk of prevalence of HIV	Medium
	Increased pressure on existing social amenities/ infrastructure.	Medium
	Loss of biodiversity due to activities of laborers e.g. hunting and fishing.	Medium
	Increase in social vices	High
	Potential for socio-cultural conflict	Medium
	Hydrocarbon contamination of environment from accidental spills e.g. faulty processes of refueling and lubricant usage	Medium
Construction	Increased exposure to radiation during welding	Medium
	Potential for disruption of soil structure due to deposition of soil/clay from inadvertent returns; on riverbank at crossing	Medium
	Potential for vegetation change due to primary succession at deposition sites (on banks and riparian habitat)	Medium
	Improper waste management leading to loss of aesthetics, habitat disruption and death of aquatic/land organisms	Medium
	Accidental release of drilling mud (bentonite) into wetlands, land	Medium
	Potential for pollution of surface water which is a source of water for domestic use	Medium
	Air pollution from exhaust/greenhouse gases	Medium
	Potential for disruption of aquifers that feed in stream upwelling at the crossing	Medium
Construction	Possible erosion, deterioration of physico-chemical properties of surface water, and increased sediment deposition upstream, from poor runoff control at construction site	Medium
	Potential for disruption of surface water flow dynamics and creation of artificial ponds, flooding, due to inadvertent returns of drilling mud on bank and riparian habitat	Medium
	Potential for introduction of foreign or undesirable organism (including disease, parasites, or pests) from contaminated equipment; detrimental to aquatic life	Medium
	Risk of physical damage (dents, coating damage, or rupture) during excavation, trenching or drilling leading to spills, gas leaks, fire and/or explosion.	Medium
Pre-Commission	Increase in temperature of receiving environment	Medium
	Environmental contamination and loss of aesthetic value due to fuel and lubricant spillage or valve and seal failure	Medium
	Environmental contamination (water and land) from disposal of waste e.g. hydro-test water, and condensate	Medium
	Air pollution from exhaust gases	Medium
	Potential for surface water degradation preventing domestic use	Medium
	Exposure to radioactive materials during weld testing, NDT	Medium
Operational Phase	Hiring of skilled and unskilled labour	Positive
	Increased income	Positive
	Opportunities for contracting and supplies	Positive
	Changes in air quality may occur from release of gaseous/misty by products during pigging	Medium

Project phase	Potential/Associated Impacts	Category
	Condensate may contaminate soil/water bodies due to spillage or valve and seal failure	Medium
	Injuries and death from gas leaks and explosion	High
	Corrosion and pipeline rupture	Medium
	Environmental Pollution as a result of pipeline interference by third parties (Vandalization	Medium
	Loss of biodiversity due to activities of laborers e.g. hunting.	Medium
	Odor and aesthetic devaluation due to waste dumping	Medium
	Destruction of assets and property from gas leak/ fire.	High
	Potential for increase in incidence of malaria, typhoid, dysentery, and other diseases	Medium
	Increased extreme heat	Medium
	Increase water stress and drought	Medium
	Increased in both flooding and wildfire events	Medium
	Fugitive methane emissions from valves, flanges and instrument connections	Medium
	Accidental gas releases arising from equipment failure	Medium
	Noise from pressure regulation and venting activities	Medium
	Potential safety hazards associated with high-pressure gas operations	Medium
	Potential Encroachment on the Pipeline Right-of-Way (RoW)	Medium
Decommissioning	Increased income	Positive
	Hiring of skilled and unskilled labour	Positive
	Opportunity for Contracting and Supplies	Positive
	Increased risk of road traffic accident due to transportation of removed structures from site	Medium
	Excavation to remove pipeline could lead to contamination of soil	Medium
	Third Party agitation	Medium
	Influx of laborers and followers (dependents, bounty seekers, CSWs, etc.)	Medium
	Increased risk of prevalence of HIV,	Medium
	Potential for increase in incidence of malaria, dysentery, and other diseases	Medium
	Increased pressure on existing social amenities/ infrastructure.	Medium
	Increase in social vices	Medium
	Loss of biodiversity due to activities of laborers e.g. hunting	Medium
	Loss of employment due to lay off of laborers	Medium
	Potential for erosion due to improper backfilling process	Medium
	Loss of aesthetics due to waste dumping	Medium
	Risk of contamination of soil and wetlands	Medium
	Risk of physical damage (dents, coating damage, or rupture) during excavation, trenching or drilling leading to spills, gas leaks, fire and/or explosion.	Medium

ES6.0 Impact Mitigation

The mitigation approach follows the mitigation hierarchy, prioritizing the avoidance of impacts, followed by minimisation and restoration where impacts cannot be fully avoided. Where residual impacts remain after these measures, appropriate compensation and, where applicable, biodiversity or other offsets will be considered for affected people,

communities and the environment. The full set of impacts, mitigation measures and residual impact ratings for all project phases is presented in Chapter 6 (Table 6.1).

The application of the mitigation hierarchy to the Project is summarised below:

- **Avoid:** selection of Route Option 2, which avoids settlements and physical displacement; routing 65 km (86%) of the pipeline within an existing RoW; no river crossings and avoidance of forest reserves, protected areas, sacred forests and shrines; no workers' camps along the RoW.
- **Minimise:** restriction of clearing to the 15 m RoW; thrust boring/HDD at major road crossings; daytime working; dust suppression; spill prevention; local recruitment to limit labour influx; worker code of conduct; engineering controls (ASME B31.8 design, 3LPE coating, cathodic protection, line-break valves, ESD, QRA).
- **Restore:** progressive backfilling with stockpiled topsoil, reinstatement and revegetation of the working strip with native species; repair of damaged access roads and drainage.
- **Compensate:** compensation at replacement cost for land, crops and economic trees on the 11 km RoW and for any crops damaged in the existing corridor; livelihood restoration and support to vulnerable persons; compensation for third-party damage.
- **Offset:** not required, as the Project affects modified habitat only and no residual significant biodiversity loss is predicted.

Key measures for High and Medium impacts, by phase:

Site preparation and construction

- Social licence and security (third-party agitation, conflict, kidnapping): implement the MoU transparently; engage traditional rulers, cluster heads/CLOs, youth and women; local recruitment and contracting procedure (≥50% host-community workforce); GRM; security plan with trained personnel and a security code of conduct.
- Labour influx, social vices and health: worker code of conduct (including GBV/SEA); alcohol and drug policy; STI/HIV and malaria awareness; site clinic, potable water and sanitation for workers; workers housed in existing accommodation, not camps.
- Biodiversity and vegetation: pre-clearance survey and demarcation of the 15 m RoW; no hunting or bushmeat purchase by workers; protection of riparian and wetland edges; progressive revegetation (Biodiversity Management Plan).
- Soil and water: erosion and sediment controls; topsoil stripping and storage; drip pans, bunding and spill kits; refuelling at designated areas; mud containment at

bored crossings; hydrotest water tested and treated to NMDPRA limits before discharge.

- Air and noise: wetting of haul roads and work areas near communities; maintained, silenced equipment; engines off when idle; advance notice of noisy work.
- Adjacent pipelines: utility detection and survey; liaison and permit-to-work with pipeline operators; minimum separation distances; supervised excavation; stop-work and notification on any damage.
- Occupational safety: HSE plan, permit-to-work, toolbox talks, PPE, radiography safety for NDT, emergency response and first aid.
- Land and cultural heritage: compensation before entry; GRM; consultation and agreed rites for graves at Ochia; chance-finds procedure.

Pre-commissioning

- Hydrotest water testing and treatment before controlled discharge; condensate and pigging-waste containment; radiation safety for NDT; spill-response readiness.

Operation

- Major accident hazards: QRA-informed design and emergency planning; line-break valves and ESD; pipeline integrity management (intelligent pigging, cathodic-protection surveys, corrosion monitoring); fibre-optic line-sensing and RoW surveillance; gas-leak contingency and emergency response plan exercised with communities and emergency services; compensation for any third-party damage.
- Fugitive methane: leak detection and repair (LDAR) at valve stations and the receiving facility; minimised venting.
- RoW encroachment and vandalism: RoW markers and signage; patrols; community pipeline-safety awareness; engagement with LGAs on land-use control.

Decommissioning

- Approved decommissioning and abandonment plan; purging and cleaning before removal or abandonment in place; contamination assessment and remediation; reinstatement and revegetation; worker and community engagement.

ES7.0 Environmental and Social Management Plan

The Proponent will have overall responsibility for implementing the ESMP, while contractors will be responsible for implementing applicable controls during construction. The ESMP will be incorporated into contractor requirements and monitored through inspections, audits and periodic reporting. The regulators (FMEnv, State Ministries) shall oversee the implementation of the ESMP. The key risk/impact management measures to be implemented are summarised in Table ES-28.

Institutional arrangements. IFF, as Project Implementing Entity, has overall responsibility for the ESMP through its Project Management Team, HSE/E&S team and Community Relations & Development department (Table ES-2). The EPC and community contractors implement the construction-phase measures through a Contractor ESMP approved by IFF. FMEnv, NMDPRA and the Rivers and Imo State Ministries of Environment provide regulatory oversight; host communities participate through the cluster committees, the GRM and participatory monitoring; AfDB and other lenders supervise compliance with the ISS.

The ESMP is summarised in Table ES-28, which sets out for each key impact or risk the management measures, the key implementation indicators to be monitored, responsibility, frequency and the indicative cost of implementation.

Table ES-28: Summary ESMP with implementation indicators and cost estimate

Key impact / risk	Key management measures	Key implementation indicators	Responsibility	Frequency	Indicative cost (N million)
Vegetation and biodiversity	Pre-clearance survey; clearing limited to 15 m RoW; no-hunting rule; progressive revegetation (Biodiversity Management Plan)	Area cleared vs approved (ha); % disturbed area revegetated; hunting/wildlife incidents (target 0)	Contractor / IFF E&S	Quarterly	20
Surface and groundwater	Bunded storage, drip pans, spill kits; hydrotest water treatment; mud containment	Number of spills; hydrotest discharge vs NMDPRA limits; pH, TSS, oil & grease, THC at SW1–SW3 and boreholes	Contractor / IFF	Quarterly	20
Air quality and dust	Dust suppression; equipment maintenance; idling control	PM10, PM2.5, NO2, SO2, CO at receptors vs limits; dust complaints	Contractor / IFF E&S	Monthly	20
Noise and vibration	Silenced equipment; daytime work; hearing protection	LAeq at nearest receptors (≤55 dB(A) day); complaints	Contractor / HSE	Monthly	10
Community health and safety	Trench barricades and signage; community awareness; community-level ERP	Community incidents/near misses (target 0); awareness sessions held	IFF / Contractor	Ongoing during construction	15
Traffic and road safety	Traffic Management Plan; journey management; flagmen; driver training	Traffic incidents; speed compliance; drivers trained (%)	Contractor	Ongoing during construction	15
Cultural heritage	Avoidance; consultation and rites for graves at Ochia; chance-finds procedure	Chance finds reported/managed; heritage incidents (target 0)	IFF / Contractor	Ongoing during construction	10

Key impact / risk	Key management measures	Key implementation indicators	Responsibility	Frequency	Indicative cost (N million)
Waste management	Waste management plan; segregation; licensed contractors; manifests	Waste by type and volume; % recycled; manifests complete (100%); illegal dumping (0)	Contractor	Ongoing during construction	15
Worker health and safety	HSE plan; PPE; permit-to-work; site clinic; NDT radiation safety	LTIs/TRIR; near misses; toolbox talks; PPE compliance	Contractor / IFF HSE	Ongoing during construction	20
Labour and working conditions	Labour clauses in contracts; worker GRM; welfare facilities	Workforce by origin (target ≥50% local); worker grievances resolved	Contractor / IFF HR	Ongoing during construction	15
Labour influx, GBV/SEA	Code of conduct; GBV/SEA training and referral pathway; STI/HIV awareness	Workers trained (%); GBV/SEA complaints and referrals	IFF / Contractor	Ongoing during construction	10
Pipeline integrity and major accident hazards	QRA; integrity management (pigging, CP surveys); LDAR; RoW surveillance; ERP drills	QRA completed before commissioning; CP potentials ≤ -850 mV; leaks detected/repaired; drills held; response time	IFF Operations / HSE	Six monthly during the construction	120
Stakeholder engagement and GRM	SEP implementation; CLOs; disclosure; GRM	Engagements held; grievances received/resolved within 30 days (%)	IFF Community Relations	Monthly / quarterly	50
E&S monitoring programme	Third-party environmental monitoring (Table ES-29); reporting to FMEnv/NMDPRA	Monitoring reports submitted on time; exceedances and corrective actions	IFF / accredited consultant	Monthly / quarterly	45
Capacity building	Programme in Table ES-3	Training sessions delivered; staff in post (if needed)	IFF	As scheduled	60
ESMP audits and lender reporting	Internal/external E&S audits; annual monitoring reports to AfDB	Audits completed; non-conformities closed	IFF	Semi-annual / annual	30
Subtotal					**475**
Contingency (10%)					**47.5**
Total indicative ESMP cost					**522.5 (≈ US$0.35 million)**

Indicative costs cover Phase 2 construction (about 18 months) and the first five years of operation, at 2026 prices (US$1 = N1,500).

The ESMP shall be treated as a living document, reviewed periodically during operations and updated as the pipeline condition, regulatory requirements, environmental conditions and stakeholder expectations evolve.

Environmental and social monitoring. The monitoring programme (Chapter 7, Table 7.4) is summarised in Table ES-29. Results will be compared with the baseline and with national and IFC/WBG limits and reported quarterly to FMEnv and NMDPRA and annually to AfDB.

Table ES-29: Summary environmental and social monitoring programme

Component	Parameters	Location	Frequency	Responsibility
Noise	LAeq day/night	RoW and nearest community receptors	Monthly in construction and decommissioning	Accredited third-party consultant
Ambient air	NOx, SO2, CO, O3, VOC, CxHy, PM10, PM2.5	RoW and communities	Monthly in construction and decommissioning	Accredited third-party consultant
Surface water	pH, TSS, TDS, turbidity, DO, BOD, COD, nutrients, metals, oil & grease	SW1–SW3	Monthly in construction; annually in operation	Accredited third-party consultant
Sediment	pH, TOC, THC, metals, nutrients	SW1–SW3	Quarterly in construction	Accredited third-party consultant
Soil and groundwater	THC/TPH, metals, pH; groundwater physico-chemistry	Spill sites; boreholes near work fronts	After any spill; before and after construction	IFF E&S
Occupational health and safety	Incidents, first aiders, PPE use, signage	Work sites	Daily	IFF EHS lead / Contractor HSE
Waste	Housekeeping, waste notes, recycling	Work sites and yards	Daily	IFF EHS lead / Contractor HSE
Social	Local employment, grievances, community incidents, compensation and livelihood status	Host communities	Monthly / quarterly	IFF Community Relations

Grievance Redress Mechanism. Complaints can be lodged verbally or in writing with the CLOs, cluster heads, the contractor or the IFF Community Relations office; they are registered, acknowledged within 7 days, investigated and resolved within 30 days where possible, with escalation to IFF management and, if unresolved, to traditional institutions or the courts. Grievance statistics are reported in the quarterly monitoring reports.

ES8.0 Decommissioning and Remediation Plans

The Decommissioning and Remediation Plan for the proposed 76 km ANOH–Indorama natural gas pipeline will ensure that the pipeline, associated facilities and disturbed areas are safely closed, remediated and, where practicable, restored to conditions suitable for the agreed post-project land use. This is consistent with the AfDB Updated Integrated Safeguards System (ISS), which requires E&S assessment to cover the full project lifecycle, including decommissioning, closure and restoration.

Key measures will include:

- Prepare a detailed decommissioning plan approximately 3–5 years before permanent closure, incorporating regulatory requirements, stakeholder consultation, risk assessment and updated environmental and social conditions.
- Safely isolate, depressurise and decommission the pipeline and associated facilities.

- Remove redundant above-ground facilities, equipment and construction infrastructure.
- Properly segregate, reuse/recycle and dispose of decommissioning wastes.
- Assess and remediate any contaminated soil or water resulting from pipeline operations.
- Restore disturbed land through topsoil replacement, erosion control and revegetation.
- Protect and, where necessary, restore habitats and cultural heritage resources.
- Address any residual livelihood and community impacts and maintain the grievance mechanism.
- Undertake post-closure environmental and social monitoring and corrective actions where required.
- Conduct a final decommissioning/completion audit to confirm that closure and remediation objectives have been achieved.

Decommissioning plan. The pipeline has a design life of 30 years, which may be extended by maintenance. Preparation of the Decommissioning and Abandonment (D&A) Plan will start 3–5 years before closure and the plan will be submitted to NMDPRA (under the Midstream and Downstream Petroleum Decommissioning and Abandonment Regulations 2023) and FMEnv for approval at least one year before scheduled abandonment. The plan will describe the components to be decommissioned, the options evaluated (mothballing, partial removal, abandonment in place after purging, cleaning and capping, or complete removal), the selected end state, schedule, cost estimate, waste inventory and handling, the decommissioning team, a risk assessment and HSE plan, and stakeholder consultation, including transfer of any facility that third parties wish to retain.

Remediation plan. After removal of gas and facilities, a site survey will assess soil and groundwater along the RoW and at the valve stations, pig traps and receiving facility; contaminated soil will be treated in situ or removed to approved facilities; trenches and excavations will be backfilled with topsoil from un-impacted areas and revegetated with native species; all wastes (pipe off-cuts, coatings, sleeves, electrodes, PPE) will be removed and disposed of through licensed contractors; and the restored RoW will be monitored until revegetation is established. IFF will contribute to the Environmental Remediation Fund under the Midstream and Downstream Environmental Remediation Fund Regulations 2023.

Social aspects and close-out. Employees, contractors and communities will be informed in advance; retrenchment will follow Nigerian labour law; the GRM will remain open until closure; and a close-out report, witnessed by NMDPRA, FMEnv and the State Ministries of Environment, will document that closure and remediation objectives have been met.

ES9.0 Conclusion and Recommendation

The ESIA study assessed the potential environmental, social, and health impacts of a proposed natural gas pipeline project. It was conducted in accordance with local and international regulations and comprised desktop studies, data reviews, and fieldwork, including community consultations. The study found that the project would deliver significant economic benefits, and any adverse impacts would be short-term and manageable with the recommended mitigation measures. An Environmental and Social Management Plan has been developed to ensure the effective implementation of mitigation strategies and ongoing environmental management. Approval for the project is recommended, provided the ESMP is followed to prevent environmental damage.

The updated ESIA is based on a two-season baseline (December 2023 and August 2026), which shows an environment of generally acceptable air, noise, soil and water quality, a modified but biodiverse vegetation mosaic, and host communities with high literacy but high unemployment and low incomes. The most significant risks are the social risks of construction (agitation, influx and security) and the major-accident hazard of a high-pressure gas pipeline; these are reduced to Low or, for major accidents, to Medium (ALARP) by the mitigation measures and the ESMP, whose indicative cost is about N522.5 million. Key commitments include completion of the OS5 land acquisition audit and livelihood monitoring for the 11 km section, a QRA and emergency preparedness with communities, local employment, implementation of the SEP and GRM, and regular monitoring and reporting to the regulators and AfDB. Subject to these commitments, the Project is considered environmentally and socially acceptable.

CHAPTER ONE

INTRODUCTION

INTRODUCTION

Indorama Fertilizer Freezone (IFF) is a leading manufacturer and supplier of urea fertilizer and chemicals based in Eleme, Rivers State, Nigeria. The company is a subsidiary of Indorama Corporation, a global conglomerate with diverse business interests including petrochemicals, textiles, and fertilizers. IFF as a leading industrial player in Nigeria, intends to construct a 76km gas pipeline from a nearby gas supplier to its fertilizer and petrochemical plant in Eleme, Rivers State. In support of Indorama's business continuity and future expansion plans, Management, following a detailed technical assessment of projected natural gas demand, has decided to increase the diameter of the proposed 65 km Phase Two pipeline from 20 inches to 24 inches to accommodate anticipated future gas requirements. Accordingly, this Addendum to the Environmental and Social Impact Assessment (ESIA) Report addresses the environmental and social implications of the proposed pipeline diameter upgrade and incorporates wet-season baseline data collected in August 2026 to ensure a more comprehensive assessment of the project's potential impacts.

1.1 Background Information

IFF is a major producer of urea fertilizer, with a facility situated on a site of approximately 51 hectares (ha) within the 361 ha Indorama manufacturing complex at Eleme, Nigeria. The operations consist of petrochemical manufacturing facilities run by Indorama Eleme Petrochemicals Limited (IEPL) and fertilizer manufacturing facilities that are run by Indorama Eleme Fertilizer and Chemicals Limited (IFF) within the Indorama manufacturing complex. Current manufacturing capacity is 2.8 MMTA of Urea & 400 KTA of Polymers (Polyethylene & Polypropylene), utilizing Natural Gas & Natural Gas Liquids as feedstock. The Petrochemical manufacturing facilities comprising of the Cracker, Polyethylene and Polypropylene plants have been in operation since 2006. The Fertilizer manufacturing facilities consist of the Train 1 and Train 2 lines, which both independently produce 2,300 and 4,000 metric tons per day (MTPD) of ammonia and urea respectively. It should be noted that an ESIA study was commissioned for Train 3 in January 2023, and this Report was submitted to the Federal Ministry of Environment (FMEnv) on 26th May 2023 and International Finance Corporation (IFC) for approval. The Train 3 expansion project consisted of the development of an additional ammonia and urea train, with a design capacity of 2,300 MTPD of ammonia and 4,000 MTPD of urea. This ESIA Report was

approved by the Federal Ministry of Environment (FMEnv) vide letter number FMEnv/EA/EIA/6063/Vol.1/243 dated 6th September 2023, and currently the construction of Train 3 is ongoing.

In order to meet the gas requirement for the proposed Train 3 and other expansion projects, Indorama has proposed to construct a 20inch x 76km gas pipeline from Anoh Gas Manifold to Indorama complex in Eleme in an already existing Right of Way (RoW). The proposed pipeline is to deliver natural gas from Anoh gas Manifold to Indorama complex at 85 bar pressure with a maximum flowrate of 300mmscfd. A uniform pipe diameter is proposed to be maintained from the point of Off take to Eleme at outlet pressure of above 85bar. However, the optimum size of pipe (20" diameter) to flow the specified volume of gas as well as the pressures shall be confirmed by simulation. Figure 1.1 and 1.2 present map showing the 22 communities hosting the pipeline project and a Google map of the pipeline route respectively. The pipeline project will be implemented in two phases:

Phase 1: Construction of a new 20-inch pipeline from the ANOH Gas Processing Plant (AGPC) to approximately KP17, where it will connect to the existing 18-inch × 83 km IFF pipeline through a hot-tapping arrangement. This section will traverse approximately 11 km of newly acquired RoW covering about 5 communities in Imo State, generally running parallel to the existing RoW.

Phase 2: Construction of the new 24-inch pipeline from the KP17 connection point near Awara Community, Imo State, onwards to the existing NAOC/IFF RoW at approximately 65km on existing RoW covering about 17 communities. The pipeline will then turn and continue within the existing corridor, running generally parallel to the existing 18-inch × 83 km pipeline until it reaches the Indorama Complex.

The scope of the proposed construction of 20inch x 76km gas pipeline from Anoh Gas Manifold in Asa in Imo State to Indorama complex Eleme LGA in Rivers State includes the following activities of the whole gas pipeline project are as follows:

Pre-Construction

The activities in this phase are essentially desktop works involving feasibility, technical and financial investigations/considerations. Pre-construction activities during this phase include:

- Land acquisition for the new 11km RoW
- Engineering design
- Procurement of materials/equipment
- Permit to re-survey existing ROW.
- Gas Pipeline Route survey

- Environment Impact Assessment (EIA)
- Oil Pipeline License (OPLL)
- Survey verification and boundary re-opening.
- Mobilization of equipment and personnel to site

Construction phase

Construction of the gas pipeline will be executed in accordance with a standard engineering/planning framework to ensure maximum efficiency in construction, minimum adverse environmental and health impact, earliest completion time, and compliance with regulatory requirements. This involves the following:

- Material Procurement and Transportation
- Bush clearing within ROW.
- Excavation/Trenching
- Construction (Tie-in Points and Receiving Gas Station)
- Pipe laying (pipe stringing/welding, hydrostatic testing Non-destructive Weld Inspection, Lowering and Backfilling and cathodic protection).
- Commissioning and Handover

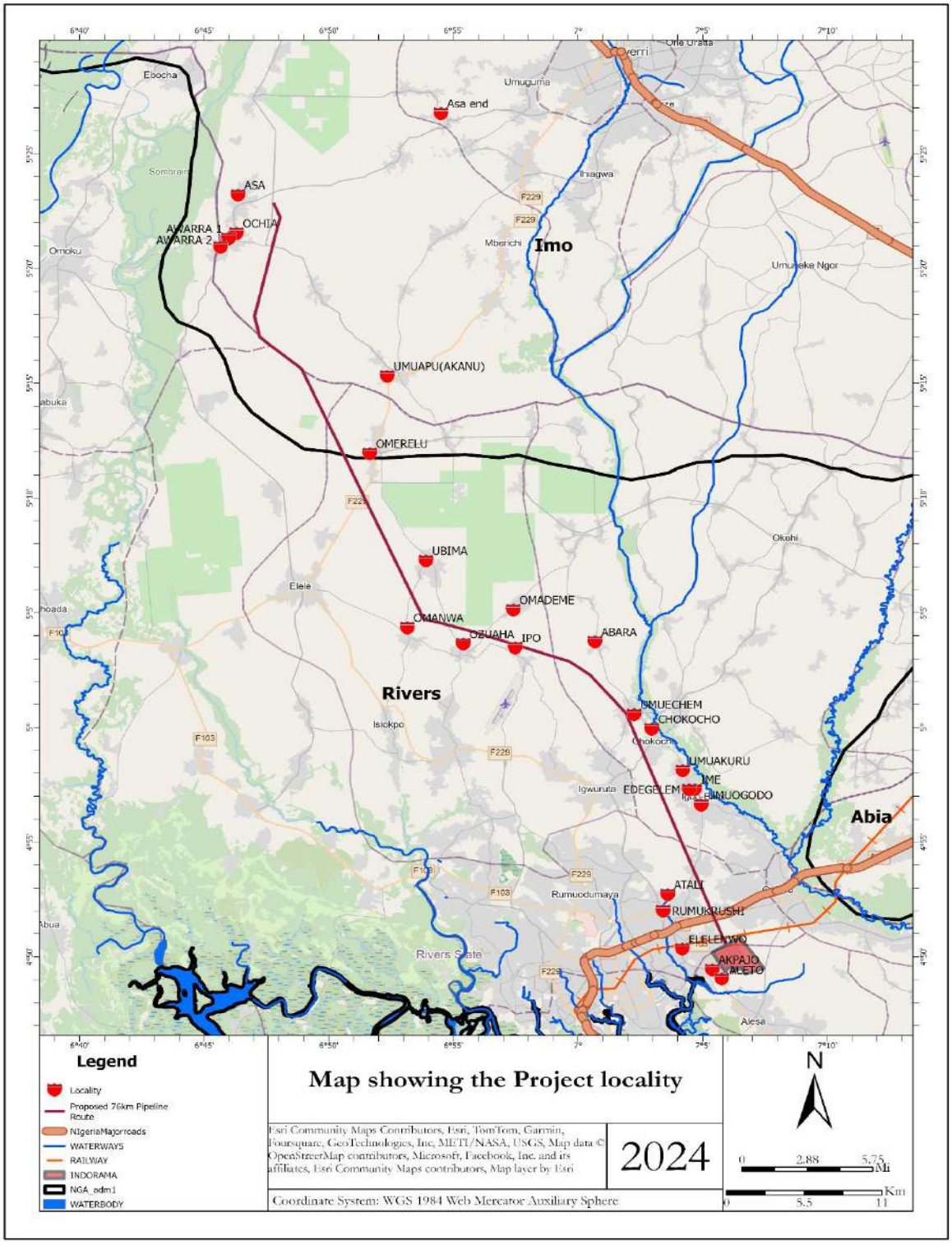


Figure 1.1: Locality map showing Pipeline RoW and Host communities.



Figure 1.2: Proposed pipeline route

1.2 ESIA Objectives

The overall objective of this ESIA study is to proactively identify and evaluate the potential environmental and social (E&S) impacts of the Project; and to put in place appropriate mitigation measures and management actions to address the identified impacts.

The specific objectives of the ESIA study are to:

- Provide a detailed description of the proposed Project (including relevant alternatives) in terms of the planned activities and the expected environmental and social aspects associated with the activities.
- Establish the existing state of the E&S conditions and to identify any sensitive resources and receptors.
- Identify and assess the associated and potential E&S impacts and risks of the Project, including potential secondary and cumulative impacts.
- Recommend appropriate mitigation measures (adopting the Mitigation Hierarchy, which is a set of guidelines that aim to achieve no overall negative impacts through the avoid, minimise, restore, and offset sequential steps) to address the identified impacts of the Project.
- Develop an appropriate Environmental, Social Management and Monitoring Plan (ESMMP) to detail how mitigation measures will be implemented and how environmental performance will be managed for the Project throughout the Project's life cycle.
- Prepare and submit a detailed ESIA Report presenting clear and concise information on the findings of the ESIA study.

1.3 Scope of ESIA

In conducting the ESIA study, the following activities have been completed:

- Review of applicable national and international laws, regulations, agreements, and industry codes.
- Submission of Project registration form together with the Terms of Reference (ToR) to FMEnv.
- Scoping and advanced stakeholder engagement.
- Literature review of relevant information pertaining to the Project Area of Influence (AoI) and the wider study area.
- Consideration of Project alternatives.
- Description of all actions/activities that will be carried out in the course of the Project.
- Determination of the physical, biological, and socio-economic baseline conditions of the study area and identification of any baseline gaps and subsequent resolutions.
- Conducting an impact assessment and identifying the effect of Project activities on the existing baseline environment.
- Advise on the mitigation of significant adverse effects of the Project during all phases.
- Recommendation of appropriate mitigation measures
- Response to the queries from stakeholders, Host Communities, regulators, and other interested parties.

1.4 Terms of Reference

In line with the requirements of the National Environmental Impact Assessment (EIA) Procedural and Sectoral Guidelines, a draft ToR for the ESIA study was prepared and submitted to the FMEnv along with the EIA registration application on 1st September 2023. The revised ToR was submitted in October 2023 after the scoping workshop. The ToR specified the technical scope of the ESIA study including the data requirements for determining the Project's environmental and social setting. The ToR was subsequently approved by the FMEnv vide letter reference number FMEnv/EA/EIA/7236/Vol.1/170 dated 27th October 2023 (Annexure 1.1). The FMEnv also classified the Project as an EIA Category One (1) Project with One (1) season baseline data vide letter number FMEnv/EA/EIA/7236/Vol.1/68 dated 12th October 2023. (Annexure 1.2). However, second season for wet season was undertaken between 6-9th of August 2026, with the lab inspection conducted 10th of August 2026 under the supervision of both Federal and State Ministries of Environment.

1.5 Policy, Legal and Administrative Framework

The ESIA study for the Project is based on the provisions of the Nigeria EIA Act No 86 of 1992 (now codified as the EIA Act CAP E12 Law of the Federation of Nigeria, 2004). In

September 2021, through Official Gazette No. 105, Vol 108, the Federal Republic of Nigeria published S.I. No. 109, Environment Impact Assessment (EIA) Procedures and Charges Regulations. This ESIA study has considered these regulations, which outline the National EIA process. The ESIA study has also considered the requirements of the International Finance Corporation's (IFC) Performance Standards (PSs) on Environmental and Social Sustainability (2012), the World Bank Group's (WBG) General guidelines, as well as relevant industry-sector Environmental, Health and Safety (EHS) guidelines and IFF Health, Safety and Environment (HSE) policy statements and Africa Development Bank (AfDB) Integrated Safeguards System (ISS). These standards include a requirement to assess the Environmental, Social and Health impacts of any development during all phases (planning, construction, and operation), so that adequate control measures can be undertaken to mitigate negative effects and enhance positive impacts.

This Section details the intricate foundational laws, regulations, policies, and guidelines both on national (Nigerian law) and international levels. The key institutional arrangements, administrative structures and legal instruments that relate to various activities applicable to the Project.

1.5.1 Institutional Framework

This Section provides a summary of the authorities with the mandate to implement aspects of Nigerian legislation over aspect relating to the Project.

1.5.1.1 Federal Ministry of Environment

The Federal Ministry of Environment (FMEnv) is the principal authority for the regulation and enforcement of environmental laws in Nigeria. The EIA Act, established by the National Assembly, which ensures that all development and industrial activities, operations and emissions are within the limits prescribed in the national guidelines and standards and comply with relevant regulations for environmental pollution management in Nigeria as and when these are released by the Ministry. Further to the Mandate, FMEnv developed laws/ guidelines on various sectors of the national economy including the Environmental Impact Assessment (EIA Act CAP E12, LFN 2004) Act and procedures for evaluating EIA reports. Furthermore, in September 2021, through Official Gazette No. 105, Vol 108, the Federal Republic of Nigeria published S.I. No. 109, Environment Impact Assessment Procedures and Charges Regulations. This ESIA study has considered these regulations, which outlines the EIA procedure from Project conception to commissioning and describes the requisite follow up activities. FMEnv consults with State Ministries of Environment and their Environmental Protection Agencies during the EIA permitting process. In addition,

other regulatory agencies/authorities with oversight over specific industries have also issued guidelines to regulate the impact of such industries on the environment.

1.5.1.2 National Environmental Standards and Regulations Enforcement Agency

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the Federal Government of Nigeria as an Agency of FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards, and regulations in Nigeria, specifically during the operational phase of development projects. However, the Oil & Gas operations are exempted in NESREA Act.

1.5.1.3 Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)

The Nigerian Midstream and Downstream Petroleum Regulatory Authority (Otherwise known as "The Authority") was created in September 2021 in line with the Petroleum Industry Act which seeks to provide legal, governance, regulatory and fiscal framework for the Nigerian Petroleum Industry and development of Host Communities. The Authority is responsible for the technical and commercial regulation of the midstream and downstream operations in Nigeria. With the scrapping of three hitherto extant oil regulatory agencies: Department of Petroleum Resources (DPR), Petroleum Products Pricing Regulatory Agency (PPPRA) and Petroleum Equalization Fund (PEF), The Authority was birthed to a new dawn with the key objective to establish a progressive fiscal framework that encourages investment in the Nigerian petroleum industry, provides clarity, enhances revenues for the government while ensuring a fair return for investors. In line with the PIA, The NMDPRA is Incharge of the Midstream and Downstream regulatory function which addresses issues like safety standards, environmental protection, pricing, product quality, consumer protection and market competition, all of which are essential for a well-functioning energy sector.

1.5.1.4 National Oil Spill Detection and Response Agency (NOSDRA)

The National Oil Spill Detection and Response Agency (NOSDRA) is a government agency operating under the Federal Ministry of Environment in Nigeria. It was established in 2006 through the National Assembly of the Federal Republic of Nigeria Act. NOSDRA's primary responsibility is to oversee the implementation of the National Oil Spill Contingency Plan (NOSCP), which includes the National Oil Spill Contingency System (NOSCS) for Nigeria. This ensures that Nigeria complies with its commitment as a signatory to the International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC, 1990).

Since its inception, NOSDRA has been dedicated to promoting adherence to environmental legislation within the Nigerian petroleum sector. As the leading agency for oil spill contingency plans in Nigeria, NOSDRA also oversees the ports and industries. It

carries out its mandate through joint investigation visits, environmental remediation of affected areas, monitoring of oil spill drill exercises, and facilitating inspections.

By enhancing its efforts to protect the environment and respond effectively to oil spills, NOSDRA plays a crucial role in safeguarding Nigeria's natural resources and ensuring sustainable development.

1.5.1.5 Institutional Capacity of Project Implementation Stakeholders

The effective implementation of the natural gas pipeline project will depend on the capacity of the Project Proponent, contractors, government agencies, regulators and host communities to fulfil their respective environmental and social responsibilities. Consequently, the table below outlines the roles and responsibilities of each group, including their institutional and administrative capacity in accordance to AfDB borrower note. This is to ensure that appropriate institutional arrangements, competent personnel, resources and monitoring systems are available throughout the project lifecycle.

Institution/Entity	Principal Roles and Responsibilities	Institutional and Administrative Capacity
Indorama Fertilizer Freezone Enterprise (IFF)	Overall responsibility for implementation of the ESMP; provision of financial, human and technical resources; obtaining and maintaining statutory approvals; integrating E&S requirements into project design, procurement and contracts; ensuring contractor compliance; stakeholder engagement; grievance management; environmental and social monitoring; incident reporting; corrective actions; and periodic review of ESMP performance.	Indorama has an established organisational structure, experienced management and technical personnel, and an operational Environmental and Social Management System (ESMS) supported by HSE procedures. The existing facility has established systems for environmental monitoring, regulatory compliance, incident management, emergency response, contractor management, stakeholder engagement and reporting. These existing systems provide the institutional foundation for implementing and maintaining the ESMP for the proposed Project. Additional resources will be provided as required during construction and operation.
Project Management Team	Incorporate ESMP requirements into project planning, engineering, procurement, construction and commissioning; coordinate	The Project Management Team will comprise experienced project, engineering, construction, HSE and

	contractors and consultants; ensure that environmental and social commitments are incorporated into work packages and contractor obligations.	environmental/social personnel. The team will have defined reporting lines and authority to incorporate E&S requirements into project decisions, approve work plans, coordinate contractors and track ESMP performance. Project-specific E&S responsibilities will be included in project implementation procedures and work packages.
HSE/Environmental and Social Management Team	Day-to-day implementation and supervision of ESMP measures; environmental monitoring; inspections and audits; waste management; pollution prevention; occupational and community health and safety; biodiversity and resource management; incident investigation; record keeping and regulatory reporting.	Indorama maintains an established HSE and environmental management function with personnel experienced in industrial environmental management, occupational health and safety, environmental monitoring, regulatory compliance and emergency response. The team will be strengthened with additional competent personnel and specialists where required, particularly during peak construction activities. It will have authority to conduct inspections, identify non-conformances, initiate corrective actions and escalate significant issues to management.
Engineering/Operations Department	Ensure that environmental and social controls are incorporated into engineering design, equipment selection, operation and maintenance; implement resource-efficiency, emission-control and pollution-prevention measures.	The Engineering and Operations teams possess technical and operational experience in large-scale pipeline design, construction and operation. Their established maintenance, process-control and operational procedures provide capacity to integrate pollution prevention, energy efficiency, emission controls, waste minimisation and environmental safeguards into project design and

		operation. Specialist engineering support will be engaged where necessary.
Procurement/Contract Management	Incorporate E&S requirements, performance standards and applicable regulatory obligations into contractor and supplier agreements; monitor contractor performance and enforce contractual corrective actions.	Existing procurement and contract-management procedures provide a mechanism for incorporating HSE, environmental and social requirements into tender documents, contracts and purchase orders. Contractors will be prequalified based on relevant technical and HSE competence, and contractual performance requirements will include compliance with the ESMP, applicable legislation and Indorama's HSE requirements.
Contractors/Subcontractors	Implement all applicable ESMP, HSE and environmental requirements within their areas of responsibility; prepare method statements and task-specific plans; provide competent personnel and PPE; undertake monitoring and reporting; manage wastes and hazardous materials; report incidents and implement corrective actions.	Contractors will be required to demonstrate adequate technical, financial, HSE and environmental capacity before mobilisation. Each major contractor will designate competent HSE/environmental personnel and implement project-specific HSE and environmental plans. Contractor performance will be subject to induction, routine inspections, audits, toolbox meetings, monitoring and corrective-action tracking by Indorama.
Federal Ministry of Environment (FMEnv)	Regulatory oversight of the ESIA process and environmental compliance; review and approval of the ESIA/ESMP; monitoring of compliance with approval conditions; inspections and enforcement in accordance with applicable environmental legislation.	FMEnv has the statutory mandate, technical departments and established procedures for ESIA review, environmental compliance monitoring, inspection and enforcement. The Ministry will provide regulatory oversight through review of the ESIA/ESMP, approval conditions, inspections,

		monitoring and review of compliance reports.
Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)	Regulatory oversight of applicable midstream/downstream petroleum and gas-related activities; review and enforcement of relevant technical, safety, environmental and operational requirements within its statutory mandate.	NMDPRA has specialised regulatory and technical capacity covering applicable gas and petroleum-sector activities, including technical, operational and safety oversight. Its established inspection, permitting, monitoring and enforcement mechanisms will support regulatory compliance for applicable gas-related aspects of the Project.
Rivers State Ministry of Environment / relevant State authorities	State-level environmental oversight, inspections, coordination and monitoring; participation in environmental compliance activities and community-related environmental matters.	The Rivers State environmental authorities provide state-level environmental oversight and have established personnel and administrative structures for environmental monitoring, inspection, stakeholder engagement and coordination with federal regulators. The Ministry will support implementation through periodic monitoring, participation in inspections and engagement on state and community-level environmental matters.
Relevant Local Government Authorities	Local administrative coordination, support for stakeholder engagement and community-level implementation of relevant project commitments.	The relevant Local Government Authorities provide an established administrative interface between the Project, host communities and state government. Their capacity will primarily support local coordination, communication, community mobilisation and participation in implementation of relevant community-level commitments.

Host Communities/Community Representatives/CDCs	Participate in consultation, disclosure, grievance management and participatory environmental monitoring; provide community feedback and assist in identifying emerging environmental and social concerns.	Existing community leadership structures, Community Development Committees (CDCs) and community representatives provide an established platform for stakeholder engagement and community participation. Their capacity will be strengthened through regular consultation, environmental awareness, grievance-management procedures and participation in **Participatory Environmental Monitoring (PEM)**.
Consultants/Independent Specialists	Provide specialist environmental and social expertise, baseline studies, monitoring, audits, capacity building and independent technical support where required.	Qualified and appropriately accredited consultants and specialists will be engaged where specialist expertise is not available internally. Consultants will support environmental and social monitoring, audits, technical studies, capacity building and independent verification. Their engagement will be subject to defined scopes of work, competency requirements and quality-control procedures.
Development Finance Institution/AfDB, IFC/WB where applicable	Oversight of applicable environmental and social requirements under the AfDB Integrated Safeguards System, including monitoring of implementation of relevant safeguard commitments.	Where applicable, AfDB, IFC/WB will provide independent safeguard oversight through review of environmental and social documentation, monitoring of ESMP implementation and engagement with the PIE and relevant stakeholders. The PIE will maintain appropriate documentation and reporting mechanisms to demonstrate compliance with applicable AfDB safeguard requirements.

1.5.1.6 Capacity Assessment and Capacity-Building Programme

Consistent with Section J and Annex 2 (item 3) of the AfDB Borrower Guidance Note on OS1, the capacity of the implementing institutions was assessed in terms of mandate, staffing, procedures, resources and experience. The regulators (FMEnv, NMDPRA, RSMEnv and ISMEnv) have clear statutory mandates and established review, permitting and inspection procedures, but field monitoring is constrained by logistics and budget. IFF, as the Project Implementing Entity, operates an ESMS, HSE and Community Relations & Development functions and a grievance mechanism for the existing pipeline communities, but requires dedicated E&S staffing for Phase 2 and specific skills in OS5 livelihood monitoring, GBV/SEA risk management and contractor E&S supervision. Contractors are required by contract to deploy qualified HSE/E&S personnel and a Contractor ESMP, and community structures require training in grievance handling and participatory monitoring. The capacity gaps and the capacity-building programme are presented in Table 1.5a.

Table 1.5a: Capacity gaps and capacity-building programme

Stakeholder	Capacity gap identified	Capacity-building measure	Timing	Indicative cost (N million)
IFF (PIE) – E&S/HSE and Community Relations	No dedicated E&S/social safeguards staff for Phase 2; limited OS5 livelihood-monitoring and GBV/SEA experience	Appoint a Project E&S personnel and a Social/Community Liaison Officer for Phase 2; training on AfDB ISS OS1–OS10, OS5 monitoring, GBV/SEA and contractor E&S supervision	Before mobilisation; refresher annually	25
EPC and community contractors	Variable HSE/E&S competence of sub-contractors and community contractors	Contractual E&S requirements; Contractor ESMP; E&S induction, toolbox talks and ESMP-specific training; minimum one HSE officer per work front	Pre-mobilisation and throughout construction	6
Cluster heads, CLOs and Grievance Committees	Informal grievance logging and limited record keeping	Training on the Project GRM, grievance registration, resolution timelines and reporting	Before construction; refresher every 6 months	5
Host communities / CDCs, women and youth groups	Limited awareness of pipeline hazards and RoW restrictions	Pipeline safety and emergency awareness campaigns	Construction and first year of operation	8
FMEnv, NMDPRA, RSMEnv, ISMEnv and LGAs	Logistics constraints for field monitoring	Facilitation of joint monitoring and inspection visits; sharing of monitoring reports	Six monthly during construction; annually in operation	12
Emergency services (State Fire Service, SEMA, local health facilities)	Limited familiarity with high-pressure gas pipeline emergencies	Briefing on the pipeline ERP	Before commissioning; annually thereafter	4
Total (indicative)				**60**

1.5.1.7 Gap Analysis between the National Framework and AfDB Requirements

The principal gaps between the Nigerian legal framework and the AfDB Operational Safeguards, and the measures adopted by the Project to close them, are presented in

Table 1.5b. Where national and AfDB requirements differ, the more stringent requirement applies.

Table 1.5b: Gaps between the national framework and AfDB requirements, and gap-filling measures

Theme	Nigerian requirement	AfDB requirement	Gap-filling measure adopted by the Project
Baseline seasons	FMEnv approved one-season (dry) baseline	Category 1: seasonal variation to be characterised (OS1)	Second (wet) season field campaign, 6–9 August 2026, integrated per component.
Land acquisition and compensation	Land Use Act: compensation for unexhausted improvements (crops, structures); land value not compensated; no livelihood-restoration requirement	OS5: compensation at full replacement cost before land access; livelihood restoration; support to vulnerable PAPs; GRM; monitoring and completion audit	Compensation for land, crops and economic trees paid before entry; GRM; livelihood restoration and vulnerable-person support; OS5 completion audit committed in the ESMP.
Stakeholder engagement and disclosure	EIA Act: public display for 21 working days and review panel	OS10: continuous, inclusive engagement through the project cycle; SEP; accessible GRM; disclosure in accessible form	SEP updated to include the 11 km communities; GRM; disclosure at LGA and State offices and in host communities.
Labour and working conditions	Labour Act and Employee Compensation Act; limited requirements for contractor workers and worker grievances	OS2: equal application to contracted workers; worker GRM; OHS; no child or forced labour	Contractual labour clauses; worker GRM; IFF HR policies (Section 1.9) applied to contractors; labour audits.
Community health, safety and security	NMDPRA technical and safety regulations	OS4: community risk assessment, emergency preparedness with communities, security personnel conduct, GBV/SEA	QRA, ERP with community component, security code of conduct, GBV/SEA code of conduct and referral pathway.
Biodiversity	Endangered Species Act; no habitat-classification requirement	OS6: habitat classification; no net loss for natural habitat; management of priority species	Habitat classification (modified habitat dominant); pre-clearance surveys; Biodiversity Management Plan.
Cultural heritage	NCMM Act protects antiquities	OS8: includes sacred sites, graves and intangible heritage; chance-finds procedure; consultation	Avoidance of sacred sites; consultation and agreed rites for graves; chance-finds procedure.
GHG emissions	Climate Change Act 2021 (no project-level quantification requirement)	OS3: estimate and report GHG emissions; minimise methane	Construction GHG estimate; leak detection and repair (LDAR); annual reporting of fugitive and vented methane.

1.5.2 National Regulatory Framework

The national policies and regulations included in Table 1.1 have E&S implications that pertain to the Project and associated ESIA study.

Table 1.1: National Policies and Regulations and the Applicability Thereof

Governing Documents	Description	Applicability
National Policies		
National Policy on the Environment, 1989	The National Policy on the Environment, 1989 (revised 1999 and 2017), provides a national mechanism for routine coordination and consultation among various tiers of local, state, and federal government to improve the development and implementation of environmental policy as well as establish effective relationships. In doing so, this Policy aims to achieve sustainable development through conserving the environment and natural resources, raising public awareness between environmental resources development, maintaining, and enhancing ecosystem processes, and co-operating with other countries, organisations, and agencies to reduce transboundary environmental degradation.	In line with the aims of the policy, this ESIA study includes an assessment of impacts to the physical, biological, and socio-economical environments related with the different phases of the Project. Moreover, this ESIA includes mitigation measures and an associated Environmental and Social Management and Monitoring Plan (ESMMP) that aim to avoid /minimise/manage the severity of identified impacts. Once the ESIA is approved by the FMEnv, IFF will need to implement ESMP obligation to ensure environmental sustainability.
National Policy on Climate Change, 2013	The mission of the National Policy on Climate Change, 2013 (revised 2021) is to strengthen national initiatives to adapt to and mitigate climate change and involve all sectors of society, including the poor and other vulnerable groups (e.g., women, elderly, youth etc.) within the overall context of advancing sustainable socio-economic development. Its main objectives are to: ■ Implement mitigation measures that will promote low carbon as well as sustainable and high economic growth ■ Strengthen national capacity to adapt to climate change ■ Raise climate change-related science, technology, and research and development to a new level that will enable the country to better participate in international scientific and technological co-operation on climate change. ■ Significantly increase public awareness and involve the private sector in addressing the challenges associated with climate change; and	In line with the National Policy on Climate Change, 2013 (revised 2021) and the Climate Change Act, 2021, this ESIA has considered the climate change adaptation requirements for the Project and management relating to GHG emissions during all Project phases.

Governing Documents	Description	Applicability
	■ Strengthen national institutions and mechanisms (policy, legislative and economic) to establish a suitable and functional framework for climate change governance.	
The National Gender Policy, 2021	The National Gender Policy, 2021 presents a set of minimum standards to meet the mandate for gender equality, good governance, accountability, and being socially responsive to the needs of vulnerable groups. The policy builds on the revision of the NGP, 2007 to respond to emerging issues across the sectors since 2006 and to incorporate current gender gaps to fulfil Nigeria's commitment to such global agenda as the SDGs. The strategic policy objectives are to bridge gender/social inclusion gaps, achieve parity in all spheres, to protect women's human rights, and mitigate sexual and gender-based violence through appropriate buffers and related services.	This ESIA process has (and continues) to be undertaken to ensure effective, transparent, and timely stakeholder engagement. Moreover, it has been structured such that all stakeholder engagement activities will take into consideration in gender sensitivities, particularly when engaging with local communities. Moreover, the ESIA considers gender equality in recruitment and that no employee or job applicant discriminated against on the basis of his or her gender, marital status, nationality, ethnicity, age, religion or sexual orientation.
National Policy on Occupational Safety and Health, 2021	The Occupational Safety and Health policy strengthens the National Labour Policy and extant labour legislations, provisions Cap 126, the workmen's Compensation Act Cap 470, Trade Union Act Cap 126, Trade Dispute Act Cap 432, wages Board and Industrial Councils Act 466 and the Labour Act Cap 198, and other relevant Laws of the Federation of Nigeria. The goal of the policy is to facilitate improvement of occupational safety and health performance by providing the framework for participative occupational safety and health protection of workers including the most vulnerable groups in all sectors of economic activities.	The safety, health, and welfare of all the workers associated with the Project will need to be addressed in line with all the provisions of this Policy throughout the Project lifecycle (construction, operational and decommissioning phases).
National Policy on Solid Waste Management, 2022	The National Policy on Waste Management 2022 provides a guidance for efficient and sustainable solid waste management in Nigeria. The policy objective is to provide a national direction on solid waste management for the Federal, States, Local governments, private sector, and all stakeholders. In doing so, the policy aims to promote a	The Project, during the construction, operational and decommissioning phases, will generate wastes majorly during construction and decommissioning phase, which will be disposed of as per the guidelines in this Policy. The ESMMP has considered these regulations and includes a section on solid waste management.

Governing Documents	Description	Applicability
	healthy and aesthetically satisfactory environment by ensuring effective, sustainable, safe, and sanitary solid waste management.	
National Environmental Sanitation Policy, 2005 (revised 2018)	This Policy serves as the instrument for securing sustainable quality environment for good health and social wellbeing of present and future generations.	This ESIA process has undertaken to cover events that could impinge on sanitation, hygiene, and health.
National Energy Policy, 2018	The national energy policy (2018) recognizes the multi-dimensional nature of energy and therefore addresses diverse issues such as research and development, energy pricing and financing, legislation, energy efficiency, environment etc. The overall thrust of the energy policy is the optimal utilization of the nation's energy resources for sustainable development with the active participation of the private sector. The policy aims to ensure the development of the nation's energy resources, with diversified energy resources option, for the achievement of national energy security and an efficient energy delivery system with an optimal energy resource mix and to guarantee adequate, reliable, and sustainable supply of energy at appropriate costs and in an environmentally friendly manner, to the various sectors of the economy, for national development. It also aims to successfully use the nation's abundant energy resources, promote research and development in, and adoption of, sustainable low carbon and clean energy technologies to mitigate environmental pollution and climate change and to ensure effective coordination of national energy planning, programmes, and policy implementation.	In line with this policy, IFF is required to abide with optimal energy consumption and environmental sustainability especially during construction phase, considering the nature of the project being a pipeline project.
National Gas Policy, 2017	The main objective of National Gas Policy, 2017 is to transform Nigeria from a crude oil export-based economy to an attractive oil and gas-based industry economy. It is also meant to extend gas penetration in the domestic market in order to facilitate the growth of the electric power, agriculture, industrial and transportation sectors, and end gas	In line with this policy, the Natural gas to be delivered by the proposed 76km pipeline will be used to produce Urea fertilizer which will help in reduction of flared gas in most oil fields in Nigeria.

Governing Documents	Description	Applicability
	flaring and address environmental issues. It is also meant to help gain a presence for Nigerian gas in international market along with primary attention to meeting local gas demand, gas-based industrialization to produce downstream high value export market products.	
General Environmental		
Environmental Impact Assessment Act 86 of 1992 (amended by EIA Act CAP E12 LFN 2004) and regulation 2021	This is the primary governing Act for EIA in Nigeria. The Act establishes a procedure and methodology to be followed to undertake an EIA study. Section 2 (2) of the Act requires that an EIA study must be undertaken in accordance with the Act when the extent, nature, or location of the proposed project or activities is likely to affect the environment significantly.	As the proposed Project will entail the construction of a natural gas pipeline of 76km, an EIA study in line with the provisions of the EIA Act is therefore required prior to the project commencing. Accordingly, an ESIA study is currently being carried out in line with the requirements of this Act and has further considered the Environment Impact Assessment Procedures and Charges Regulation, 2021, IFF shall be required to commit to implementing the commitments included in the ESMMP laid out in this ESIA Report and any other conditions as laid out by FMEnv, should an ESIA licence be issued for the Project.
National Environmental Impact Assessment Procedural and Sectoral Guidelines, 1994	FMEnv developed the National EIA Procedural Guidelines in response to the establishment of the EIA Act. The Procedural Guidelines assists proponents in conducting detailed E&S assessments by providing an overview of the baseline information, key issues, impacts, mitigation, and management plans to be considered as part of the EIA study.	As mentioned, an ESIA study is currently being undertaken for the Project. This ESIA has been undertaken to comply with the requirements of these Guidelines. IFF shall be required to commit to implementing the ESMMP laid out in this ESIA, and any other conditions stipulated by FMEnv.
Waste and Pollution		
National Environmental (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991, S.I.9	These Regulations impose restrictions on the release of toxic substances into the environment and stipulate requirements for pollution monitoring units, machinery for combating pollution, and contingency plans to be implemented by industries.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be disposed of as per the guidelines in these Regulations. The ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.
National Environmental Protection (Effluent	The National Effluent Limitation Regulation, S.1.8 of 1991 (No. 42, Vol. 78, August 1991) makes it mandatory for	The Natural Gas pipeline Project, during the construction, operational and decommissioning phases, will generate

Governing Documents	Description	Applicability
Limitation) Regulation 1991, S.I.8	industries such as waste generating facilities (including research institutes, clinics, hotels etc.) to install pollution prevention and pollution abatement equipment on site. The regulation is specific for each category of a waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contraventions are also specified in the regulation.	waste effluent especially during hydro-testing, which will need to be managed per the guidelines in these Regulations.
National Environmental (Management of Solid and Hazardous Wastes) Regulations, 1991, S.I.15	This instrument regulates the collection, treatment, and disposal of solid and hazardous waste streams from municipal and industrial sources. It gives a comprehensive list of chemicals and chemical waste by toxicity categories. The regulation requires the project proponent to practice waste segregation (at source) and engage the services of a government-approved waste management agents for appropriate waste disposal throughout the project's life cycle.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be managed and disposed of as per the guidelines in these Regulations. The ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.
National Environmental (Sanitation and Wastes Control) Regulations, 2009, S.I.28	This Regulation aims to adopt sustainable and environment-friendly practices in environmental sanitation and waste management to minimise pollution.	The provisions included in this Regulation have been considered as part of the Project ESMMP.
Soils and Water		
National Environmental (Soil Erosion and Flood Control) Regulations, 2011, S.I.12	The overall objective of this Regulation is to ensure that projects developed on sites that are vulnerable to flooding, including facilities that serve such projects, are protected against flooding by appropriate design at the time of initial construction.	The provisions included in these Regulations will need to be considered by IFF as part of Project Engineering designs for the pipeline project considering the nature of the terrain as to flooding.
National Environmental (Surface and Groundwater Quality Control) Regulations, 2011, S.I.22	The purpose of these Regulations is to enhance and preserve the physical, chemical, and biological integrity and to maintain existing use of groundwater and surface water resources. The standards contained herein provide for the protection of surface and ground water from pollutants so that the waters shall be protected, used, developed,	The Project will be associated with waste generation, more specifically solid and effluent wastes only during hydro-testing, which should be managed and disposed of in an environmentally friendly manner to avoid any form of pollution, including water (surface) pollution. This ESIA and associated ESMMP has considered these regulations.

Governing Documents	Description	Applicability
	conserved, managed, and controlled in ways that take into account: ■ Citizens right of access to clean water and sanitation ■ Protection of aquatic ecosystems and long-term sustainability of water resources; and ■ Reduction and prevention of pollution and degradation of surface water resources and recognition of preventive, precautionary, and polluter-pays-principles.	
Water Resources Act, CAP W2 LFN, 2004	This Act is aimed at promoting the optimum planning, development, and use of Nigeria's water resources; ensuring the coordination of activities that are likely to influence the quality, quantity; distribution, use, and management of water; providing the application of appropriate standards and techniques for the investigation, use, control, protection, and management of water resources; and facilitating technical assistance and rehabilitation for water supplies.	In line with the requirements of this Act, IFF will need to safeguard the integrity water systems within and surrounding the Project area throughout the implementation of the Project. This includes implementing proper waste management to prevent water pollution during the construction, operational and decommissioning phases.
Climate Change		
Climate Change Act, 2021	The Climate Change Act provides a legal and institutional framework for reducing GHG emissions in Nigeria. The objective of the law is to establish a framework for reducing GHG emissions and to embed climate change actions into national plans and programmes. The Act establishes the National Council on Climate Change (NCCC), which has been delegated the authority to make policies and decisions on all matters relating to climate change in Nigeria. The NCCC is directed to collaborate with the Federal Inland Revenue Service (FIRS) to develop a carbon tax in Nigeria. The proceeds from the carbon tax will go to the Climate Change Fund established under the Act. The Fund is to be used for the administration and general operation of the NCCC, the funding of innovative climate change mitigation and adaptation projects, conducting assessments of climate	In line with the requirements of this Act, this ESIA has considered the climate change adaptation requirements for the Project and management relating to GHG emissions during all Project phases.

Governing Documents	Description	Applicability
	change impacts on vulnerable communities, and incentivizing the transition to clean energy. The law is the first stand-alone comprehensive climate change legislation in West Africa. The Climate Change Act seeks to achieve net-zero GHG emissions in Nigeria between 2050 and 2070. It further provides a framework to help achieve Nigeria's NDCs and mandates the Ministry of Environment, in consultation with the Federal Ministry for Budget and National Planning, to set a carbon budget to keep the average increase in global temperature to within 2°C, and to help keep to 1.5°C rise above pre-industrial levels. The Act also requires the NCCC to collaborate with the FIRS to develop and implement a mechanism for carbon emission trading and empowers the Ministries to periodically revise the carbon budget, in line with Nigeria's NDCs with a view to complying with Nigeria's international obligations. The Climate Change Act also requires the preparation of a National Climate Change Action Plan (every five-years) to ensure that the carbon budgets are being met, and that climate change mitigation actions are identified and are being actively applied. In summary, the Climate Act 2021 provides a framework for achieving low greenhouse gas emission (GHG), inclusive green growth and sustainable economic development. Its main objectives are to: ▪ Ensure that Nigeria formulates programmes for achieving its long-term goals on climate change mitigation and adaptation. ▪ Facilitate the coordination of climate change action needed to achieve long-term climate objectives. ▪ Mainstream climate change actions in line with national development priorities.	

Governing Documents	Description	Applicability
	▪ Facilitate the mobilization of finance, and other resources necessary to ensure effective action on climate change. ▪ Ensure that climate change policies and actions are integrated with other related policies for promoting socio-economic development and environmental integrity. ▪ Setting a target for year 2050-2070 for the attainment of a net zero GHG emission, in line with Nigeria's international climate change obligations. ▪ Identify risks and vulnerabilities, building resilience and strengthening existing adaptive capacities to the impacts of climate change. ▪ Implement mitigation measures that promote low carbon economy and sustainable livelihood; and ▪ Ensure that private and public entities comply with stated climate strategies, targets, and National Climate Change Action Plan.	
Air Quality		
National Environmental (Air Quality and Control) Regulations, 2021, S.I.88	The objective of the Regulations is for the prevention, control, and reduction of air pollution to ensure clean and healthy ambient air. It provides for the establishment of emission standards for various sources such as mobile sources (e.g., vessels, motor vehicles) and stationary sources (e.g., industries). Emission limits for different areas and facilities have been set. The regulations make provision for designating controlled areas and the setting of objectives of air quality management plans for these areas.	The Pipeline Project, during the construction, operational and decommissioning phases, may generate air emissions. As part of this ESIA process, an air quality study has been undertaken. The primary objective of the air quality study is to consider and assess the potential impacts which the Project may have upon existing air quality, during both construction and operational phases. The assessment of construction impacts focuses on the potential effect of construction dust and construction-related combustion emissions (including vehicles) at existing sensitive receptor locations to the project environment. Air impacts have been quantified by comparison measured air parameter concentrations with the Project applicable air standards (which have considered these Regulations)

Governing Documents	Description	Applicability
		Moreover, the ESMMP includes specific controls to mitigate air quality emissions.
Noise		
National Environmental (Noise Standards and Control) Regulations, 2009, S.I.35	The Regulation highlights the permissible noise levels to which a person may be exposed, control and mitigate noise, permits for noise emissions above acceptable levels and enforcement maximum permissible noise levels a facility or activity to which a person may be exposed to.	The Project, during the construction and decommissioning phases, will generate noise. As part of this ESIA process, a noise study has been undertaken. The study has considered noise emissions at the potentially most affected noise sensitive receiver (NSR) locations in proximity to the Project. The Project will be required to comply with these Regulations to promote a healthy and safe working environment throughout all Project phases. Noise impacts have been quantified by comparison measured noise levels with the Project applicable noise standards (which have considered these Regulations). Moreover, the ESMMP includes specific controls to mitigate noise emissions.
Biodiversity		
National Environmental (Control of Alien and Invasive Species) Regulations, 2013, S.I.32	This regulation seeks to prevent the decline and minimise the modification and destruction of the ecosystem and human health caused by alien and invasive species.	This ESIA and associated ESMMP has considered a range of potential ecological impacts associated with the Project, including ecosystem services derived from them. However, the issue of alien and invasive species is not likely to occur during this project implementation.
Endangered Species Act CAP E9 LFN, 2004 as amended 2016	This Act prohibits, except under a valid license, the hunting, capture, or trade-in animal species, either presently or likely being in danger of extinction, and defines the liability of any offender under this Act. It also provides for regulations to be made necessary for environmental prevention and control regarding the purposes of this Act.	These regulations have been considered in the biodiversity study for the ESIA and associated ESMMP.
Health and Safety and Labour		
Employment Laws and Regulations Nigeria 2023	The Employment Laws and Regulation 2023 strengthens employment laws as stated in the constitution of the Federal Republic 1999, the Labour Act 2004, Federal and State laws that relate to labour and employment, and international	IFF will be bound to abide to Nigeria labour and employment laws and regulation during its Project lifecycle.

Governing Documents	Description	Applicability
	conventions, treaties and protocols relating to labour and employment, industrial relations or matters connected therewith that have been ratified by Nigeria.	
Factories Act, CAP F1 LFN 2004	The Factories Act 1990 (amended in 2004) is the primary law regulating the health, safety, and welfare of workers in the country's factories. The Law holds management and staff personally responsible for violations of the provisions in the Act.	The safety, health, and welfare of all the workers associated with this pipeline Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.
Labour Act, CAP L1 LFN 2004	Nigeria has ratified all core International Labour Organisation Conventions. The Labour Act 1990 (amended in 2004) is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers.	IFF will be bound by this Act to abide to its stipulation on employee management and remuneration during its construction and operational phases. Basically, for the staff that will be retained after the project construction phase.
Trade Unions Act, 2005	This Act contains provisions with respect to the formation, registration, and organization of trade unions. It includes stipulation of 'equal pay for equal workers without discrimination on account of sex, or any other ground whatsoever'.	The Proponent will respect workers' rights to join (or not join) unions of their choice and to engage with those unions which workers are members of in relation to collective bargaining, disciplinary proceedings, and retrenchment of workers.
National Minimum Wage Act, 2019	The Act prescribes the national minimum wage and provides for a legal framework for a seamless review of the stated national wage.	IFF will abide with the stipulation of this Act on employee remuneration during the Project lifecycle.
Employee Compensation Act, 2010	This Act repeals the Workmen's Compensation Act W6 LFN 2004 and makes comprehensive provisions for payment of compensation to employees that suffer from occupational diseases or suffer injuries from accident at workplace or in the course of the employment.	The safety, health, and welfare of all the workers associated with the pipeline Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.
Pension Reform Act, 2014	This Act makes provision for the contributory pension scheme for public and private sectors in Nigeria.	IFF will be bound by this Act to abide to its stipulation on employee remuneration during all Project phases.
Violence against Persons (Prohibition) Act, 2005	The Violence against Persons (Prohibition) Act (VAPP) was passed into law in May 2015. The Act was necessitated as a result of agitations for the protection of persons against different forms of violence. The Act has strengthened	The safety, health, and welfare of all the workers and communities associate with the Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.

Governing Documents	Description	Applicability
	advocacy against rape, female genital mutilation, partner battery, stalking, harmful widowhood practices while prohibiting all forms of violence, including physical, sexual, psychological, domestic, harmful traditional practices and discrimination against persons. It also provides maximum protection and effective remedies for victims and punishment of offenders.	
Land		
Land Use Act CAP L5 LFN, 2004	Land Use Act No. 6 was enacted in 1978 (revised in 1990 and 2004). The Act vests all land in the territory of each State (except land vested in the Federal Government or its agencies) solely in the Governor of the State, who holds such land in trust for the people and is solely responsible for the allocation of land in all areas, to individual resident in the State and to organizations for residential, agricultural, and commercial purposes.	IFF have legally secured rights to use the existing RoW for the proposed pipeline Project. However, where land acquisition is required, it will be carryout in accordance to Land Use Act CAP L5 LFN, 2004
Other		
National Environmental (Ozone Layer Protection) Regulations, 2009, S.I.32	This regulation prohibits the use, emission, storage, and disposal of stratospheric ozone-depleting substances (ODS) and articles which contain those substances.	IFF will need to ensure that equipment containing ODS's will either not be used on site or, if currently being used, will need to be phased out.
National Environmental (Construction Sector) Regulations (S.I No. 19), 2011	The purpose of these Regulations is to prevent and minimize pollution from construction, decommissioning and demolition activities applicable to Nigerian projects. It stipulates that new projects in the construction sector shall apply cost-effective, up-to-date, efficient, use best available technology, to minimize pollution to the barest degree practicable.	This ESIA considers a variety of potential impacts that may result in pollution to the environment during the construction and decommissioning phases of the pipeline Project. IFF shall be required to commit to implementing the ESMMP laid out in this ESIA, and any other conditions stipulated by FMEnv.
Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN, 2004	The Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN, 2004 prohibits and declares unlawful activities relating to the purchase, sale, importation, transit, transportation, deposit, and storage of harmful wastes. Appropriate penalties for infringement are prescribed.	The Pipeline Project is not anticipated to generate any harmful waste, ESMMP (Chapter 7) has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.

Governing Documents	Description	Applicability
Criminal Code of 1990 (now CAP 38 LFN, 2004)	The Act contains the primary criminal law offences related to environmental damage, public health, and natural resources. Some environmental crimes include causing a public nuisance, fouling the water of any spring, stream, well, or reservoir of a place, and violating the atmosphere in any position to make it harmful to the health of persons.	IFF shall be required to commit to implementing the ESMMP laid out in this ESIA, and any other conditions stipulated by FMEnv.
Petroleum Industry Act,2021	The Petroleum Industry Act (PIA) 2021 provides legal, governance, regulatory and fiscal framework for the Nigerian Petroleum Industry and development of Host Communities and related matters. It is dealing with Rights of Pre-emption, incorporated joint Ventures, Domestic Base Price and Pricing Framework, Pricing formula for Gas Price for the Gas based Industries, Capital Allowances, Production allowances and cost price ratio limit, Petroleum fees, rents, and royalty. The act creates two regulatory bodies, known as the Nigerian Upstream Regulatory Commission responsible for the technical and commercial regulation of upstream petroleum operations and the Nigerian Midstream and Downstream Petroleum Regulatory Authority responsible for the technical and commercial regulations of the midstream and downstream operations.	IFF shall be required to obtain required approvals from Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) prior to commencement of construction phase and other approvals for the pipeline operations.
The Mineral Oil (Safety) Regulations, 1963 (Amended 1997)	The Mineral Oil (Safety) Regulations 1963 require the implementation of specific safety measures for workers in Drilling and Production operations in accordance with recognized International Standards. It also deals with safe discharge of noxious or inflammable gases and specifies penalties for contravention and non-compliance. These regulations provide that a licensee or lessee shall: • Ensure that no pipeline is put into operation without the approval of the Director of Petroleum Resources. • Make sure that the right of way (ROW) of every pipeline is free of overgrowth and weeds in order to allow for easy access for conducting operational tests,	IFF shall be committed to protection of workers during the construction and operation of the pipeline and also ensure adequate maintenance of the RoW.

Governing Documents	Description	Applicability
	other maintenance works and for prompt detection of leakages. • Carry out cathodic protection potential survey on all buried pipelines at intervals of not more than 2 years to ensure that every section of the protected line attains a negative potential of not less than 850mV with respect to copper/copper sulphate reference electrode. • Provide clear, comprehensive, safe and practical Operational Procedures and Guidelines for the workforce;	
Oil Pipelines Ordinances (CAP) 145, 1956 and Oil Pipelines Act, 1965	The Oil Pipelines Ordinance (CAP 145) of 1956, which was later amended by the Oil Pipelines Act of 1965, establishes the legal framework for the transportation of mineral oil, natural gas, and other oil or gas products. According to Section 4(2) of this ordinance, individuals or organizations seeking to survey a pipeline route must obtain a Permit to Survey (PTS) from the Minister of Petroleum Resources. This permit allows them to transport the aforementioned substances to any desired destination for purposes related to the petroleum trade or operations.	IFF shall make an application to the Minister of Petroleum Resource to obtain a Permit to Survey (PTS), which will enable transportation products on the proposed pipeline.
Petroleum Regulations 1967	These Regulation prohibit discharge or escape of petroleum into waters within harbor areas and make provisions for precautions in the conveyance of petroleum, and rules for safe operation of pipelines.	IFF shall be required to commit to implementing the ESMMP laid out in this ESIA, and any other conditions as highlighted by this regulation.

Governing Documents	Description	Applicability
Petroleum (Drilling and Production) Regulations (1969)	The Petroleum (Drilling and Production) Regulations of 1969 bestow significant powers upon the holder of an Oil Prospecting License (OPL) within the specified area covered by the license (Section 15(1)). It is crucial to understand that Section 15(2) places the license holder in full accountability for the actions carried out by their agents and contractors.	IFF shall be required to commit to implementing the ESMMP laid out in this ESIA, and any other conditions as highlighted in this regulation, especially provision of PPEs to their worker especially during the pipeline construction and decommissioning phase.
Oil in Navigable Waters Act (1968)	This prohibits discharge of oil or oil mixture containing oil into the territorial or navigable inland waters.	The proposed pipeline RoW has no river crossing. IFF shall be required to commit to implementing the ESMMP laid out in this ESIA to prevent surface water pollution as a result of product spillage.
The Midstream and Downstream Petroleum Environmental Regulation 2023	The Regulation is designed to ensure that environmental standards and practices are upheld across midstream and downstream petroleum operations in order to ensure environmental protection	IFF shall be required to commit to implementing the ESMMP laid out in this ESIA to ensure environmental protection,
The Midstream and Downstream Petroleum Safety Regulation 2023	The regulation is promulgated to prioritizes safety measures and procedures in the midstream and downstream sector	IFF shall be required to commit to implementing the ESMMP laid out in this ESIA ensure safety of personnel and equipment
The Midstream and Downstream Decommissioning and Abandonment Regulation 2023	The regulation outlines the requirements and procedures for the decommissioning and abandonment of petroleum facilities in the midstream and downstream	IFF shall be required to commit to implementing the ESMMP laid out in this ESIA, especially during the decommissioning phase to ensure environmental protection.
The Midstream and Downstream Environmental Remediation Fund Regulation 2023	The regulation sets out the establishment and financial contribution of the Fund for Midstream and Downstream Operation. The fund aims to provide resources for the cleanup, rehabilitation, or management of negative environmental impact from petroleum operations nationwide.	IFF is required to register and follow financial contributions as outlined in the regulation.
Nigerian National Minimum Wage Act of 2019	The Nigerian National Minimum Wage Act of 2019 established a mandatory minimum wage of ₦30,000 per month for	IFF is expected to follow and go above the requirements of this regulation.

Governing Documents	Description	Applicability
	workers in Nigeria. In 2024, the Act was amended to increase the minimum wage to ₦70,000 per month due to inflation and rising living costs. This change also shortened the review period from five to three years for more frequent adjustments to the minimum wage based on economic conditions.	
Discrimination Against Persons with Disabilities (Prohibition) Act, 2018	The Discrimination Against Persons with Disabilities (Prohibition) Act, 2018 is a Nigerian law that protects the rights of persons with disabilities. It prohibits discrimination in public and private spheres, requires accessibility in buildings and transportation, ensures equal opportunities in employment, guarantees access to education and healthcare, and establishes a National Commission for Persons with Disabilities. Violators face fines or imprisonment. Challenges in enforcement and awareness persist, and ongoing advocacy and government support are needed for full implementation and improvement of the lives of people with disabilities in Nigeria.	IFF is expected to treat all employees and individuals, including those with disabilities, fairly and without discrimination in all their interactions and engagements.
Fire Service Act CAP F29, LFN 2004	The Fire Service Act in Nigeria establishes the Federal Fire Service as the national authority responsible for fire prevention, firefighting, and rescue operations. It outlines their functions, powers, and responsibilities, such as fire prevention, inspection of premises, training of firefighters, and investigating fire incidents. Fire officers have the authority to enter buildings, seal off dangerous premises, use force to extinguish fires, and enforce fire safety codes. The Act also mandates the development of fire safety regulations for buildings and imposes penalties for non-compliance.	The Act mandates the development of fire safety regulations for buildings, and compliance thus imposes penalties for non-compliance.

1.6 State Laws & Administrative Institutions on Environmental Protection

Section 20 of the 1999 constitution of the Federal Republic of Nigeria, states that, "The State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria". Furthermore, the EIA Act No. 86 of 1992 recommends the setting up of state environmental agencies to support the efforts of the FMEnv in regulating the consequences of project development on their environment.

1.6.1 Rivers State Ministry of Environment

Since the inauguration of the present democratic administration, Rivers State Government has established a full-fledged Ministry of Environment (RSMENV) headed by a commissioner. The Ministry was created from the Rivers State Environmental Protection Agency (RSEPA). RSMENV was empowered by the decree that set up the repealed FEPA (Decree 58 of 1988, as amended by Decree 59 of 1992), which encourages State governments to set up their own Environmental Protection Agencies.

Consequently, RSMENV is charged with the protection of the environment of Rivers State and operates with Edict No. 2 of 1994. In 2002, RSMENV published the Interim Guidelines and Standards on Environmental Pollution Control and Management in Rivers State which was revised in 2013. The guidelines seek to:

- Regulate the generation, handling, storage, disposal, and management of all wastes of whatever origin in Rivers State
- Regulate physical development in compliance with the principle of sustainable development.
- Enhance and where possible, restore the quality of the environment and protect the biodiversity of the flora and fauna of Rivers State.

1.6.2 Rivers State Waste Management Agency (RIWAMA)

The Rivers State Waste Management Agency (RIWAMA) is responsible for the enhancement of the environment but is also mandated to positively change the living conditions and reduce diseases and health problems in the state. It was created in 2013 by the Rivers State House of Assembly and was assented by the state governor in July 2014. Prior to this, the agency functioned as the "Rivers State Environmental Sanitation Authority (RSESA)".

1.6.3 Rivers State Noise Control Edict, No. 20, 1985

The law targets reducing occupational noise exposure of workers to noise from factories/industrial machines and exposure of the neighbouring population to noise from nearby factories. It also sets limits for other sources of noise including aircrafts, loud music and public address systems and recommends daily noise exposure limits for industry workers and communities.

1.6.4 Rivers State Environmental Protection and Management Law, CAP A42, 2019

The objective of law is to exploit, develop and manage resources to achieve a higher quality of life by ensuring sustainable development. The law prescribing and listing activities that require environmental permits both in manufacturing and non-manufacturing sectors. The law also specifies terms for registration of environmental consultants in the state and conditions for issuance or renewal of the accreditation certificates / permits.

1.6.5 Imo State Ministry of Environment (ISMEnv)

The Imo SME is charged with the responsibility of conservation and protection of the environment and all other matters concerning the environment in the state particularly monitoring and controlling pollution and the disposal of solid, gaseous, and liquid wastes. Some of the specific functions of the Ministry include:

(i) Formulating and enforcing policies, statutory rules and regulation on solid waste collection and disposal, general environmental protection, flood control and regulation of the ecological, system and all activities related therein, throughout the State.

(ii) Conducting public enlightenment campaign and disseminates vital information on environmental and ecological matters, and to mobilize the inhabitants of all areas for effective

observance of environment of environmental rules and guidelines, for the purpose of healthy and safe environment.

(iii) monitoring the implementation of EIA studies and other environmental studies for all development projects in the State.

1.6.6 Imo State Environment Protection Agency Law of 1992 (Amended, 1997)

Imo State Government in 1992 established the Imo State Environment Protection Agency (ISEPA) and charged them with the responsibility of the overall conservation and protection of the environment and all other matters concerning the environment in the

state particularly monitoring and controlling pollution and the disposal of solid, gaseous and liquid wastes.

1.7 International Conventions, Protocols and Agreements

Nigeria is a signatory to several international conventions and agreements targeted toward the conservation and protection of the environment to ensure sustainable development. The relevant international conventions and regulations most applicable to the project are highlighted below in Table 1.2.

Table 1.2: List of Relevant International Conventions and Regulations

Conventions	Year Adopted	Overview
The Paris Accord	2015	The Paris Accord is a legally binding international treaty on climate change. It was adopted by 196 Parties at the United Nations Climate Change Conference, COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. The Paris Accord's long-term temperature goal is to keep the rise in mean global temperature to well below 2 °C (3.6 °F) above pre-industrial levels, and preferably limit the increase to 1.5 °C (2.7 °F), recognizing that this would substantially reduce the impacts of climate change. Emissions should be reduced as soon as possible and reach net-zero in the second half of the 21st century. It aims to increase the ability of parties to adapt to climate change impacts and mobilize sufficient finance. Under the Agreement, each country must determine, plan, and regularly report on its contributions.
International Health Regulations (IHR)	2005	The IHR is an international legal instrument that is binding on 196 countries across the globe, including all the Member States of World Health Organisation (WHO). This binding instrument of international law was first adopted in 1969, revised in 2005 and entered into force on 15 June 2007. The purpose and scope are "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks and which avoid unnecessary interference with international traffic and trade".
International Labour Organization (ILO): ILO-OSH, 2001 - Guidelines on Occupational Safety and Health (OSH) Management	2001	These guidelines call for coherent policies to protect workers from occupational hazards and risks while improving productivity. The guidelines present practical approaches and tools for assisting organisations, competent national institutions, employers, workers, and other social partners in establishing, implementing, and improving occupational safety and health management systems, with the aim of reducing work-related injuries, ill health, diseases, incidents, and deaths. At the organisational level, the guidelines encourage the integration of OSH management system elements as an

Conventions	Year Adopted	Overview
		important component of overall policy and management arrangements. Organizations, employers, owners, managerial staff, workers, and their representatives are motivated in applying appropriate OSH management principles and methods to improve OSH performance. Nigeria ratified the guidelines in 2001.
The United Nations Convention on Biological Diversity	1994	The Convention was adopted in 1994. The objectives of the Convention include the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.
The Rio Declaration on Environment and Development	1992	The Declaration was made in 1992 in Rio de Janeiro, reaffirming the declaration of the United Nations Conference on Human Environment adopted at Stockholm in 1972. The principle works towards international agreement which respects the interest of all and protects the integrity of the global environment and development. The principles of the declaration relevant to the proposed project include: Principle 4: In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. Principle 17: EIA as a national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.
The United Nations Framework Convention on Climate Change	1992	The Convention on Climate Change was adopted in 1992 during the Rio Earth Summit in Rio De Janeiro, Brazil and entered into force in 1994 to limit Greenhouse Gas (GHG) emissions which cause global warming.
International Convention on Oil Pollution Preparedness, Response, and Co-operation (OPRC)	1990	Parties to the International Convention on OPRC are required to establish measures for dealing with pollution incidents, either nationally or in co-operation with other countries. Parties to the convention are required to provide assistance to others in the event of a pollution emergency and provision is made for the reimbursement of any assistance provided. Ships and operators are required to carry a shipboard oil pollution emergency plan, oil pollution emergency plans or similar arrangements which must be coordinated with national systems for responding promptly and effectively to oil pollution incidents.
The Montreal Protocol on Substances that Deplete the Ozone Layer. Adopted on	1987	The Protocol was adopted on 16 September 1987 as an international treaty to eliminate ozone depleting chemicals production and consumption.

Conventions	Year Adopted	Overview
September 16, 1987.		
Vienna Convention for the Protection of the Ozone Layer.	1985	The Vienna Convention was adopted in 1985 and entered into force on 22 September 1988. It places general obligations on countries to make appropriate measures to protect the environment against adverse effects resulting from human activities which tend to modify the ozone layer.
Protocol Concerning Cooperation in Combating Pollution in Cases of Emergency in the West and Central African Region	1981	The objective of the protocol is to protect the marine environment, the coastal zones and the related internal waters falling within the jurisdiction of the States of the West and Central African region against pollution in cases of emergency. The Parties undertake to cooperate in all matters relating to the protection of their respective coastline and related interests from the threat and effects of pollution resulting from marine emergencies, especially by exchanging relevant information (arts. 4, 5, 6, 7, 8 and 10). They agree to assist each other, on demand, in cases of marine emergencies (art. 8). Finally, they are to endeavor to maintain and promote marine emergency contingency plans (art. 9) and take appropriate measures to prevent, reduce, combat, and control the effects of pollution (art. 10).
Convention on the Conservation of Migratory Species of Wild Animals, 1979	1979	This Convention, also known as the Bonn Convention, was adopted in 1979 and entered into force in 1983. It stipulates actions for the conservation and management of migratory species including habitat conservation. West African Aquatic Mammals Memorandum of Understanding (MoU), 2008 This MoU concerns the conservation of the manatee and small cetaceans of Western Africa and Macaronesia. It is a Multilateral Environmental MoU and entered into effect on 3 October 2008 under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals. The MoU aims to protect these species at a national, regional, and global level. MoU concerning Conservation Measures for Marine Turtles of the Atlantic Coast This MoU requires signatories to endeavour to put in place measures for the conservation and, where necessary and appropriate, strict protection of marine turtles at all stages of their life cycle (including eggs, hatchlings, juveniles, sub-adults and adults. It came into effect in 1999 and is an agreement under Article IV, paragraph 4, of the Convention on the Conservation of Migratory Species of Wild Animals.
African Convention on the Conservation of Nature and	1968	The African Convention on the Conservation of Nature and Natural Resources was adopted in Algiers, Algeria, on 15 September 1968, and entered into force on 16 June 1969. The Convention stipulates that the contracting States shall undertake to adopt the measures necessary to ensure conservation, utilization and development of soil, water, flora

Conventions	Year Adopted	Overview
Natural Resources		and fauna resources in accordance with scientific principles and with due regard to the best interests of the people.
Kyoto Protocol on Greenhouse Gas Emission Reductions (2004 for Nigeria)	2004	The Kyoto Protocol, adopted in 1997 and enacted in 2005, requires industrialized nations to reduce greenhouse gas emissions. It introduced tools such as emissions trading and the Clean Development Mechanism. Nigeria ratified the protocol in 2004 and committed to reducing emissions, although developing countries like Nigeria were not bound by strict targets but encouraged to pursue sustainable development.
Cartagena Protocol on Biosafety (2003 for Nigeria)	2003	The Cartagena Protocol on Biosafety, adopted in 2000 and enforced in 2003, aims to protect biodiversity from the potential risks of genetically modified organisms (GMOs) created through biotechnology. Key provisions include the requirement for Advanced Informed Agreement (AIA) before receiving GMOs, the establishment of a Biosafety Clearing-House for sharing GMO information, and the ability for countries to ban GMOs as a precaution even without full scientific certainty of harm. Nigeria, as a country with rich biodiversity, ratified the protocol to regulate GMO use and protect its ecosystems.
The Basel Convention on Hazardous Waste Control (1989, in force for Nigeria in 1992)	1992	The Basel Convention on Hazardous Waste Control was adopted in 1989 and became effective in Nigeria in 1992. Its goal is to regulate the movement of hazardous wastes across borders and ensure they are disposed of in an environmentally safe manner. Key provisions include requiring exporting countries to obtain consent from receiving countries, banning hazardous waste exports to developing countries, and mandating the reduction of waste production. Nigeria has ratified the convention and has dealt with issues of illegal hazardous waste imports, making the treaty important for the country's safety.
The Rotterdam Convention on Hazardous Chemicals & Pesticides (1998, in force for Nigeria in 2004)	2004	The Rotterdam Convention, adopted in 1998 and in force for Nigeria since 2004, aims to promote shared responsibility in the international trade of hazardous chemicals and pesticides. Key provisions include Prior Informed Consent (PIC), information exchange, and the right to refuse shipments. Nigeria ratified the convention to better control harmful chemicals and protect public health due to its heavy reliance on agriculture and industry.

1.8 International Best Practice Standards and Guidelines

1.8.1 Equator Principles (EPIV)

The Equator Principles provide a set of 10 principles of voluntary standards that present a credit risk management framework for determining, assessing, and managing social and environmental risk in Project financing. The Equator Principles are based on the IFC

Performance Standards on social and environmental sustainability and on the World Bank Group EHS Guidelines. The Project has committed to complying with this set of principles, which together with the IFC Performance Standards and the EHS Guidelines will be used as a benchmark for IBP.

Details of the applicability of the Equator principles to the Project ESIA process are provided in Table 1.3.

Table 1.3: Applicability of the Equator Principles to the Project ESIA Process

Principle	Relevance to Project
1: Review and Categorisation	Category A project.
2: Social and Environmental Assessment	IFF are currently undertaking an ESIA for the Project.
3: Applicable Social and Environmental Standards	The ESIA and associated ESMMP has been undertaken in accordance with standards and recommendations of IFC Performance Standards and EHS Guidelines.
4: Action Plan and Management System	At this stage, IFF have a number of environmental, social, occupational health and safety and human resource plans, policies, and procedures. These plan, policies and procedures relate to all IFF's operations in Port Harcourt. Over the life of all of IFF's operations, the vehicle by which the commitments set out in the ESMMP related to this ESIA and other plans, policies and procedures should be developed into specific actions which can be implemented through an overarching Environmental and Social Management System (ESMS).
5: Consultation and Disclosure	On-going stakeholder engagement, community consultation and disclosure are being undertaken.
6. Grievance Mechanism	A Project's Grievance Mechanism has been developed and is being implemented.
7. Independent Review	The Project lenders will need to appoint an independent review panel to review all Project documentation.
8. Covenants	Relevant Nigerian legislation is being complied with. IFF employees and activities will need to comply with commitments included in the ESMMP. Annual reports will need to be prepared documenting actions and activities demonstrating these commitments.
9. Independent Monitoring and Reporting	The Project lenders will need to appoint an independent review panel to review all Project documentation.
10. Equator Principle Founding Institute (EPFI) Reporting	Not IFF's responsibility.

1.8.2 International Finance Corporation Performance Standards on Environmental and Social Sustainability, 2012 (IFC PSs)

IFC's Sustainability Framework (International Finance Corporation, World Bank Group) articulates the Corporation's strategic commitment to sustainable development and is an integral part of IFC's approach to risk management. The Sustainability Framework

comprises IFC's Policy and Performance Standards (PSs) on Environmental and Social Sustainability, and IFC's Access to Information Policy.

The Policy on Environmental and Social Sustainability describes IFC's commitments, roles, and responsibilities related to environmental and social sustainability. IFC's Access to Information Policy reflects IFC's commitment to transparency and good governance on its operations and outlines the Corporation's institutional disclosure obligations regarding its investment and advisory services.

The PSs are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities.

IFC requires its clients to apply the PSs to manage environmental and social risks and impacts so that development opportunities are enhanced. The IFC PSs are outlined in Box 1.1.

Box 1.1 International Finance Corporation Performance Standards

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

The requirements of each of the eight IFC PSs, and their relevance to the Project, are presented in Table 1.4.

Table 1.4 IFC PSs and the Relevance to the Project

Performance Standards	Key Requirement	Relevance to the Project
IFC PS1: Assessment and Management of Environmental and Social Risks and Impacts	This PS relates to integrating and managing E&S performance throughout the life of a project in line with national regulations and international standards. The standard requires the development of an Environmental and Social Management System (ESMS) that entails a structured approach to managing environmental and social risks and impacts. Moreover, the PS describes how E&S issues are to be handled in project	The Project poses a number of E&S risks and impacts, which will need to be appropriately managed. Appropriate management measures have been included in the ESMMP (Chapter 7). Moreover, as part of the ESIA process stakeholders at the State and Local Government and Community level have been consulted and engaged and will continue being engaged

Performance Standards	Key Requirement	Relevance to the Project
	development and serves as the core around which the other standards are framed. This standard requires that nearby communities be appropriately engaged on issues that could potentially affect them. Key requirements include: • Conducting an informed consultation and participation process with affected communities • Working in an inclusive and culturally appropriate manner • Addressing the needs of disadvantaged or vulnerable groups; and • Making available an effective grievance management system.	during the ESIA process and post-ESIA. At this stage, IFF have a number of environmental, social, occupational health and safety and human resource plans, policies and procedures. These plan, policies and procedures relate to all IFF's operations within their operational area. Over the life of all of IFF's operations, the vehicle by which the commitments set out in the ESMMP related to this ESIA and other plans, policies and procedures should be developed into specific actions which can be implemented through an overarching Environmental and Social Management System (ESMS).
IFC PS2: Labour and Working Conditions	This standard aims to ensure that the Proponent establishes, maintains, and improves a worker-management relationship that promotes the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws and international standards (as defined by the International Labour Organisation (ILO). In particular, PS2 addresses child labour and forced labour, and promotes safe and healthy working conditions, and protecting and promoting the health of workers by recognising the role of employees.	Project workers (for all Project phases) will need to be provided with fair labour and working conditions. This will apply to all categories of workers irrespective of whether directly engaged by IFF or Contractor (direct workers), engaged through third parties (contracted workers), and workers engaged by the client's primary suppliers (supply chain).
IFC PS 3: Resource Efficiency and Pollution Preventions	This PS aims to abate pollution to air, water, and land that may threaten people and the environment at the local, regional, and global levels. This Performance Standard promotes the ability of private sector companies to adopt such technologies and practices where feasible.	Development of the Project will require a number of resources, which have the potential to cause some negative E&S impacts. All required resources will need to be used efficiently and all wastes managed in accordance with the waste management hierarchy, where avoidance of waste generation is the priority.
IFC PS 4: Community, Health, Safety and Security	The role of this PS is to anticipate and avoid adverse impacts on the health and safety of the affected communities throughout the life of the project as a	Implementation of the pipeline Project will need to ensure that the health, safety, and security of all

Performance Standards	Key Requirement	Relevance to the Project
	result of routine and non-routine events. The PS also requires an assessment of how use of security by the project to safeguard personnel and property could impact on community security taking into account considerations of human rights.	Project affected communities are not compromised.
IFC PS5: Land Acquisition and Involuntary Resettlement	PS5 refers to the management of physical and economic displacement resulting from project-related land acquisition through resettlement and livelihood restoration processes. Objectives are to: • Avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. • Avoid forced eviction. • Anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by: – Providing compensation for loss of assets at replacement cost; and – Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. • Improve, or restore, the livelihoods and standards of living of displaced persons. • Improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.	IFF have legally secured rights to use the existing and new Pipeline RoW for the proposed Pipeline Project. However, securing land and access restrictions to surrounding communities will need be in line with the requirements of PS5.
IFC PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	This PS aims to protect and conserve biodiversity based on the Convention on Biological Diversity. It divides habitat into three categories, modified, natural, and critical. For projects in natural habitat, mitigation measures should be designed to achieve no net loss of biodiversity where feasible. For projects in critical habitats, the project's mitigation strategy should be described in a Biodiversity Action Plan and be designed to achieve net gains of those	Assessment of the proposed Project's impacts on biodiversity has been carried out in line with the requirements of PS 6.

Performance Standards	Key Requirement	Relevance to the Project
	biodiversity values for which the critical habitat was designated.	
IFC PS7: Indigenous Peoples	This PS deals with safeguarding Indigenous Peoples. The aim of this PS is to protect the interests of Indigenous Peoples (IPs) during project implementation. On a broader scale, it requires project implementation to avoid adverse impacts on Indigenous Peoples as well as ensuring their participation and consent.	No recognized IPs are impacted by this Project, hence PS7 is not triggered.
IFC PS8: Cultural Heritage	Cultural heritage, according to this PS, refers to tangible forms of cultural heritage, such as tangible movable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and religious values; unique natural features or tangible objects that embody cultural values, such as sacred groves, rocks, lakes, and waterfalls; and certain instances of intangible forms of culture that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles.	As part of this ESIA process a cultural heritage impact assessment (considering both tangible and intangible forms of cultural heritage) has been undertaken in accordance with PS8.

1.8.3 African Development Bank's (AfDB) Integrated Safeguard System (ISS) - Operational Safeguards on Environmental and Social Sustainability, 2023 (AfDB OSs)

The AfDB's Integrated Safeguards System (ISS) is a set of policies, procedures, and guidelines established to identify, assess, and mitigate potential E&S risks and impacts associated with the Bank's funded projects and programs. The ISS were designed to ensure that the Bank's investments promote sustainable development and do not harm people or the environment. The updated ISS (April 2023) are comprised of the following:

- AfDB's Vision for Sustainable Development
- AfDB's E&S Policy
- Ten E&S Operational Safeguards (OS)
- E&S Guidance Notes (ISS Guidance notes)

There is a significant overlap between the AfDB operational safeguards and the IFC PSs; nevertheless, as the AfDB safeguards are also relevant to this Project the assessment of

E&S performance is also assessed against these. A summary of the AfDB Safeguards is provided in Table 1-5 below

Table 1.5 AfDB's OSs and the Relevance to the Project

AfDB Safeguard	Description	Applicability
E&S OS 1 (Assessment and Management of Environmental and Social Risks and Impacts)	The aim of this overarching OS, along with the nine other Oss that complement it, is to mainstream E&S considerations; including those related to climate change vulnerability; into Bank operations and thereby contribute to sustainable development in Africa. An ESIA study carried out under this OS helps to determine the scope and extent to which other OSs are addressed. It sets out the Borrower's (or Project's) responsibilities for assessing, managing, and monitoring E&S risks and impacts associated with each stage of an operation/project supported by AfDB. This OS, together with OS10 (Stakeholder Engagement and Information Disclosure) provide the overall process framework for the E&S assessment and management of AfBD financed operations at project level.	OS1 triggered due to construction and operation of the pipeline with potential environmental and social impacts
E&S OS 2 (Labour and Working Conditions	The objectives of OS2 are as follows: protect workers' rights; promote safety and health in the workplace; promote the fair treatment, non-discrimination, and equal opportunity of project workers; protect project workers, including vulnerable workers; prevent the use of all forms of forced labour and child labour; support the principles of freedom of association and collective bargaining of project workers, provide project workers with accessible means to raise workplace concerns; and enquire that the Bank, and national competent authorities as appropriate, be informed promptly of any material adverse impacts and events relating to labour protection and health and safety at the workplace. The applicability of this OS is established during the ESIA described in OS1.	OS2 will be triggered due to involvement with contractors and workers

AfDB Safeguard	Description	Applicability
E&S OS 3 (Resources Efficiency and Pollution Prevention and Management)	OS3 sets out the requirements to address resource efficiency and pollution 36 prevention and Management throughout the project life cycle in a manner consistent with Good International Industry Practice (GIIP). Throughout the different phases of the project's lifecycle—planning and design, construction, commissioning, operations, and decommissioning—the project is required to assess and evaluate resource-efficiency and pollution-prevention techniques and implement them, taking into consideration their technical and financial feasibility and cost-effectiveness. The applicability of this OS is established during the ESIA described in OS1.	OS3 will be triggered considering potential generation of construction and GHG emissions
E&S OS 4 (Community Health, Safety and Security)	This OS addresses potential risks and impacts on communities that may be affected by project activities. Occupational health and safety (OHS) requirements for project workers are set out in OS2, and measures to avoid or minimize impacts on human health and the environment due to existing or potential pollution are set out in OS3. The applicability of this OS is established during the ESIA described in OS1.	OS4 will be triggered, considering the fact that the pipeline will pass through communities and other human receptors
E&S OS 5 (Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement)	The objectives of OS5 are to: avoid involuntary resettlement where feasible, or minimize resettlement impacts where involuntary resettlement is deemed unavoidable after all alternative project designs have been explored; ensure resettlement plans and activities are informed by social assessments (including gender issues); avoid forced evictions; mitigate unavoidable adverse social and economic impacts from land acquisition or restrictions on land use; improve living conditions of poor or vulnerable persons who are physically displaced by the project; establish a mechanism for monitoring the performance and effectiveness of involuntary resettlement activities which result from project activities; conceive and execute resettlement activities as sustainable development programs; and ensure that resettlement activities are planned and implemented with appropriate disclosure of information, meaningful consultation, and the informed participation of those affected. The applicability of OS5 is established during the ESIA described in OS1	OS5 will be triggered considering the fact that the 11km RoW will be newly acquired

AfDB Safeguard	Description	Applicability
E&S OS 6 (Habitat and Biodiversity Conservation & Sustainable Management of Living Natural Resources)	This OS outlines the requirements for the Project to (i) identify and implement opportunities to conserve and sustainably use biodiversity and natural habitats, and (ii) observe, implement, and respond to requirements for the conservation and sustainable management of priority ecosystem services. The applicability of OS6 is established during the ESIA as described in OS1.	OS 6 will be triggered considering vegetation clearance and construction activities that may affect terrestrial habitat
E&S OS 7 (Vulnerable Groups)	OS7 contributes to poverty reduction and sustainable development by ensuring that projects supported by the Bank enhance opportunities for vulnerable groups to participate in, and benefit from, the development process in ways that do not threaten their unique cultural identities and well-being. The applicability of OS7 is established during the ESIA as described in OS1	OS7 will not be triggered Not triggered for Indigenous Peoples or highly vulnerable rural minorities, as none are present in the sense of OS7. Vulnerable individuals (women, elderly, youth, persons with disabilities and vulnerable PAPs) are addressed under OS1, OS5 and OS10 through the SEP, GRM

AfDB Safeguard	Description	Applicability
E&S OS 8 (Cultural Heritage)	This OS sets out general provisions on risks and impacts to cultural heritage from project activities. OS7 sets out additional requirements for cultural heritage in the context of vulnerable groups and highly vulnerable rural minorities including Indigenous Peoples (IPs). The applicability of this OS is established during the ESIA described in OS1.	OS8 will be triggered since there was some shrine/sacred bushes observed during field data collection.
E&S OS 9 (Financial Intermediaries (FIs))	The objectives of this OS are to: set out how the FI will assess and manage environmental and social risks and impacts associated with the subprojects it finances; promote good environmental and social management practices in the subprojects the FI finances; o promote good environmental and sound human resources management within the FI; support the adoption of best practice standards in corporate governance, business management and corporate responsibility by enterprises supported by the Bank based upon the requirements of OSs 1 through 10, as appropriate; and encourage the consideration of environmental and social governance issues in capital market institutions such as development finance entities and stock exchanges	OS9 is not triggered: the Project is financed directly and does not involve a financial intermediary on-lending to sub-projects.
E&S OS 10 (Stakeholder Engagement and Disclosure of Information)	This OS therefore recognizes the importance of open and transparent engagement between the project and project stakeholders as an essential element of good international practice. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation. OS10 applies to all Bank Group's funded operations. The project will engage with stakeholders as an integral part of the project's ESIA and project design and implementation, as outlined in OS1	OS 10 will be triggered since project will cut across multiple LGAs and communities requiring meaningful consultation

1.8.4 The World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines

The World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines (1991 and updated in 2007) are a set of technical reference materials that provide pollution related limits and standards. In general, the Guidelines seek to avoid, minimize and control environmental, health and safety (EHS) impacts during the construction, operation and decommissioning phase of a project or facility and are applicable to this Project. The EHS Guidelines serve as a technical reference source to support the implementation of the IFC PSs.

General EHS Guidelines exist, which contain information on cross-cutting EHS issues potentially applicable to all industry sectors; these are listed in Box 1.2 below.

Box 1.2 IFC General EHS Guidelines

General EHS Guidelines
1. Environmental
1.1 Air Emissions and Ambient Air Quality
1.2 Energy Conservation
1.3 Wastewater and Ambient Water Quality
1.4 Water Conservation
1.5 Hazardous Materials Management
1.6 Waste Management
1.7 Noise
1.8 Contaminated Land
2. Occupational Health and Safety
2.1 General Facility Design and Operation
2.2 Communication and Training
2.3 Physical Hazards
2.4 Chemical Hazards
2.5 Biological Hazards
2.6 Radiological Hazards
2.7 Personal Protective Equipment (PPE)
2.8 Special Hazard Environments
2.9 Monitoring
3. Community Health and Safety
3.1 Water Quality and Availability
3.2 Structural Safety of Project Infrastructure
3.3 Life and Fire Safety (L&FS)
3.4 Traffic Safety
3.5 Transport of Hazardous Materials
3.6 Disease Prevention
3.7 Emergency Preparedness and Response
4. Construction and Decommissioning
4.1 Environment
4.2 Occupational Health and Safety
4.3 Community Health and Safety

Where applicable, the abovementioned EHS Guidelines were considered in this ESIA process; however, the Air Emission and Ambient Air Quality Guideline (1.1); the

Wastewater and Ambient Water Quality Guideline (1.3); the Water Conservation Guideline (1.4); and the Noise Guideline (1.7) are of particular importance to the proposed ESIA process. These are discussed in more detail in the Sections below.

1.8.5 IFC EHS Guidelines – 1.1 Air Emissions and Ambient Air Quality

The IFC recommend that the air quality guidelines as set out by the WHO be utilized in such an assessment. The WHO standards are divided into a few stages, which have interim targets and a final guideline target. The WHO guidelines are recognized to be particularly conservative, as they make no consideration of the economic burden of achieving the stipulated guidelines. The WHO final guideline target is aspirational, and as such, this target should be progressively worked towards.

As mentioned in Section 1.6, the Nigerian Government has developed a list of environmental standards for the purpose of preventing significant industrial pollution. Nigerian ambient air quality standards are set out in Table 1.6.

Table 1.6: Nigerian Air Quality Standards

Pollutant	Averaging Period	Value (µg/m^3)
Nitrogen dioxide (NO_2)	Annual	80
	24 hours	120
	1 hour	200
Particulate Matter (PM_{10})	Annual	60
	24 hours	150
Particulate Matter ($PM_{2.5}$)	Annual	20
	24 hours	40

It must be noted that the IFC/WHO do not set guidelines for ammonia and therefore guidelines from the Environment Agency for England (EAE) are suggested. Table 1.7 provides the WHO/IFC and EAE ambient air quality guidelines for those pollutants included in the Nigerian air quality standards.

Table 1.7: WHO/IFC and EAE Ambient Air Quality Guidelines

Pollutant	Averaging Period	Value (µg/m^3)
NO_2	Annual mean	40
	1 Hour Maximum	200
PM_{10}	Annual mean	70 (interim target -1)
	24 Hour, 4th Highest (99th percentile)	150 (interim target 1)

Pollutant	Averaging Period	Value (µg/m³)
$PM_{2.5}$	Annual mean	35 (interim target 1)
	24 Hour Maximum	75 (interim target 1)

Taking the above into account, the Project specific guidelines (which consider Nigerian ambient air quality standards and air quality guidelines from the WHO/IFC and EAE) are presented in Table 1.8.

Table 1.8: Project Specific Guidelines

Pollutant	Averaging Period	Origin of Guideline	Value (µg/m³)
NO_2	Annual mean	IFC	40
	1 Hour Maximum	IFC	200
PM_{10}	Annual mean	Nigeria	60
	24 Hour Maximum	Nigeria	150
$PM_{2.5}$	Annual mean	Nigeria	20
	24 Hour Maximum	Nigeria	40

1.8.6 IFC EHS Guidelines – 1.3 Wastewater and Ambient Water Quality, 2007

Project implementation does not envisage wastewater generation being a pipeline project except during hydro-testing prior to project commissioning. However, IFC EHS Guideline 1.3 specifies that discharges should not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality. Receiving water use and assimilative capacity, taking other sources of discharges to the receiving water into consideration, should also influence the acceptable pollution loadings and effluent discharge quality.

The WBG EHS Guideline states that process wastewater should be consistent with the applicable Industry Sector EHS Guidelines and in compliance with national or local standards for wastewater discharge. As such, this ESIA process has considered the Industry Specific EHS Guideline for Nitrogenous Fertilizer Production (refer to Section 1.9.5) together with local Nigerian standards. IFC EHS Guidelines – 1.4 Water Conservation, 2007

Mechanisms included in the water conservation guidelines include –

- The setting of targets for water use, and monitoring of water flows against these targets
- Water reuse where possible; and

- Reducing leaks and making more efficient use of water within the water reticulation system.

1.8.7 IFC EHS Guidelines – 1.7 Noise, 2007

The IFCs EHS Guidelines – *General EHS Guidelines: Environmental Noise Management 1.7 Noise* (IFC 1.7 Noise) is an internationally recognised guideline document containing information for the assessment and management of noise.

Table 1.8 presents the IFC noise guidelines that should not be exceeded at the nearest Noise Sensitive receptor (NSR) locations offsite. These guidelines are generally based on an interpretation of the relevant section of the WHO 1999 guidance concerning the effect of noise on people and implied potential health effects. They are designed to apply to noise emissions from facilities and stationary noise sources (such as factories).

In addition to the absolute values provided in Table 1.9, the IFC also requires that noise increase above existing (background) levels should not exceed 3 dB at the nearest receptor location off-site.

Table 1.9: IFC Noise Level Guidelines

Receptor	One Hour L_{Aeq} (dB(A))	
	Daytime (07:00 – 22:00)	Night (22:00 – 07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

LAeq = A-weighted equivalent sound levels over a measurement period, dB(A) = A-weighted decibel

IFC noise guidelines give no guidance on construction noise. As such, for the construction phase of the Project specifically, the ESIA process has adopted the Nigerian noise criteria included in the National Environmental (Noise Standards and Control) Regulations, 2009, S.I.35.

Table 1.10: Nigerian Construction Noise Criteria

Receptor	Maximum noise level permitted L_{Aeq} dB(A)	
	Day time	Night-time
Hospitals, schools, institutions of higher learning, homes for the disabled, etc.	60	50
Buildings other than those prescribed above	75	65

Construction activities will take place only during the daytime; therefore, the assessment of construction noise is based only on the daytime noise criteria.

In addition to construction noise specific criteria, the Nigerian Noise Standards and Control Regulation includes maximum permissible L_{Aeq} levels for a range of receptor types.

Table 1.11: Maximum Permissible Noise Levels in Nigeria

Receptor	Maximum noise level permitted L_{Aeq} dB(A)	
	Day time 06:00 – 22:00	Night-time 22:00 – 06:00
Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites	45	35
Residential buildings	50	35
Mixed residential	55	45
Residential + industry or small-scale production+ commerce	60	50
Industrial (outside perimeter fence)	70	60

The NSRs in the proximity of the Project can be classified as "*residential + industry or small-scale production+ commerce*" according to the Nigerian standards; however, for this ESIA process the more stringent criteria for "*residential, institutional; educational*" receptors as prescribed by the IFC will be used.

As such, for Project activities during the operational phase to create a significant noise impact, the noise generated must be above the noise impact threshold levels, as summarised in Table 1.12.

1.9 Project Proponent's Specific EHS Policies and Standards

1.9.1 IFF Non-Discriminatory Policy, 2021

IFF is an equal opportunity employer and as per the Non-Discriminatory Policy does not and shall not discriminate against any employee or any applicant for employment on the basis of race, colour, religion (creed), gender expression, age, disability, military status, sexual orientation, and national origin in any of its activities or operations. These activities include but are not limited to employment – recruitment, selection, hiring, compensation, termination, upgrading, promotions, and other conditions of employment.

1.9.2 IFF Child Labour Prohibition Policy, 2021

IFF does not and shall not offer employment nor employ any person below the age of eighteen (18) years. The Company maintains zero tolerance towards the breach of this policy.

In line with the Policy, IFF shall maintain appropriate documents of all relevant details of employees including their age and these documents shall be open for verification by authorized personnel or the relevant statutory body. The Human Resources Department is responsible for the implementation of this Policy.

1.9.3 EFCL Human Rights and Labour Policy, 2021

The IFF Human Rights Policy is guided by the International Human Rights Principles as enshrined in the Universal Declaration of Human Rights, the ILO Declaration on fundamental Principles of Rights at Work, and the African charter on Human Rights on the constitution of the Federal Republic of Nigeria 1999, as amended. Specifically, IFF employees shall have the following rights:

- Freedom of association
- Freedom of express
- Healthy work environment
- Safety at workplace
- Non-discrimination
- Freedom of worship
- Freedom from bullying, sexual harassment
- Right to fair hearing
- Any other such rights as necessary and recognized by the law of the Federal Republic of Nigeria.

1.9.4 IFF Independent Contractors' Policy, 2021

For the purpose of this Policy, independent contractors are workers working for IFF. IFF directs all independent contractors working with the Company to strictly comply with the guidelines on the following internal policies: Employee Hand Book, Grievance Handling and Management Policy, Anonymous Grievance Handling Mechanism, Child Labour Prohibition Policy, Human Rights Policy, Non-discriminatory Policy, Retrenchment Planning (Redundancy) as stipulated in the National Labour Law, Work Place Discipline Policy, Security and Safety Policy, Employee Compensation Policy and any other policy necessary for the wellbeing of the independent contractors and their employees.

1.9.5 IFF Gender Based Violence and Harassment Policy, 2021

IFF is committed to promote gender diversity in the organization and recognizes the potential risk of Gender Based Violence and Harassment (GBVH). IFF has a zero tolerance for GBVH and on continual basis endeavours to identify the risk areas, upgrade preventive measures; create awareness amongst both internal & external stakeholders, enhance capability building and increase effectiveness of grievance management system. The objective this Policy is to define a policy framework and define strategies for addressing the issue of GBVH. This Document also aims to provide an integrated framework for stakeholder engagement and grievance management system with a focus on GBVH at all states of business cycle.

1.9.6 IFF Anti-Retaliatory Policy, 2021

IFF is committed to providing access to effective grievance management systems for its employees, stakeholders, and local business partners. Further, IFF also expects from its local business partners working with the company to provide access to effective grievance management systems for its employees and stakeholders for freedom of expression and grievance redressal without any fear of Retaliation or victimisation. The objective of this Policy is to provide a framework, establish organisational commitment, assess risk, build organisation capabilities for preventative and mitigation measures, as well as proffer an effective grievance management system for safeguarding the human rights values.

1.9.7 IFF Community and Stakeholder Policy, 2021

IFF is committed to respecting the rights, cultures, customs, and values of employees and communities affected by its activities and will manage its businesses in a fair and equitable manner to meet its social responsibilities. The objective of the Policy is to ensure proactive engagement with key stakeholders on sustainable development challenges and opportunities in an open and transparent manner and to ensure effective grievance mechanisms are in place.

1.9.8 IFF Environmental & Climate Change Policy, 2022

IFF is committed to effective environmental management. The aim of this Policy is to minimise impacts on the environment and reduce impacts on climate change throughout its operations. The objective of the Policy is to ensure the development and implementation of Environmental Management Systems that are compliant with applicable national, regional, and local environmental regulations, and good international practice.

1.9.9 IFF Occupational Health, Safety & Wellbeing Policy, 2022

The Policy aims to promote the health and safety of employees, service providers, and any other person who is impacted by IFF operations. The goal of the Policy is zero harm as well as safe and healthy workplaces.

1.9.10 IFF Product Stewardship Policy, 2022

IFF is committed to the highest standards of product safety, quality, and business integrity to meet customer expectations and achieve customer delight. The Policy goal is to minimise the health, safety, environmental, and social impacts of their products.

1.9.11 IFF Responsible Business Policy, 2021

The Responsible Business Policy objective is to make positive contributions to the economic, environmental, and social progress at the locations where IFF operates. IFF is committed to promoting business practices that provide benefits to society, transparently and ethically, and address potential negative impacts associated with its operations.

1.9.12 IFF Social Media Policy, 2021

The IFF social media Policy provides a framework for use of social media for corporate or personal accounts to protect against damage to the organization. The policy objective is to provide practical ways to avoid issues that may arise from the improper use of social media.

1.9.13 IFF Confidential Reporting Policy, 2021

IFF is committed to high ethical standards and encourages reporting of any acts listed below by any employee irrespective of their position. The Policy prohibits anyone from retaliating against any person who in good faith raises or helps to resolve any of the acts below or any other ethical concern. Confidential reporting applies to:

- Any violation of Indorama's Code of Conduct.
- Any act that adversely affects the business interest of IFF.
- Any act that is illegal under local or international law.
- Any abuse of authority.

1.10 ESIA Process

The Environmental and Social Impact Assessment (ESIA) for the proposed Project has been undertaken in accordance with the Environmental Impact Assessment Act (CAP E12 LFN 2004) and the Environmental Impact Assessment Procedures and Charges Regulations

(S.I. No. 109 of 2021), together with relevant international standards and good practice guidelines, mainly the IFC PSs (2012) and AfDB ISS (2023). The FMEnv ESIA process adopted for the project is summarised in Figure 1.3.

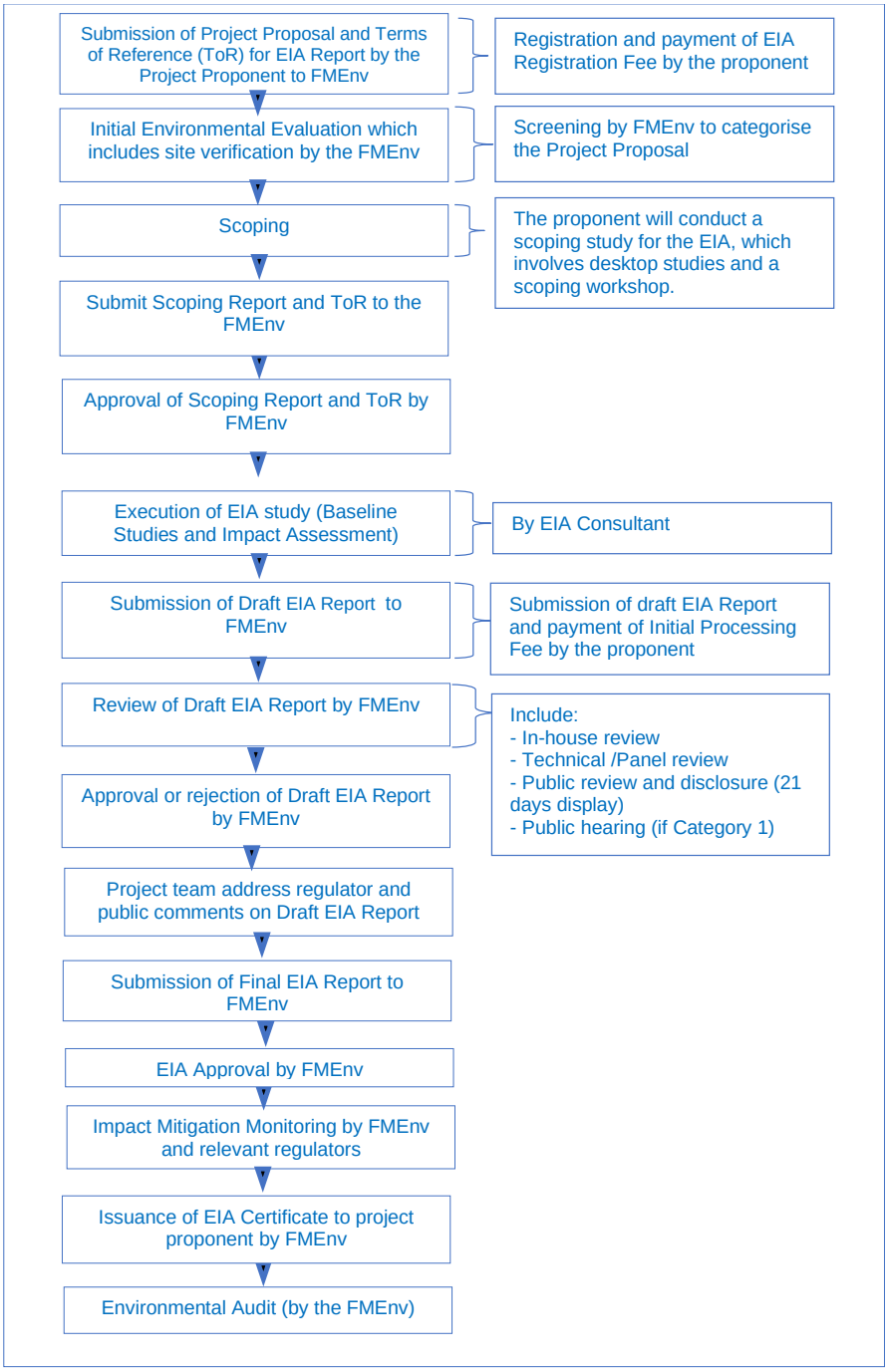


Figure 1.3: FMEnv Environmental Impact Assessment Process

1.11 Report Structure

In line with the FMEnv Procedural Guidelines, this ESIA study has been organised into ten main chapters, preceded by the Executive Summary:

- **Chapter One**: Introduction containing an overview of the proposed project, the objectives and scope of the ESIA study and applicable legal and institutional framework.
- **Chapter Two**: Project Justification containing a rationale for the proposed Project, as well as the analysis of Project alternatives.
- **Chapter Three**: Project Description containing the technical elements of the Project.
- **Chapter Four:** Description of existing environmental and socio-economic conditions of the Project Area of Influence (AoI). This chapter details the baseline data relevant to decisions about the Project location, development, and operation.
- **Chapter Five**: Discussion of all relevant environmental and socio-economic risks and impacts of the Project, including associated and cumulative impacts.
- **Chapter Six**: Mitigation measures for the identified environmental and socio-economic impacts and a discussion of residual impacts.
- **Chapter Seven**: Environmental and Social Management Plan for the Project. This chapter summarizes the key measures and actions and the timeframe including responsibility for the implementation of the recommended measures. This chapter will refer to a standalone ESMMP that will be included as an attachment / appendix to the ESIA.
- **Chapter Eight**: Decommissioning and remediation plan for the proposed Project at the end of its operating life.
- **Chapter Nine**: Conclusion and Recommendations.
- **Chapter Ten: References.**

1.12 Declaration

IFF has proposed to embark on the construction and operation of 20-inch X 76km gas pipeline within the existing right of way. Consequently, the planning, construction, operational and decommissioning stages of this project IFF shall:

- Comply with environmental regulations, laws, statues, and edicts applicable to the proposed project.
- Adopt appropriate measures to mitigate, identify and predicted adverse environmental impacts arising from or associated with the project and enhance positive impacts.

CHAPTER TWO

PROJECT JUSTIFICATION

INTRODUCTION

This chapter presents the Environmental and Social Impact Assessment (ESIA) project alternatives analysis. The purpose of this analysis is to provide a clear and objective basis for identifying the best means of implementing the proposed 20" x 11km, 24 x 65km Natural Gas Pipeline Project, while ensuring compliance with regulatory, stakeholder, proponent, and sponsor requirements. The analysis considers various factors, including technical, economic, environmental, safety, health, security, and social aspects. By considering these aspects early on, along with other key components of the project, the project proponent can effectively plan and implement the project to achieve its objectives.

Furthermore, this section of the ESIA report will provide clarity on the project's needs, benefits, and the methodology used to select the optimal alternative that meets project objectives, as well as local, national, and international requirements. By conducting a thorough analysis and considering all relevant factors, IFF can ensure that the chosen alternative is not only the most suitable for the project, but also aligns with the interests of all stakeholders involved.

2.1 Need for the Project

As earlier mentioned, in chapter one, Indorama operates a Petrochemical and Fertilizer manufacturing facilities within the Indorama Complex in Eleme, Port Harcourt, Rivers State, Nigeria having manufacturing capacity of 2.8 MMTA of Urea & 400 KTA of Polymers (Polyethylene & Polypropylene) utilizing Natural Gas & Natural Gas Liquids as feedstock. The Petrochemical manufacturing facilities comprising of the Cracker, Polyethylene and Polypropylene plants have been in operation since 2006. The Fertilizer manufacturing facilities consists of two trains of 2,300 TPD & 4000 TPD each of Ammonia and Urea, respectively. While the first line of Fertilizer was commissioned in 2016, the second line was commissioned in May 2021 and recently the construction of train 3 is ongoing which upon commission will require more gas for smooth operation of both Fertilizer plant and the power plants. Consequently, in order to meet the gas requirement for the proposed Train 3 and other expansion projects, Indorama has proposed to construct a 20inch x 11km and 24” x 65km gas pipeline from Anoh Gas Manifold to Indorama complex in Eleme. The proposed pipeline is to deliver natural gas from AGPC Manifold to Indorama battery limit at 63bar pressure with a maximum flowrate of 370mmscfd. A uniform pipe

diameter is proposed to be maintained from the point of Off take to Eleme at outlet pressure of above 63bar.

2.2 Project Benefits

Upon successful implementation of the proposed 76km gas pipeline project by Indorama Eleme Fertilizer & Chemicals Ltd, will significantly benefit the company by providing affordable and reliable gas supply, reducing production costs, and reducing the carbon footprint of its operations. Very importantly the project will improve the social well-being of the project host communities in terms of new skill acquisition, job creation, scholarship, grant to the women and contract award to Indigenous contractors during project implementation. It is, therefore, a justified project that will benefit both the company and the environment in so many ways as stated below:

- **Increased Fertilizer Production:** The construction of a gas pipeline will provide a stable and cost-effective source of natural gas, which is a crucial feedstock for fertilizer production. This will enable Indorama Fertilizer to increase its production capacity, meeting the growing demand for fertilizers in Nigeria and potentially reducing the need for fertilizer imports.
- **Energy Efficiency:** Natural gas is a cleaner and more efficient source of energy compared to alternative fuels. By using natural gas, Indorama Fertilizer can improve the energy efficiency of its operations, reducing operational costs and environmental impact.
- **Economic Growth:** The construction and operation of the gas pipeline will create jobs and stimulate economic growth in the region. It will also encourage further investment in the area and contribute to the overall economic development of Nigeria.
- **Reduction of Flaring:** The availability of natural gas through the pipeline can help reduce the flaring of associated gas in the region. This is in line with environmental regulations and commitments to reduce greenhouse gas emissions, contributing to a more sustainable energy industry in Nigeria.
- **Reliable Energy Supply:** Natural gas pipelines are known for their reliability, providing a consistent source of energy. This will reduce the operational risks associated with supply interruptions and price volatility.
- **Infrastructure Development:** The construction of the pipeline will contribute to the development of necessary infrastructure in the region. This can improve access to energy resources, potentially attracting other industries and enhancing the overall infrastructure of the area.

- **Environmental Benefits:** Natural gas is a cleaner-burning fuel compared to other hydrocarbons. This can lead to a reduction in air pollution and environmental degradation, improving the overall quality of life for local communities.
- **Long-Term Viability:** The construction of a 76km gas pipeline is a long-term investment. It ensures the sustainability of Indorama Fertilizer's operations and its contribution to the Nigerian economy for years to come.

Finally, the new pipeline will provide a stable and secure supply of natural gas, which will help Indorama to optimize fertilizer production and improve its overall production efficiency. Other benefits of the proposed project include job creation, income generation, industrialization, new business opportunities, skill acquisition and transfer of skills, economic growth.

2.3 Value for the project

The initial cost of the proposed 76 km x 20" gas pipeline was estimated at N95 billion, covering materials, construction, personnel, equipment, approvals and corporate social responsibility activities. The first phase has been completed. The second phase 24" x 65km natural gas pipeline cost is estimated approx. 90 billion naira only. A significant portion will benefit the Nigerian economy through contracts, subcontracts, local procurement and employment, while the gas supply will support fertilizer production and power generation at the Indorama complex. The Project will also support gas-flaring and greenhouse-gas reduction. World Bank data indicate that about 600 MMSCF/day of gas was flared globally in 2021. With a fertilizer line consuming approximately 90 MMSCF/day, the Project has the potential to avoid about 2.1 MMTPA of CO_2-equivalent emissions, subject to actual gas availability and operating conditions, while contributing to Nigeria's gas-flaring reduction and climate objectives.

Furthermore, according to World Bank data obtained from the Global Gas Flaring Tracker Report (2022), approximately 600 million standard cubic feet (MMSCF) gas was flared daily on average in 2021. In comparison, the proposed pipeline is expected to supply gas to Indorama complex for fertilizer production and power generation. Specifically, a line fertilizer plant consumes about 90 MMSCF per day and hence the project have potential to reduce approx. 2.1 MMTPA CO_2 eq. greenhouse gas and more. As such, the proposed Project has the potential to reduce flaring.. The equivalent CO_2 emissions resulting from the reduction of flaring contribute significantly to global warming (World Bank, 2023)[1].

[1] https://www.worldbank.org/en/programs/gasflaringreduction/gas-flaring-explained#:~:text=Assuming%20a%20'typical'%20associated%20gas,of%20CO2%20equivalent%20emissions%20annually.

2.4 Envisaged Sustainability

2.4.1 Environmental Sustainability

The 76 km gas pipeline project is focused on environmental sustainability by following the recommendations of an Environmental Impact Assessment (EIA) study. This study will guide the design criteria, identify potential impacts, and suggest effective mitigation measures.

Furthermore, the pipeline will also be constructed in line with green engineering principles, ecosystem services and resources integrity, which is the major reason for alignment with existing pipeline RoW, to achieve minimal disturbance to the environment and also ensure that resources are used in a way that does not degrade or diminish their availability for future generations while maintaining of ecological balance.

2.4.2 Economic sustainability

The AGPC field has large reserves of natural gas and currently has a gas processing facility of 300 million standard cubic feet per day. Consequently, there are therefore proven reserves of gas that can economically and commercially viable to support the proposed pipeline project and other propject operational in Indorama. Thus revenue will accrue from the sale of gas which would otherwise have been flared for Associated Gas (AG) or unutilized for Non-associated Gas (NAG). There is high demand for natural gas in the local market. The project will therefore contribute substantially to the revenue accruing to Nigeria. The project will definitely stimulate economic activities around the area as long as gas Indorama complex is operational. The execution of the project will ensure increase income to those employed.

2.4.3 Technical Sustainability

The proposed project is expected to be technically sustainable due to the utilization of proven technology for the piping and auxiliary facilities. Moreover, strict adherence to internationally accepted engineering design and construction standards, as well as codes of practice, will be implemented at all stages of the project to ensure technical sustainability. To execute the proposed project, innovative technologies that are economically viable and have minimal environmental, social, and health impacts will be employed. This approach will not only enhance the project's overall efficiency but also contribute to its long-term success as to delivering good quality projects.

2.4.4 Social Sustainability

The project will leverage on existing Social Action Plan from the existing Gas Pipeline project and continue to consult with stakeholders throughout its lifetime. The project is expected to provide jobs, skills training, infrastructural development, grant to women, contracts, and generally improve the well-being of the project host communities. A

Grievance Redress Mechanism will be established to prevent conflicts with the local community. Furthermore, the project's social sustainability will be maintained through ongoing consultations with the community, fostering a positive working relationship between Indorama and the project communities.

2.5 Project Options

2.5.1 Do nothing Option

In the field of Environmental Social Impact Assessment (ESIA), it is considered essential to thoroughly evaluate all possible alternatives, including the Do-Nothing option. This alternative entails the scenario where no project is implemented, meaning that the strategic gas pipeline infrastructure and its associated development would not be constructed. However, opting for the Do Nothing alternative would impede the expansion plans of the Indorama facility in Eleme, particularly the proposed Train 3 Project and future trains. As a result, the nation would miss out on numerous social, economic, and environmental benefits, such as job creation, revenue generation, social development, and crime reduction. Therefore, this option was ultimately rejected due to its failure to fully harness a proven strategy for empowering both the people and the nation.

2.5.2 The 'Delayed' Option

This option suggests that the planned project will be postponed to a later date. Typically, this option is chosen when conditions are unfavorable for project implementation, such as during times of war or when the host community strongly opposes the project. Additionally, if the current economic climate is not conducive to the project, delaying it may be a feasible option. However, none of these conditions apply in this case. In fact, the social, economic, and political environment are highly favorable towards the project. Therefore, choosing the delayed project option would render all the preliminary work and associated efforts and costs useless. Moreover, due to inflationary trends, such a delay may lead to unforeseen increases in project costs, potentially impacting the final profit. Consequently, this would discourage private and local investors. Considering these concerns and evaluating the current proposed site, the delayed option is not a viable choice. The presence of these and other related problems makes it impractical to adopt the delayed option. Therefore, it is unappealing to choose the "Delayed Project" option.

2.5.3 Go Ahead Option

Nigeria boasts abundant gas resources, making it an ideal choice for cleaner and more environmentally friendly fertilizer production and power generation. The transmission pipeline industry plays a vital role in our society's infrastructure, ensuring the safe transportation of products from wells to refineries and ultimately to consumers and

businesses. Throughout history, pipelines have consistently proven to be the safest means of transporting natural gas and liquids.

Given the economic viability and numerous advantages of utilizing gas for fertilizer production and as an energy source for industries in Nigeria, this option was deemed the most favorable. The project development option stands out as the best choice, considering its economic, technological, and environmental merits. During the design development phase of the proposed project, various alternatives were carefully evaluated to ensure compliance with Nigeria's ESIA procedures and international best practices.

This option emerged as the "**preferred one"**, which will help the smooth running of the Train 3 Fertilizer plant and other industrial activities within the Indorama Complex, Port Harcourt, Rivers State Nigeria.

2.6 Project Alternatives

Project screening is a crucial process that aims to assess the potential environmental impacts of a proposed project. Typically, this evaluation occurs during the initial stages of project design or after submitting a planning application to the Regulatory Agency. Following the EIA procedural guidelines set by the Federal Ministry of Environment (FMEnv), an initial screening was conducted for the project. The results of this screening indicated that the proposed project, which involves significant oil and gas activities, is expected to have notable environmental impacts. Consequently, an Environmental Impact Assessment (EIA) study is necessary to thoroughly examine these effects.

2.6.1 Transportation Alternative

(a) Road Trucking

Transporting compressed natural gas in tankers is challenging due to high pressures and the risk of explosions. However, scientific advancements in the mid-20th century introduced a solution: liquefied natural gas (LNG). By converting natural gas into a liquid state at extremely low temperatures, LNG can be transported more efficiently over long distances. This method is particularly beneficial in areas lacking pipelines or natural gas sources. However, the use of LNG requires specialized refueling stations and equipment capable of handling cryogenic temperatures, which increases costs. Despite this, the environmental advantages of using natural gas make it a compelling option.

To transport LNG, specialized trailers are employed to deliver natural gas from storage tanks to fueling stations. At the fueling station, the LNG must be stored in insulated tanks to maintain its low temperature. However, the limited availability of transportation infrastructure and specialized equipment poses challenges to the widespread adoption of LNG as an alternative fuel source. Consequently, the risks associated with poor transportation infrastructure make it not recommended. (**Not Recommended)**

(b) Pipelines

Transmission pipeline industry is an irreplaceable component of our society infrastructure as stated earlier. These pipeline systems have safely transported products from wells to refineries and ultimately to the necessary markets, including consumers and businesses. Pipelines have historically been the safest means of transporting natural gas and historically liquids. Pipelines play a very critical role in the transportation process because most of the oil and gas move through pipelines for at least part of the route. Strategic planning involves determining the shortest and most economical routes where pipelines are built, the number of pumping stations and natural gas compression stations along the line, and terminal storage facilities. The advantages of piping over trucking are that:

- It can be transported continuously, is not affected by the weather, and has high reliability throughout the day.
- The pipeline can take shortcuts, and the transportation distance is short.
- The transportation volume is large.
- High environmental benefits and no harmful substances.
- The energy consumption is small, which is the lowest among various modes of transportation.
- Safe and reliable, no pollution, low cost; **Recommended**

However, the few impacts associated with the pipeline system include minimal loss of biodiversity and vandalization. The project design has considered these impacts by aligning the pipeline with the existing RoW at 65km, with 11km RoW to be newly acquired, and by using a high-technology surveillance system to manage the impact associated with vandalism.

2.6.2 Route Alternative

The three choice routes were selected as alternatives to choose the most suitable due to availability of adequate land needed, considerably adequate access and least impact with the existing environment. Appropriate site selection in minimizing the associated ecosystem impacts and exploring restoration opportunities of degraded ecosystems aim to preserve the natural ecosystem functioning as much as possible considering requirements such as habitat connectivity, indigeneity, trophic web integrity, physical-chemical water quality and system resilience. To achieve the objective of transporting Natural Gas from the Asa Gas Manifold to Indorama complex three option were considered.

2.6.2.1 Selection Criteria

Considering the sensitivity of the various ecological areas that the proposed 76km natural gas pipeline will traverse, important physico-biological, cultural, and socio-economic parameters will be considered. Careful evaluation and understanding of the parameters will be necessary to ensure a sustainable project that will not allow for environmental

degradation and un-sustainability. The main considerations in evaluation and adoption of scenarios taken are:

- Use of existing Right of Way (ROW)
- The cumulative length of the pipeline route
- Access to site (Construction and operations)
- Length through existing Right of Way
- Existence of forest reserve
- Number of existing river/creek crossing
- Number of existing major road crossing
- Number of existing pipeline crossing
- New land intake (the extent)
- Number of built-up areas traversed.
- Number of existing livelihood sources sites to be traversed (i.e. farmland, fishing area, lumbering/timber forest, wine tapping etc.)

Therefore, all the selection criteria outline above were summarized into three management and decisions components namely:

- Availability and source of gas
- Use of existing Right of Way (ROW)
- Route topography, terrain conditions and accessibility

2.6.2.2 Confirmation of Optimum Option

As conceived, out of all the options, the one with less major roads crossing, alignment with existing RoW and least cumulative distance to be covered by pipeline compared to other options will be considered. In consideration of all the factors evaluated in the concept selection including such factors as communities, population density, ecosystem integrity, constructability, absence of infrastructure and obstacles which amount to environmental considerations and the lower project implementation cost, will be adjudged the best route. The general characteristics of the line route to consider in accordance with the terms of reference of the mission are:

- Alignment to existing RoW to reduce cost and impact of the environment.
- short, to minimize cost and the impact on the environment.
- rectilinear, to minimize the angles and the footprint.
- accessible, near roads, to facilitate maintenance.
- bypassing towns and villages, to minimize the demolition of the built environment and relocation of populations.

Route Options	Length of Route (Km)	Physical Structure/Settlements	Length of River/Creeks /Creeklets Crossings (Km)	Area of route to be required acquired
Option 1	78	Route acquisition shall result in substantial physical displacement of people living along the route. Impact on livelihood and residential and industrial assets very high.	No river crossing, Major wetlands	100% of route
Option 2	76	14% new route acquisition with minimal physical displacement of people. Route deliberately chosen to avoid physical settlements. Impact on livelihood low relative to options 1 & 3	No river crossing, Few wetlands	Only 14% of route (ie 11 km) will be newly acquired, while 65 km will be on the existing 83km pipeline RoW To Indorama complex
Option 3	79	Route acquisition shall result in substantial physical displacement of people living along the route. Impact on livelihood and residential assets relatively higher than option 2	No river crossing, Major wetlands	100% of route

Route Option 2 was identified as the preferred route for the project based on its comparatively lower environmental and social impacts, as well as its technical and economic advantages. The option requires acquisition of approximately 11 km of new Right-of-Way (RoW), thereby minimizing land acquisition, physical displacement and potential disruption to existing settlements. It is also expected to result in comparatively lower impacts on local livelihoods and economic activities. From an engineering and economic perspective, Route Option 2 was considered more favourable and practicable than Route Options 1 and 3, and was therefore selected as the preferred route.

2.6.3 Pipe size Alternative

The following pipe size options were considered for the delivering of the required volume of gas to Indorama complex.

- 12”x 76km pipeline to deliver 300mmscf/d
- 18” x 76km pipeline to deliver 300mmscf/d
- 20’’ x 76km pipeline to deliver 300mmscf/d
- 24’’ x 76km pipeline to deliver 370mmscf/d

In the options above, the length of the route, datum/ coordinate system, external coatings, operating environmental data e.g. terrain, soil/water parameters, geotechnical and geophysical characteristics, load combinations and allowable stresses, pipeline design methodology, pipeline route crossings(roads and rivers), cathodic protection, pipeline stabilization, riser design (if applicable), pipeline laying, provisions for pigging are the same except for the internal diameter that varies between 12", 18",20 and 24". The 20" and 24" pipeline diameter was recommended for the following reasons:

- Firstly, both diameters (20" and 24-inch) pipe allows for greater flow rates and higher volumes of material to be transported through the pipeline. This increased capacity also means that larger equipment and machinery can be used to transport materials, which can improve overall efficiency and productivity.
- Secondly, both pipes of 20" and 24" diameter can reduce pressure drop and increase energy efficiency. Smaller pipe diameters can cause higher pressure drops due to increased friction, which can lead to increased energy consumption and lower system efficiency.
- Another benefit is that both diameter pipe is that it allows for a wider range of materials to be transported. Larger diameter pipes can transport thicker and denser materials, making them suitable for a wider range of applications and industries.
- Finally, both pipe diameter can reduce the maintenance and repair costs associated with piping systems. Larger diameter pipes are less prone to clogging and blockages, reducing the need for frequent maintenance and repairs.

Overall, the benefits of both (20-inch and 24inch) pipe diameter over other diameters are significant and can have a significant impact on the overall performance, efficiency, cost-effectiveness and the future natural gas requirement from the piping system **"was selected"**.

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

This Chapter provides a description of the proposed NG Pipeline from ANOH Gas Plant (AGPC) to IFF Line 2 (IFF Line 4) Project which is approximately 76km from project site, related activities, and ancillary infrastructure. This Project description formed the Terms of Reference for specialist studies associated with the ESIA.

Table 3.1: Permanent and Temporary Project Components

Particulars
New Permanent Project Components
11km, 20 inch pipeline from AGPC manifold to KP 17 from Ob-Ob RoW
65km, 24 inch pipeline from KP 17 Ob-Ob RoW to IFF Gas receiving facility
Manifold having Ultrasonic metering unit for custody transfer at AGPC Tie in point within AGPC manifold
Corrosion inhibition injection system.
Pig Launching & Receiving station
Two (02) units of Line break valve stations and One (01) unit of valve station along the RoW
Gas Receiving facility within Indorama Manufacturing Complex
• Gas chromatograph at IFF plant
• Slug catchers and Knock out Drum IFF
•
• Emergency shut down valves IFF
• Metering station IFF
New Temporary Project Components (only required for the construction phase)
Temporary Office facilities.

Particulars
Laydown, Pre-fabrication, Construction warehouse area

3.1.1 Land Acquisition for the 11 km RoW

The proposed project involves the construction of a 20-inch x 11km and 24-inch x 65km high-pressure natural gas pipeline connecting the ANOH Gas Processing Plant in Imo State to the Indorama facility. Approximately 65 km of the pipeline will be routed within existing Rights-of-Way (RoW), while approximately 11 km will require acquisition of a new RoW. The pipeline will maintain a consistent 20-inch diameter at 11km and 24inch at 65km along the alignment to ensure hydraulic efficiency, operational reliability and adequate gas flow.

Land acquisition for the approximately 11 km new Right-of-Way (RoW), covering an estimated 16.5 hectares (165,000 m²) was acquired from three (3) communities namely Assa, Ochia and Awarra. The 11 km new RoW, land acquisition was undertaken through a structured and participatory process guided by the principles of "plan–consult–identify–value–compensate–restore–monitor." The process prioritises the avoidance and minimisation of physical and economic displacement and ensures that only the land required for safe and efficient pipeline construction and operation is acquired.

The land acquisition process includes engagement with affected landowners, land users and communities; identification and verification of affected land and assets; transparent and fair valuation; payment of appropriate compensation; and implementation of livelihood restoration measures if required where project activities affect sources of income.

Meaningful stakeholder engagement was maintained throughout the process, supported by an accessible Grievance Redress Mechanism (GRM) through which affected persons can raise concerns relating to land acquisition, valuation, compensation and livelihood impacts. The approach is consistent with the principles of AfDB Operational Safeguard 5 (OS5) on Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement.

A gazette notification was published in Imo State Gazette No 13, Volume 49 indicating the purpose of the land acquisition, and giving a 19 days window for any objection related to valuation; payment of appropriate compensation and overall acquisition process. The

public hearing under the supervision of Imo State ministry of lands survey, housing and urban planning and Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) was conducted on 18th of June 2025 with no objection.

The pipeline project will be implemented in two phases:

- Phase 1: Construction of a new 20-inch x 11km pipeline from the ANOH Gas Processing Plant (AGPC) to approximately KP17, where it will connect to the existing 18-inch × 83 km IFF pipeline through a hot-tapping arrangement. This section will traverse approximately 11 km of newly acquired RoW, generally running parallel to the existing RoW.
- Phase 2: Construction of the new 24-inch x 65km pipeline from the KP17 connection point near Awara Community, Imo State, onwards to the existing NAOC/IFF RoW at 65km on the existing RoW. The pipeline will then turn and continue within the existing corridor, running generally parallel to the existing 18-inch × 83 km pipeline until it reaches the Indorama Complex.

Figures 3.1 to 3.5 below present the overall project area, including the project's location within Nigeria, the two states traversed by the pipeline, the Right-of-Way (RoW), and the communities along the proposed pipeline route.

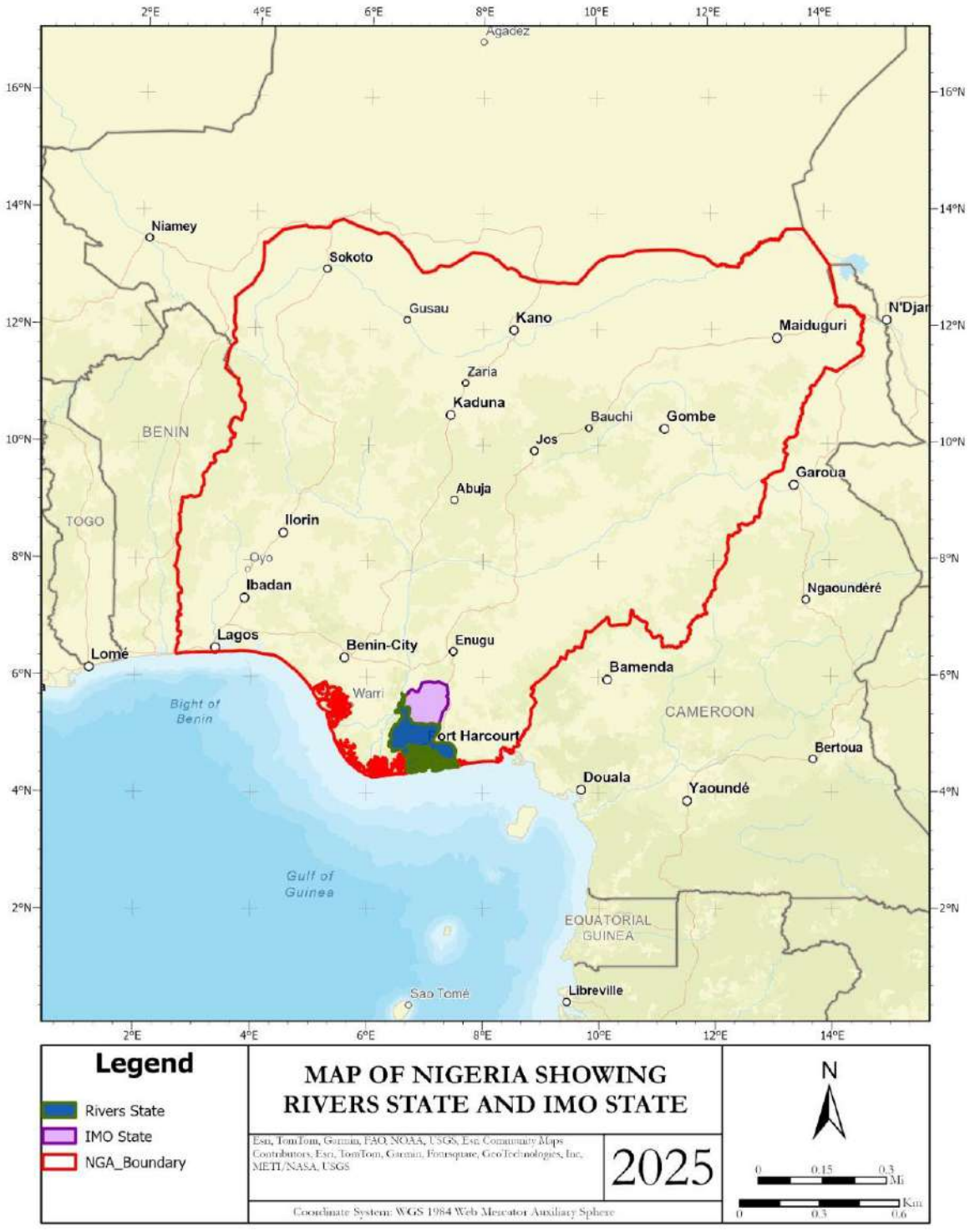


Figure 3.1: Administrative map of Nigeria showing the two-host state

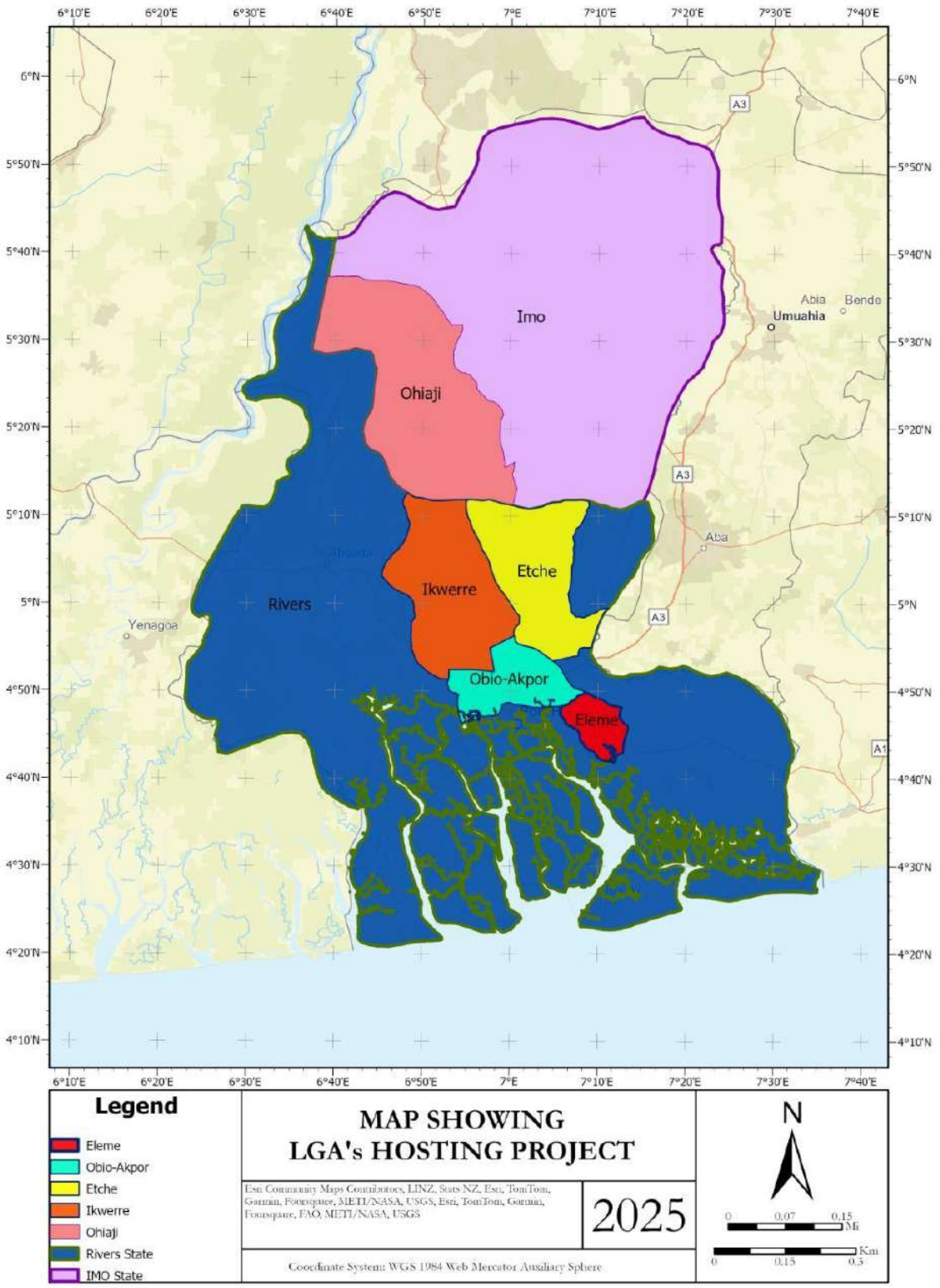


Figure 3.2: Administrative map both States showing the project host LGAs



Figure 3.3: Right of Way

APPROXIMATE COORDINATES

POINT	EASTING (m)	NORTHING (m)	LATITUDE	LONGITUDE	DIRECTION
PI 0	255776.670	595690.130	5° 23′ 6.89"	6° 47′ 45.96"	
PI 1	255783.929	595251.050	5° 22′ 52.60"	6° 47′ 46.24"	179°
PI 2	256342.722	593946.940	5° 22′ 10.23"	6° 48′ 04.54"	157°
PI 3	254181.825	584831.456	5° 17′ 13.33"	6° 46′ 55.44"	193°
PI 4	257877.700	581667.814	5° 15′ 30.80"	6° 48′ 55.79"	131°
PI 5	266915.734	561626.787	5° 04′ 39.56"	6° 53′ 51.36"	156°
PI 6	269181.060	561089.883	5° 04′ 22.32"	6° 55′ 04.94"	103°
PI 7	278533.883	557896.075	5° 02′ 39.33"	7° 00′ 08.84"	109°
PI 8	281937.720	553925.336	5° 00′ 30.42"	7° 01′ 59.71"	139°
PI 9	285246.867	545562.383	4° 55′ 58.54"	7° 47′ 47.90"	158°
PI 10	289004.228	536073.563	4° 50′ 50.03"	7° 05′ 50.72"	158°
PI 11	289179.489	535041.219	4° 50′ 16.44"	7° 05′ 56.50"	170°

APPROX. LENGTH OF PIPELINE	'PI 0' - 'PI 11' = 75.766km

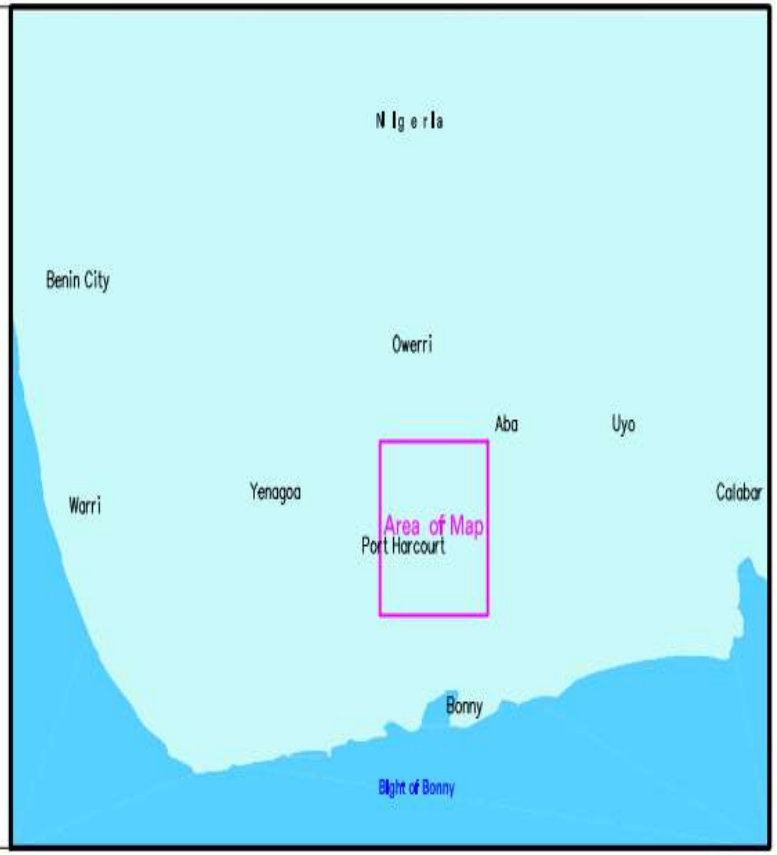


Figure 3.4: PTS route map with co-ordinates for the entire 76km pipeline

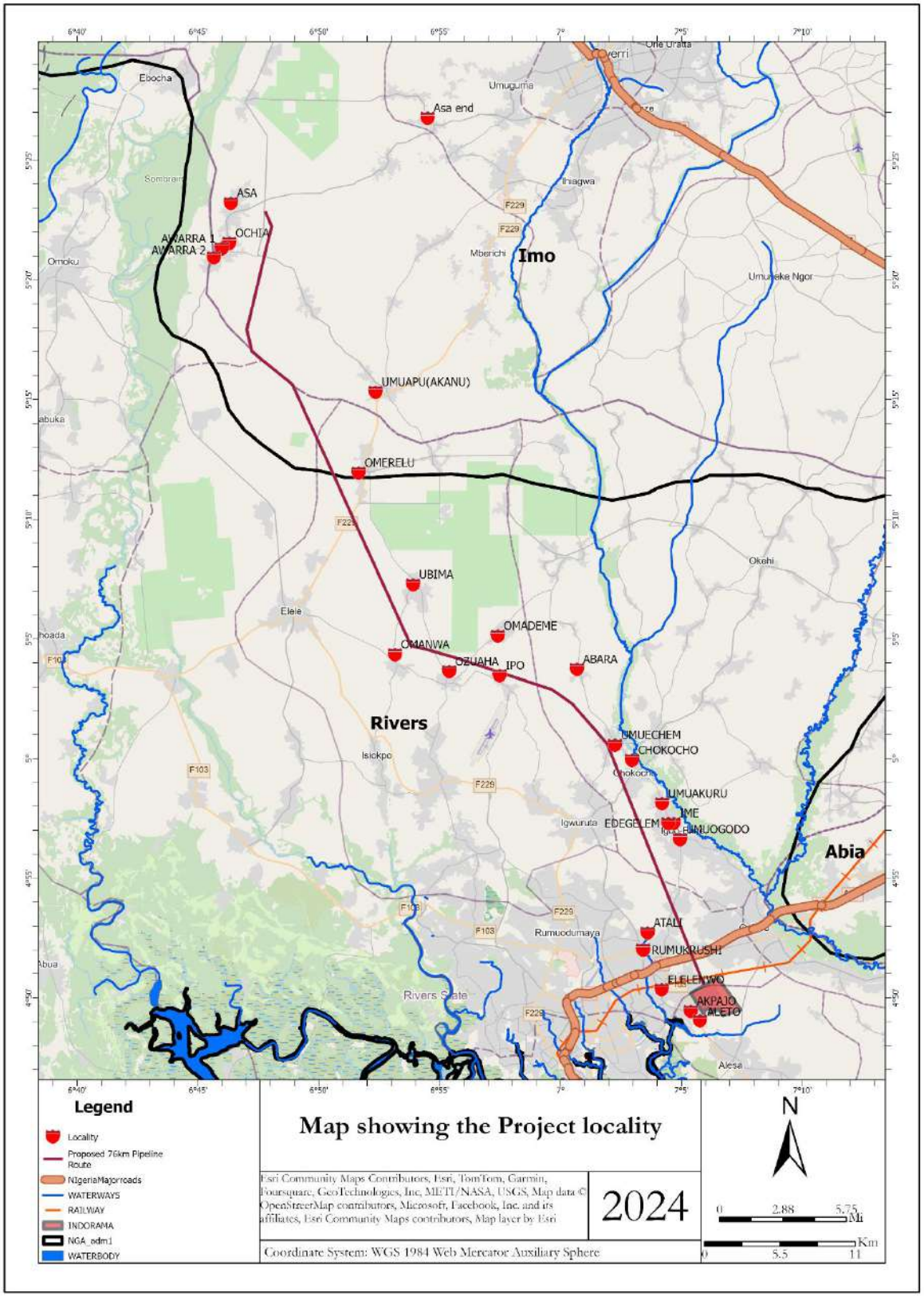


Figure 3.5: Pipeline Right of Way (Project Locality Map)

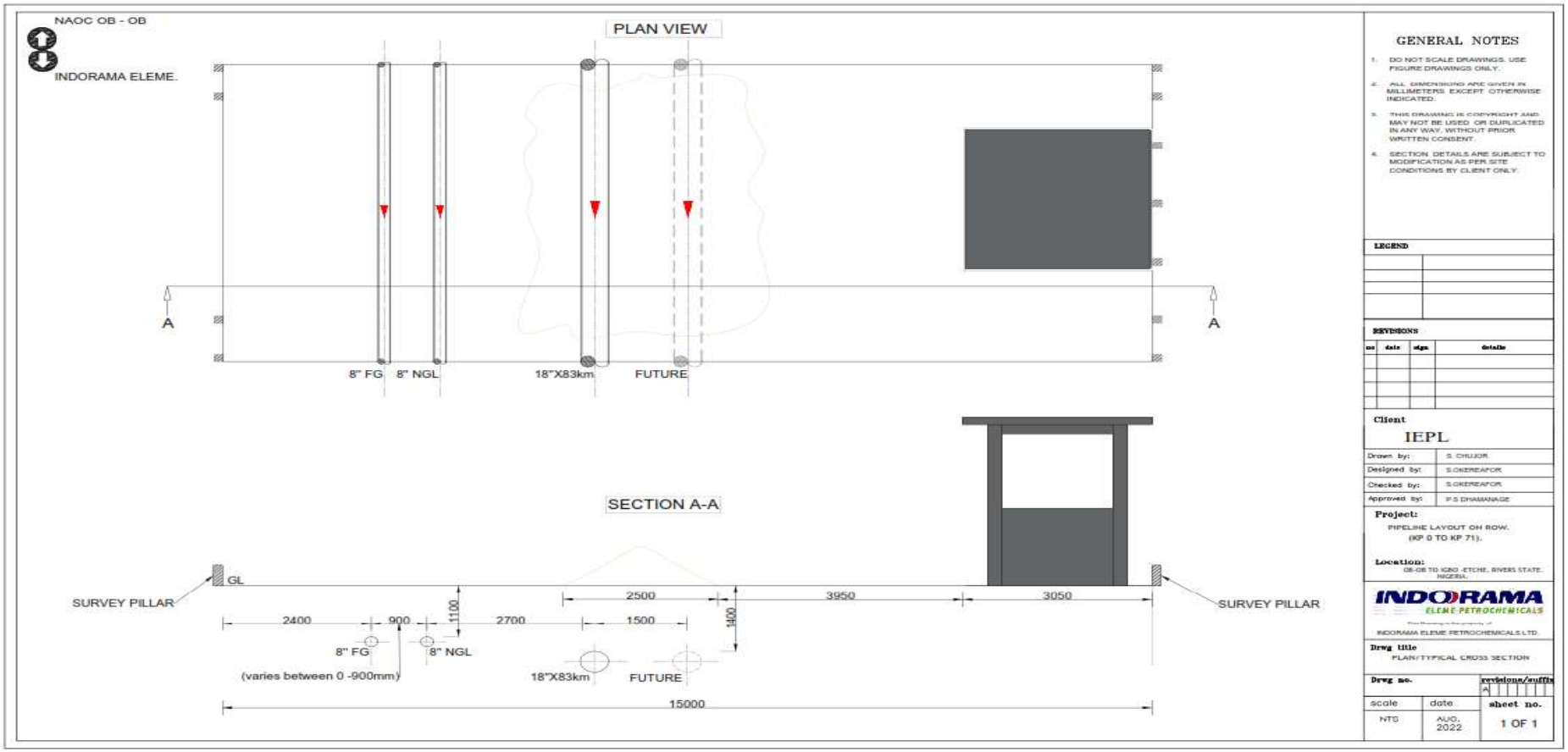


Figure 3.6: Pipeline Layout

Table 3.2: Natural gas composition

Component	Composition (Mole %)
N2	0.10
CO2	0.50
C1	87.40
C2	4.00
C3	3.20
iC4	0.90
nC4	1.30
iC5	0.60
nC5	0.50
C6	0.50
C7	0.50
C8	0.40
C9	0
C10+	0.10
Molecular Weight	20.52
Gravity (air = 1)	0.708
Viscosity (cP)	0.9159
C10 + Mol wt	142.686

3.2 Project Scope

The scope of work covered by this section is the Engineering, Procurement, construction, testing and commissioning of the 20" X11km and 24" x 65km AGPC to Indorama Natural Gas Gas pipeline. The highlights of this scope are listed below:

- Engineering design
- Procurement of materials/equipment
- Mobilization to site
- Survey verification and boundary re-opening.
- Right of Way (ROW) clearing
- Stringing of pipes along the Right of Way
- Weld, NDT and lay.
- Trench excavation
- Lowering of the pipe into the trench
- Installation of saddle weights
- Backfilling of the trench
- Road and rivet crossings
- Reinstatement of graded working strip
- Pipeline cleaning and gauging.
- Installation of pig trap and mainline valve
- Paint coating of above ground installation
- Commissioning

3.3 Pipeline System Design

The pipeline system will be designed according to the highest industry standards and best practices to ensure safety and ease of maintenance during operation. The overall design philosophy is to minimize risk, maximize integrity through diligent application of the appropriate location classes (with respect to population density), engineering principles, materials and wall thickness, technology for protection and control of a high-pressure pipeline system for continuous transportation of natural gas.

3.4 Design Codes, Standards and Regulatory Requirements

The pipeline system will be designed in accordance with the following code, standards, and regulatory requirements:

3.4.1 American Petroleum Institute (API)

- API RP 520 Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries Part 1 — Sizing and Selection
- API RP 521 Guide for Pressure Reliving and Depressurizing Systems
- API 526 Flanged Steel Pressure Relief Valves
- API 5L Specification for Line Pipe
- API RP 1102 Steel Pipelines Crossing Railroads and Highways
- API STD 1104 Welding of Pipelines and Related Facilities
- API RP 5L1 Recommended Practice for Railroad Transportation of Line Pipe
- API RP 5L5 Recommended Practice for Marine Transportation of Line Pipe
- API 600 Steel Gate Valves — Flanged and Butt-Welding Ends
- API 6D Specification for Pipeline valves

3.4.2 American Society of Mechanical Engineers (ASME)

- ASME VIII Boiler and Pressure Vessel Code
- ASME B16.1 Cast Iron Pipe Flanges and flanged fitting.
- ASME B16.5 Steel Pipe flanges and flanged fittings
- ASME B.16.9 Factory made wrought Steel Butt welding fitting.
- ASME B31.3 Chemical Plant & petroleum Refinery Piping • ASME B31.8 Gas Transmission and Distribution Piping System
- ASME B31.8 Gas Transmission and Distribution Piping Systems

3.4.3 Codes and Standards

Electrical

- IEC60826-2003: Design criteria of overhead transmission lines.
- IEC 61865: Overhead Lines-Calculation of the electrical component of distance between live parts and obstacles- Method of calculation.
- IEEE C2-2012: National Electrical Safety Code (NESC). I

- EEE 516-2009: IEEE Guide for Maintenance Methods on Energized Power Lines.
- GB 50545-2010: Code for design of 110-750kV overhead transmission line Electricity utilities specification

Civil Work

- ASCE 7-05: Minimum Design Loads for Buildings and Other Structures
- ASCE 10-97: Design of Latticed Steel Transmission Structures
- IEEE Std 691TM 2OO1: IEEE Guide for Transmission Structure Foundation Design and Testing American concrete institutes (ACI)

Material

- IEC61 089: Round wire concentric lay overload electric standard conductor.
- IEEE 812: Definition of terms relating to the fiber optics.
- IEG 60120: Dimensions of ball and socket coupling for string Insulators.
- ISO 898: Mechanical properties of fasteners made of carbon steel and alloy steel. ASTM: American Society for Testing and Materials.
- GB/T 700-2006: Carbon structural steels.
- GB/T 1591-2008: High strength low alloy structural steels.

Structure Code for Design

- IEEE Guide for Transmission Structure Foundation Design and Testing (IEEE Std 69lTM 2001)
- American concrete institutes (AC1318)
- American Society for Testing and Materials (ASTM)

3.5 Project Phases

The proposed IFF Pipeline Project will be developed in the following set phases:

- Preconstruction Design Phase
- Construction Phase
- Operational Phase
- Commissioning and Decommissioning phases

Each of these four phases have a different combination of activities and the commencement of each phase is dependent on the outcome and success of its predecessor. It must be noted that the scope of the proposed Project, and the associated Project ESIA, relates to all four phases. The above-mentioned Project phases are discussed in this Section.

3.5.1 Pre-Construction

Pre-mobilization phase: The activities in this phase are essentially desktop works involving feasibility, technical and financial investigations/considerations. Pre-construction activities during this phase include:

- Land acquisition for the new 11km RoW
- Engineering design
- Procurement of materials/equipment
- Permit to re-survey existing ROW.
- Gas Pipeline Route survey
- Environment Impact Assessment (EIA)
- Oil Pipeline License (OPLL)
- Survey verification and boundary re-opening.
- Mobilization of equipment and personnel to site
- Setting up of stacking/storage area, and site office/camp

3.5.1.1 Land Acquisition and Right-of-Way (RoW) Management

Land acquisition for the approximately 11 km new Right-of-Way (RoW), covering an estimated area of 16.5 hectares, was undertaken through a participatory and transparent process that emphasised early consultation, fair treatment of affected persons and the protection of their livelihoods. The approach was guided by the principles of plan, consult, identify, value, compensate, restore and monitor, with priority given to avoiding or minimising physical and economic displacement wherever practicable.

The process involved engagement with affected landowners, land users and host communities to explain the purpose of the proposed pipeline, the extent of the land required and the potential implications for land use, access and livelihoods. These consultations provided an opportunity for affected persons to express their concerns, seek clarification and participate in discussions concerning the acquisition process and the treatment of affected assets. Particular attention was given to identifying landholdings, crops, economic trees, structures and other assets that could be affected by the project, where applicable.

Affected assets were identified and assessed to establish an appropriate basis for compensation. The valuation process was intended to ensure that eligible affected persons received fair compensation for their losses in accordance with applicable requirements and the agreed compensation arrangements. Final engagement with affected landowners was held on 18 June 2025, providing an opportunity to discuss outstanding issues and clarify

matters relating to the acquisition and compensation process before the relevant agreements were concluded and payments or other agreed measures implemented.

Beyond compensation for land and affected assets, the process recognized the importance of protecting the livelihoods of persons whose economic activities or access to resources might be disrupted by the project. Accordingly, livelihood restoration measures and additional support for vulnerable persons were to be provided, where applicable, based on the findings of the assessment, identified needs and agreed commitments. These measures are important to help affected persons adapt to changes associated with the new pipeline corridor and, where necessary, restore their income-generating activities and means of livelihood.

A Grievance Redress Mechanism (GRM) was also established to provide affected persons with a clear and accessible channel for raising concerns, seeking clarification and reporting complaints relating to land acquisition, asset valuation, compensation and livelihood restoration. The mechanism is intended to ensure that grievances are recorded, assessed and addressed in a timely and transparent manner, without preventing affected persons from pursuing other available avenues for redress. Continued communication with affected communities is equally important to ensure that emerging concerns are identified and resolved throughout project implementation.

The land acquisition and RoW management approach is aligned with the objectives of the African Development Bank's Operational Safeguard 5 (OS5) and the International Finance Corporation's Performance Standard 5 (IFC PS5), which emphasise the avoidance or minimisation of involuntary resettlement, meaningful consultation, fair compensation and the restoration or improvement of affected livelihoods. Consistent with these principles, the process should extend beyond the initial acquisition of land to include monitoring of compensation commitments, implementation of livelihood restoration measures, resolution of outstanding grievances and engagement with affected persons after acquisition.

Generally, the approach ensured that the land acquisition process is conducted fairly and transparently, that affected persons have opportunities to participate in decisions affecting them, and that adverse impacts on their land use, income and livelihoods are appropriately addressed. Continued monitoring and documentation will be important to demonstrate that the agreed commitments have been fulfilled and that affected persons are not left worse off as a result of the Project.

The key facts of the land acquisition for the 11 km RoW are summarised in Table 3.3a. Bracketed items are being compiled from the IFF land acquisition and compensation records.

Table 3.3a: Summary of land acquisition for the 11 km new RoW

Aspect	Details
Extent	About 11 km x 15 m = 16.5 ha (165,000 m²), Ohaji/Egbema LGA, Imo State.
Affected communities	Assa, Ochia and Awara.
Ownership / tenure	Customary land held by individuals, extended families and communities (land vested in the Governor under the Land Use Act 1978; customary rights of occupancy).
Land use affected	Farmland, bush fallow and secondary vegetation, crops and economic trees; sacred bush along the Ochia alignment and three graves within the RoW at Ochia.
Physical / economic displacement	No physical displacement (route selected to avoid settlements and structures); economic displacement through loss of crops and economic trees and permanent restriction of incompatible land uses on the RoW.
Acquisition process	Route selection to avoid settlements → RoW survey and pegging → identification and verification of landowners, land users and assets → valuation of land, crops and economic trees → gazette notification in Imo State Gazette No. 13, Vol. 49 (19-day objection window) → public hearing supervised by the Imo State Ministry of Lands, Survey, Housing and Urban Planning and NMDPRA on 18 June 2025 (no objection) → final engagement with affected landowners on 18 June 2025 → payment of compensation before land entry → livelihood restoration and vulnerable-person support → monitoring.

Table 3.3: Pipeline design data

S/No	DESIGN PARAMETERS	11 Km Pipeline	65 km Pipeline
1	Nominal pipe diameter (inches)	20	24
2	Length of pipeline, km	11	65
3	Flange pressure rating	600#	600#
4	Design pressure	85bar	85bar
5	Capacity at maximum operating pressure	300mmscfd	370mmscfd
6	Minimum pipe wall thickness	12.7mm	15.9mm
7	Coating for external corrosion protection	3LPE	3LPE
8	Depth of burial (swamp)	Minimum cover of 3.0m	Minimum cover of 3.0m
9	Depth of burial (land)	2.0m	2.0m

Current Design

The 20-inch x 11 and 24 inch x 65 km pipeline Project will follow the pattern of the 18-inch x 83 km pipeline except for the pipeline size and length, as the equipment design, process flow sheets, layout, etc. IFF shall engage competent Construction Contractors for pipe laying, welding, NDT and coating, while RoW clearing, excavation, backfilling and revegetation will be handled by competent community contractors. For the purposes of this ESIA, the following regarding the Project is important to note:

Project design is such that the Project will have an operational lifespan of 30 years., with a planned shutdown for pigging purpose

3.5.2 Construction Phase

Construction of the gas pipeline will be executed in accordance with a standard planning framework to ensure maximum efficiency in construction, minimum adverse environmental and health impact, earliest completion time, and compliance with regulatory requirements. This involves the following:

- Material Procurement and Transportation
- Bush clearing within ROW.
- Excavation/Trenching
- Construction (Tie-in Points and Receiving Gas Station)
- Manifold with custody transfer meter within AGPC manifold
- Pipe laying (pipe stringing/welding, hydrostatic testing, non-destructive weld inspection, lowering and backfilling, and cathodic protection).
- Commissioning and Handover

Manifold and custody transfer meter

The manifold and custody transfer facilities form an integral part of the natural gas pipeline infrastructure, providing the necessary arrangements for gas routing, isolation, measurement and transfer between gas suppliers and the receiving Indorama complex. The manifold facility is designed to facilitate the controlled receipt, distribution, isolation and regulation of gas flowing between interconnected pipelines and associated facilities. The proposed 76km natural gas pipeline project, manifold will be located within the AGPC manifold, which will serve as an interface between the upstream gas supply infrastructure at the Anoh Gas Manifold/AGPC facility and the transmission pipeline conveying gas to the Indorama complex in Eleme, Rivers State. The facility is expected to incorporate appropriate pipeline connections, isolation valves, pressure monitoring instruments and other flow-control components required for safe and reliable gas transfer.

The custody transfer facilities provide measurement and verification of the quantity and quality of natural gas delivered from gas suppliers to Indorama. The facilities typically comprise a gas metering skid, flow meters, pressure and temperature measurement instruments, gas sampling points and, where required, a gas chromatograph to determine gas composition and calculate the gas's energy content. The metering system will enable determination of the transferred gas volume and associated energy in accordance with applicable contractual and industry measurement standards.

ROW survey and bush clearing.

The total length of the RoW is 76 km and the RoW width is 15 m, giving a total RoW area of approximately 114 ha (1,140,000 m²): about 16.5 ha (165,000 m²) for the newly acquired 11 km section and about 97.5 ha (975,000 m²) within the existing 65 km NNPC/Oando (NAOC) pipeline corridor, where no new land acquisition is required. Before any construction begins, IFF will conduct a thorough survey of the pipeline corridor to identify all crossings, such as roads, creeks, and rivers, as well as the locations of existing facilities. IFF's surveyors will reopen the pipeline Right of Way (ROW) and ensure that all boundaries along the ROW are accurately marked. Additionally, IFF will take responsibility for preserving the existing survey pillars, ensuring they are not damaged during construction activities.

To prepare for the laying of new lines, IFF will clear, grade, and strip the ROW, focusing grading operations on dry land. The entire width of the ROW will be cleared, while at minor road crossings, topsoil removal will be minimised and surface materials will be removed only when necessary, during the crossing process. Adequate space will be provided by IFF for the handling of materials and equipment on-site.

In order to meet international construction standards, all worksites will be prepared in accordance with the specifications outlined in sections 2, 3, and 4 of the International Standard Construction Specifications. This ensures that the project is carried out professionally and in line with industry best practices.

Trenching

The trench dimensions must exceed the outside diameter of the pipe by at least 30cm. In cases where the pipeline approaches crossings or other specialized route sections, the trench depth and width should be adjusted accordingly. To prevent collapse, appropriate measures such as timber planks or sheet piles must be used to secure the excavated trench. Manual excavation is necessary to locate any existing structures. Once the pipeline installation is finished, all timber planks, sheet piles, and other securing materials must be completely removed.

Stringing & Bending

IFF shall string the line pipes along the ROW beside the open ditch with suitable equipment and handling tools. Stringing of pipes shall be interrupted where necessary to allow passage of vehicles, livestock, etc. Coated pipes shall rest on padded supports or timbers to avoid damage to coating. This shall apply also during transportation of pipes. Strung pipes shall be provided with caps at both joint ends to keep the joint free from dirt and extraneous materials. Joint and weld numbers shall be permanently marked on the external surface of the pipe at suitable locations to allow proper recording of welds. Factory-made hot bends having a minimum bend radius of 15D shall be used in the project.

Horizontal and vertical deviations shall be obtained as much as possible by stress free elastic bands.

Bevelling, Welding and Non-destructive Weld Inspection

An approved pipe cutter or thermal cutting and bevelling machine shall be used to perform joint bevelling. Manual cutting shall not be permitted. Bevels shall conform to the requirements of the welding specification. Pups required for tie-ins shall be cut from undamaged pipes. The minimum length of pup to be inserted in the line shall be 1.0m. The line pipes will be laid and welded by separate crews. They will be laid on padded supports or timber skids for welding along the ditch. The tents have a dual purpose of protecting the welds from the elements and provides for easy collection and disposal of welding waste. Insert shows auto welding equipment and operator. Non-destructive testing of welds using radiographic procedures, which expose the full circumference of the joint, will be carried out following the completion of the weld. One hundred percent radiography of all weld joints shall be employed. All radiography films will be processed and interpreted on site to facilitate quick repairs of defective welds. Fillet weld joints shall be subjected to dye penetration tests. IFF QA/QC representative on site prior to acceptance must certify the entire weld joints okay.

Crossings

(a) Road Crossing

The minor track shall be by "Open Cut", while the major road shall be by "Thrust Boring". Horizontal thrust boring shall be done with a 26" cased auger section which shall be pulled out after boring shall be deployed.

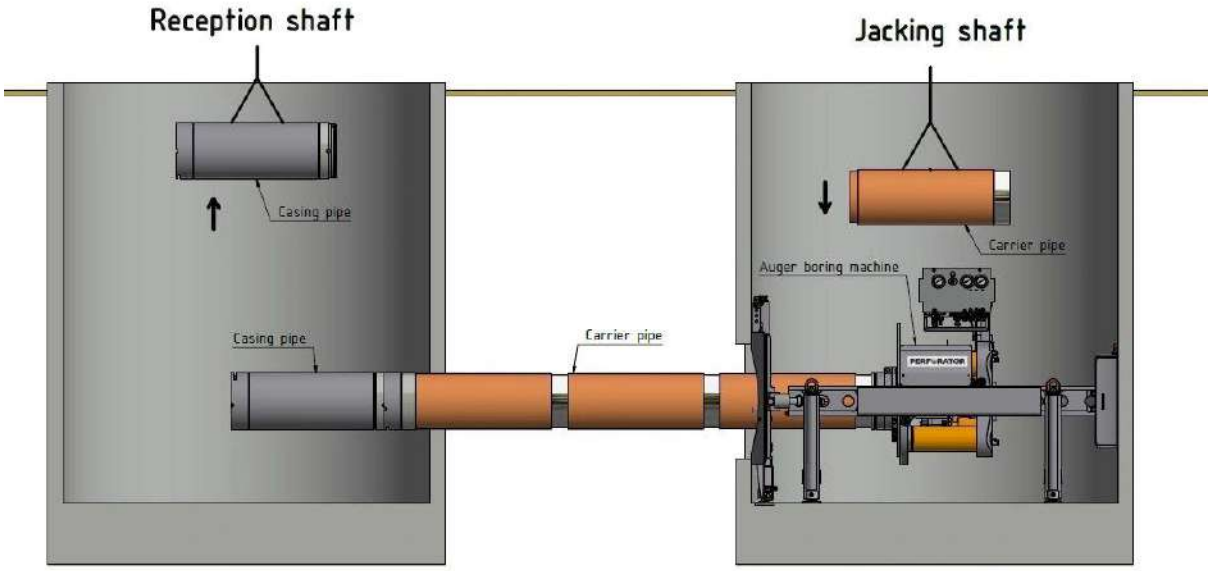


Figure 3.7: Thrust boring system.

Lowering and Backfilling

Lowering

The welded pipe shall be lowered gently into the ditch without subjecting the line to any stress. The pipes will conform to the ditch and substantially supported by the ditch bottom. The bed underneath the pipe shall be prepared by installation of soft material (medium sand bed) to obtain a soft surround for the installed pipe. The material shall be free of stones, rocks, timber, roots, debris and any other material, which may damage the pipe coating. The sand bed shall have a minimum depth of 150mm. During lowering in dry land special care shall be taken to ensure the pipe coatings sustain no damage. Coated pipes shall be handled with rubber-covered broadband slings adequate for the pipe diameter. Strings shall be constructed so that they can be removed from under the pipe without dragging any metal parts against the pipe coating.

Backfilling

Initial backfilling shall be carried out by installation of soft material (medium sand bed) to obtain a dampened surround for the installed pipe. Initial backfill material shall be free of stones, rocks, timber, roots, debris and any other material, which may damage the pipe coating. The sand bed shall have a minimum depth of 150mm. Stockpiled spoil and shall crown it (heap up) along the top of the trench line. Backfilling operations shall be carried out with due attention to avoid pipeline uplifting.

Cathodic Protection

The pipeline shall be buried in accordance with Standard Construction Specification. External anti-corrosion coating would be supplemented with a Cathodic Protection system that would cover any damaged or deteriorated area of the coating. The Cathodic Protection system would comprise a transformer-rectifier combination for the provision of direct current and a deep well-grounded approved anode material. Cathodic protection of the pipeline shall be provided by impressed current system.

Cleaning, Gauging, Pressure testing and De-watering

The new line shall be cleaned using brush-cleaning pigs. The pipeline shall also be gauged using aluminium gauging plate(s). The new line shall be flushed, clean, and pressure tested to 1.25 times based on the design pressure for 24 hours. Hydrostatic test shall be conducted to ensure integrity of the pipeline system prior to commissioning to avoid leaks and possible fire and any environmental issues. Groundwater from borehole will be used for the hydrotesting, and because the water is fresh inhibitors might not be used. In accordance with International Standard Construction Specification, borehole water will be used and the water will be kept to a minimum time, so as to eliminate the use of inhibitors. IFF site representative shall supervise the pressure test. Calibrated pressure and temperature charts shall be used to record pressure and temperature respectively during

the pressure test. The new line shall be dewatered after pressure testing using compressed air and foam pig. The released water shall be treated before discharged to the environment.

Concrete Works

All civil works involved in the hook-up of the new line such as manifolds for spur lines shall be carried out in accordance with the International Standard Construction Specification. All existing concrete works damaged by the construction exercise shall be re-instated to its original grade.

Site Clean-up and Demobilization from Site

At the end of site works, Engineering contractor in conjunction with IFF shall ensure that the ROW and work site are properly backfilled, cleaned, and revegetated. All identified scrap/surplus materials shall be documented and appropriately disposed.

Note, the construction phase cannot commence prior to the approval of the associated ESIA study. It is assumed that construction will continue for a duration of approximately 24 months. Activities during the construction phase will typically involve establishment and installation of the line-pipes, line break valve stations, Gas chromatograph, metering station, slug catcher, knock out drum, pig launcher / receiver, equipment foundations, piping erections and Local Equipment Room.

The construction phase will also undertake the installation of corrosion inhibition / monitoring system.

Process Flow scheme.

The natural gas is sourced from the AGPC in Assa gas plant carrying gas with main composition is Methane (78~85%), Ethane (6~8%) and propane (3~6%) into a tie-in station at a temperature of 15-25°C. The Tie-in station is made up of facilities to enable venting in case of abnormal high pressure, pigging facility to clean the line and a control room and emergency shutdown (ESD). The flow volume and pressure will be monitored at the pipeline manifold at OB/OB and at the terminal point at IFF. There will be two (2) block valve stations for isolation flow of gas and enable maintenance of the pipeline in sections. The gas flow scheme is attached in figure 3.6.

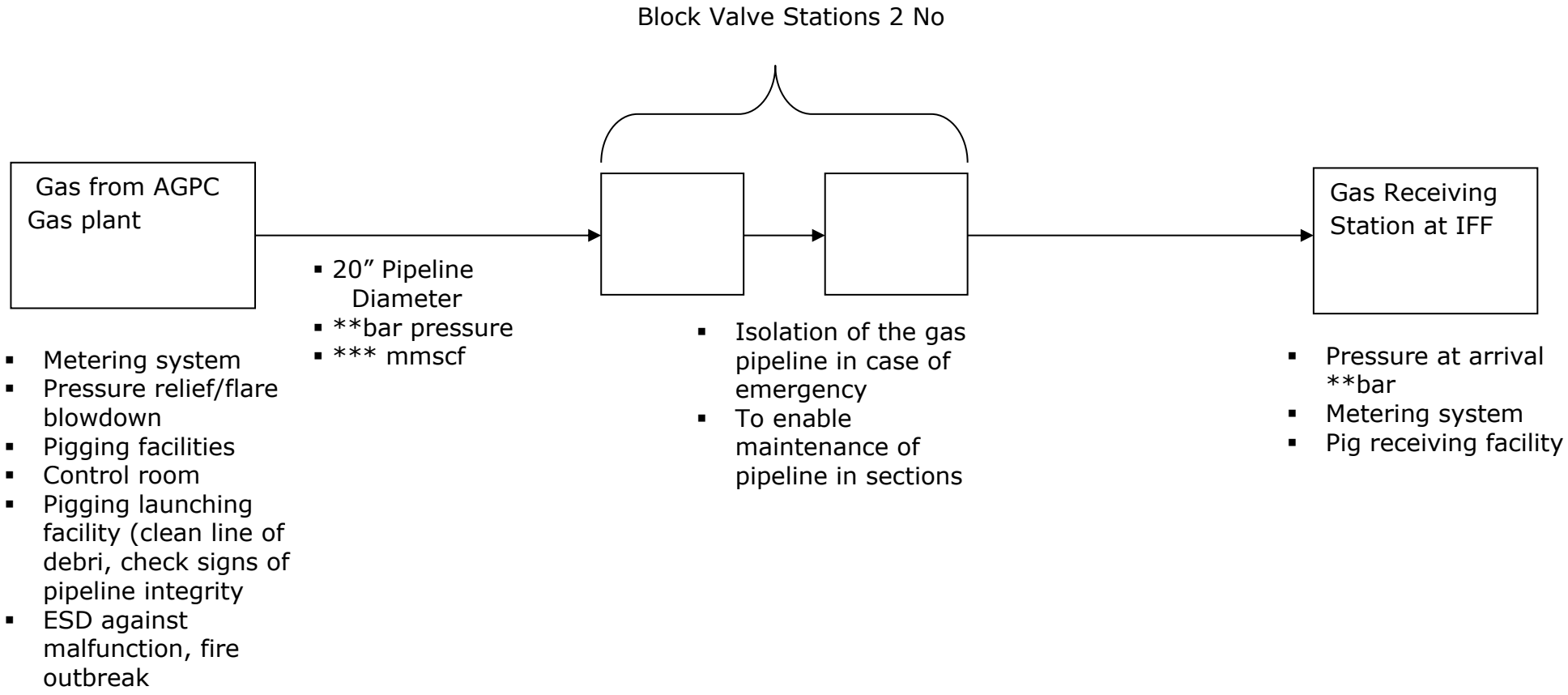


Figure 3.8 BLOCK DIAGRAM OF GAS SUPPLY

3.5.2.1 Pipe Laying Processes

Materials

The pipes to be used for the gas transportation projects are 3LPE coated steel line pipes manufactured to API 5L PSL2 X70M carbon steel specifications. The coating shall be factory-applied external polyethylene for corrosion protection. The details shall be confirmed after detailed engineering design.

Pipe Laying

The pipeline will be buried with a minimum soil cover of 2.0 meters, with the pipe laying process depending on the environment, which is in line with NUPRC guideline for the design, construction, operation and maintenance of oil and gas pipeline system in Nigeria 2021.

Normal Ground:

In normal ground, the ditch would be excavated such that the sides are 200mm clear from the pipe and back filled with selected (usually granular) material.

Swamps:

The ditch would be excavated with side sloping at 2:1 to minimize side slippage. The pipe would be laid with a continuous concrete weight coating to prevent flotation from buoyancy effects. The width and depth of the ditch shall be sufficient to accommodate all flotation equipment and to provide the minimum distance from swamp level to top of pipeline. The bottom of the trench shall be uniformly graded and free from loose rocks, large gravel and other objects that may damage the pipe or its coating. The backfill material shall be silt or sand and free of rocks, which might damage the pipeline or its coating.

Special Crossings

Roads and Railways

Roads are classified as minor (earth) and major (tarred/express) roads. Minor roads are open cut, and the pipe would be laid with a minimum cover of 2.0 m from the top of the pipe. This depth is intended to make access difficult for vandalisation. The extra cover would be extended 5m from the centerline of the track, measured perpendicular to the track. For standard major road and railway crossing, pipes would be laid by thrust boring.

Excavated soil / spoil.

The pipeline will be constructed in an already existing pipeline right of way. The length is approximately 76 kilometers. The pipeline is 20 inches (0.508 m) and 24 inches (0.61m) in diameter.

Phase 1

Estimated Trench width	=	0.30m+0.508m= 0.808m
Estimated Trench depth	=	2 meters

Estimated Volume of excavated spoil	=	0.808m x 2m x 11000m (17,776m3)
Phase II		
Estimated Trench width	=	0.30m+0.61m= 0.91m
Estimated Trench depth	=	2 meters
Estimated Volume of excavated spoil	=	0.91m x 2m x 65000m (118,300m3)

Total estimated volume of soil to be excavated during phase I and II is 136,076m^3

Note: It is estimated that about 25% of the above figure comprises vegetation /biodegradable waste and topsoil. This therefore implies that only about 75% will be available for actual backfill.

3.5.2.2 Construction Utilities

It is anticipated that the following utilities will be required during the construction phase of the Project:

- **Water** – total consumption will be required for the pipeline flushing and hydrotest. Aapproximately 6,000 cubic meters (m^3), which will consist of treated water from the existing operation.
- **Diesel Consumption** – total consumption will be approximately 248,000 liters (L), with an average consumption of approximately 8000 litres/month for the first 10 months and, and approximately 12000 litres /month subsequently during the construction period.
- **Construction Power** – Minimal power will be required during the construction phase since the contractor will supply a self-welding machine. Power for site offices will be supplied from the existing power generating units.
- **Compressed air** – during construction, the compressed air shall be generated from portable air compressor.

3.5.2.3 Major Process Equipment

Knock Out Drum (KOD) & Slug Catcher

A knockout drum is used to remove any Slug, oil or water from the relieved gases. Vapour travels upward at a designed velocity which minimizes the entrainment of any liquid droplets as it exits the top of the vessel.

A Knock-out (KOD) drum consists of a vertical vessel specially designed to separate vapor and liquid from a two-phase process flow. The inlet diffuser and de-entrainment mesh pad are designed to maximize the collection of liquid contained in the vapor as it travels to the top of the vessel.

All knockout drums include the vapour-liquid inlet line, the vapour area, and the liquid zone. They also have a liquid level gauge or an indicator, a control valve, a de-entrainment pad, and an intel distributor in some cases.

The slug catcher is a vessel type with the following main characteristics.

- Length= 9000mm
- Diameter= 2750mm
- Volume=49m3

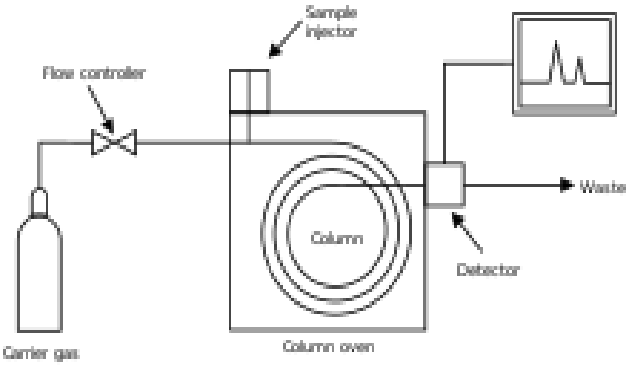


Gas Chromatograph

Gas chromatography (GC) is an analytical technique applicable to gas, liquid, and solid samples (components that are vaporized by heat). If a mixture of compounds is analyzed using GC system, each compound can be separated and quantified.

Typical uses of GC include testing the purity of a particular substance or separating the different components of a mixture.

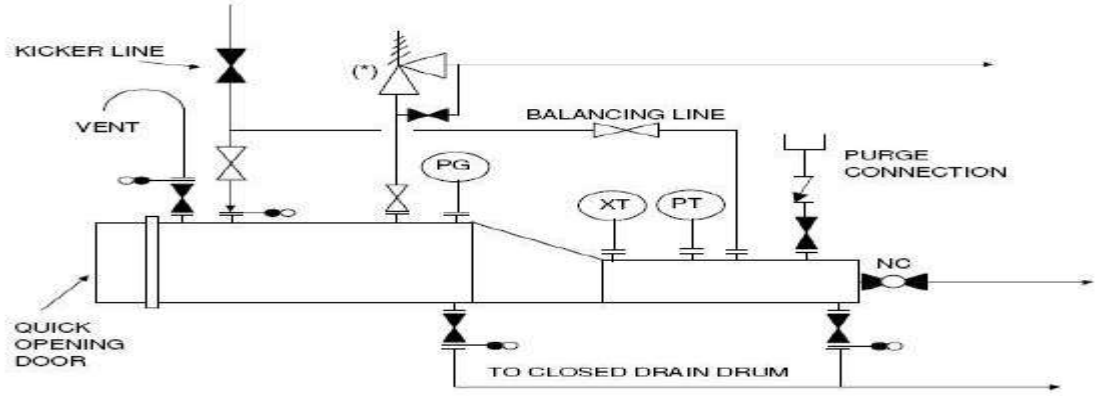
A gas chromatograph is made of a narrow tube, known as the *column*, through which the vaporized sample passes, carried along by a continuous flow of inert or nonreactive gas. Components of the sample pass through the column at different rates, depending on their chemical and physical properties and the resulting interactions with the column lining or filling, called the *stationary phase*. The column is typically enclosed within a temperature-controlled oven. As the chemicals exit the end of the column, they are detected and identified electronically.



Pig Launcher/ Receiver

In simplest terms the PIG launchers and PIG receivers are the sections of the pipeline which allow the PIG to enter and exit the pipeline. They are generally funnel, Y-shaped sections of the pipe which can be pressurized or depressurized and then safely opened to insert or remove PIGs.

Pig launchers and receivers are essential components of a pipeline that are used during the pre-commissioning phase for cleaning, gauging, and dewatering of the pipeline. For this project, PIG will be launched within AGPC in Asa North and received at KP17 within the 11km, while for the 65km PIG will be launched at KP17 and received at Indorama complex. Waste generated during pig activities will be incinerated, using Incinerator located at Indorama Complex.



The manifold within AGPC Gas supply and IFF gas receiving facilities shall comprise the following facilities:

- Emergency shut down (ESD) valves.
- Metering system
- Pigging facilities

Line Break Valve

Line-break valves are used to detect pipeline ruptures. When the pressure decline at the valve of the control port exceeds the reference value, the valve closes the complete pipeline. The rate of the pressure decline is adjustable.

The automatic line-break control valve (LBV) is a robust self-contained pipeline monitoring system which is widely used to prevent gas releasing upon rupture or large leakage event in the oil and gas pipelines.

The block valve manifolds will be equipped with full-bore valves, pressure indicators and pipeline blow-down facilities on each side of the buried line block valve.

It is expected that 2 stations will adequately cover the 76 km pipeline route.

Metering Station

Gas metering stations play an important role in ensuring the quality and accuracy of natural gas that is delivered to commercial customers. They are designed to monitor and measure the amount of natural gas consumed by consumers, as well as calculate the cost of the gas consumed.

Emergency Shut Down Valve

A shut-down valve (also referred to as SDV or Emergency shutdown valve, ESV, ESD, or ESDV) is an actuated valve designed to stop the flow of a hazardous fluid or external hydrocarbons (gases) upon the detection of a dangerous event. This provides protection against possible harm to people, equipment, or the environment.

Venting

The system will incorporate installation of Blow down assemblies to allow for the evacuation of gas from sections of the pipeline under emergency conditions or for scheduled maintenance operations. The assembly shall be sized to ensure minimum blow down (venting) time and quantity of vented gas between two valves.

3.5.3 Commissioning and Operation

At the completion of installation of pipeline, pressure testing will be conducted after which it will be commissioned. A period of approximately two months will be required for the final testing of the pipeline prior to its start-up. The pipeline is designed to last for a minimum of 30 years. When the use of the pipeline is no longer required, it will be decommissioned. If the need arises in the future to decommission the pipeline, IFF will set up a decommissioning team to plan and ultimately, implement standard procedures for decommissioning and abandonment of the project. The decommissioning and abandonment exercise will involve:

- Removal of gas.
- Cleaning the pipeline.

- Removal of all surface facilities; and
- Capping and sealing all open ends.

Adequate commitment shall be maintained with stakeholders to mutually ascertain alternative needs and possible use of the facilities by other parties. IFF will maintain a record of the abandoned facilities and a copy will be given to the regulators.

At the Pipeline end of life, the decision to either replace or decommission the pipeline also results in the generation of wastes which must be properly handled to avoid impacting the environment negatively.

3.5.3.1 Decommissioning and Abandonment

The design of the pipeline recognized the need to decommission at the end of their operational life. The activities planned for this phase of the project include:

- Dismantling of all surface equipment.
- Excavation; and
- Removal and disposal of concrete works and pipes.

The abandonment procedure involves removal of all equipment and machinery from the site, removal and disposal of wastes and re-instatement of adversely impacted sites. Adequate commitment shall be maintained with stakeholders to mutually ascertain alternative needs and possible use of the facilities by other parties. Indorama will maintain a record of the abandoned facilities and a copy will be given to the regulators.

3.6 Waste Generation

Majority of these wastes are of low toxicity. To fully comply with NMDPRA and Federal Ministry of Environment policies, a Waste Management Programme has been prepared for the activities of this project. The disposal methods for the enumerated wastes have been clearly defined. Wastes refer to any material - (solid, liquid, gaseous or mixture) that is surplus to requirements. Indorama shall take all practical and cost-effective measures to minimize the generation of wastes, by employing the four R's (Reduce, Reuse, Recycle, and Recover) through process of optimization or redesign, efficient procedures, and good housekeeping. Waste shall be managed in the following ways.

- Inventorization
- Classification
- Segregation
- Wastes quantification
- Wastes tracking; and
- Wastes disposal

The types of wastes generated during the construction activities shall be classified as: Solid wastes, liquid wastes, and gaseous wastes. The solid wastes will include food waste,

papers, rags, empty cans, and bottles, pipe off-cuts, coating tapes, electrode butts and general garbage. Liquid wastes will include sewage, spent chemicals (adhesives, lubricants, grease, etc). Generally, there are three likely kind of waste that shall be handled during the project, these include.

- Solid waste
- Aqueous/Non-Aqueous waste
- Gaseous waste

3.6.1 Solid Wastes

These types of waste include cleared vegetation, domestic refuse, pigging trash, scrap metals, filters, welding torches and spent electrodes. Trees would be felled along ROW and cut into useable lengths. In line with waste management procedures, identified solid wastes will be sorted and disposed of in designated areas. All chemicals used by IFF through its Contractors would be handled and ultimately disposed of according to the requirements of Safe Handling of Chemicals (SHOC) system. There shall be maintained records of all chemicals stored on site, identifying their Health, Safety and Environmental implications. IFF would work to ensure that records are maintained, and storage facilities are in good handling practices. Solid wastes would be disposed of in the following manner:

- Plastic containers depending on their size will be returned to the supplier, cleaned for reuse or crushed.
- The disposal of industrial wastes would be conducted in designated areas in accordance with regulation.

3.6.2 Aqueous/Non-Aqueous Wastes

Black and Grey Water

Black water refers to sewage whereas grey water is domestic wastewater. These shall be disposed of by use of mobile toilets which shall be used during the course of the project in accordance with national standards and guidelines.

Hydrotest Water

Prior to operation, the pipeline will be pressure-tested using fresh water from the closet River. The wastewater is free from additive and safe; however, it will be treated further in Indorama complex before it is discharge to nearby waterbody in accordance to stipulate guidelines and standards.

Diesel/Oil/Condensate

These wastes would emanate from working equipment such as welding machines, excavators, bulldozer etc. These wastes shall be scooped, contained, and disposed of in designated sites. The wastes expected in this gas pipeline project and options/methods for managing them are summarized in Table 3.4.

Table 3.4: Waste Streams from the gas pipeline Project

Waste stream	Main source	Estimate quantity	Classification	Management
Vegetation/clearing waste	RoW clearing	3,000–8,000 m³	Non-hazardous	Reuse/mulching; controlled disposal
Excavated subsoil	Pipeline trenching	136,076m3	Non-hazardous	Backfilling/reinstatement; surplus managed appropriately
Rock/boulders	Trenching	5,000–20,000 m³	Non-hazardous	Reuse as suitable construction material
Scrap metal/pipe offcuts	Welding/pipe installation	30–80 tonnes	Non-hazardous	Segregation and recycling
Welding electrodes/residues	Welding	5–15 tonnes	Non-hazardous/special	Collection and recycling/disposal
Coating/abrasive waste	Field joint coating	10–30 tonnes	Potentially hazardous	Characterisation and controlled disposal
Packaging materials	Pipes, fittings, equipment	20–60 tonnes	Non-hazardous	Reuse/recycling
Wood/pallets	Material handling	10–30 tonnes	Non-hazardous	Reuse/recycling
Domestic/general waste	Workforce/camps	150–300 tonnes	Non-hazardous	Segregation and approved disposal
Sewage/greywater	Camps and welfare facilities	5,000–12,000 m³	Liquid waste	Treatment and compliant discharge
Hydrotest water	Pipeline testing	8,000–15,000 m³	Liquid waste	Testing/treatment and controlled discharge
Drilling mud/cuttings	HDD/watercourse crossings	1,000–5,000 m³	Special waste	Dewatering, reuse or approved disposal
Used oils/lubricants	Equipment maintenance	10,000–25,000 L	Hazardous	Bunded storage and authorised disposal/recovery
Oily rags/filters/absorbents	Maintenance/spills	2–8 tonnes	Hazardous	Controlled hazardous-waste management
Contaminated soil	Accidental spills	100–500 m³	Potentially hazardous	Characterisation and remediation
Used batteries	Vehicles/generators	1–3 tonnes	Hazardous	Return/recycling
Used tyres	Construction vehicles	100–250 units	Special	Reuse/recycling
Medical waste	First-aid/site clinic	0.1–0.5 tonnes	Hazardous/special	Dedicated healthcare-waste management
E-waste	Temporary facilities/equipment	0.5–2 tonnes	Special	Specialist recycling

Waste stream	Main source	Estimated quantity/rate	Classification	Management
Used lubricating oil/grease	Valve stations, actuators and maintenance	1,000–3,000 L/year	Hazardous	Recovery/recycling through approved handlers
Oily rags/absorbents	Maintenance activities	0.2–1 tonne/year	Hazardous	Controlled storage and disposal
Contaminated soil	Leak/spill maintenance	10–50 m³/year	Potentially hazardous	Characterisation and remediation
Scrap metal	Pipeline/valve maintenance	2–10 tonnes/year	Non-hazardous	Recycling
Used filters	Gas filtration/maintenance	0.5–2 tonnes/year	Potentially hazardous	Controlled disposal/recycling
Used batteries	Instrumentation/valve systems	0.2–1 tonne/year	Hazardous	Approved recycling
Packaging waste	Spare parts/maintenance materials	1–5 tonnes/year	Non-hazardous	Reuse/recycling
Domestic waste	Operational personnel	5–20 tonnes/year	Non-hazardous	Approved collection/disposal

Waste stream	Main source	Estimated quantity/rate	Classification	Management
Sewage	Permanent/periodic facilities	100–500 m³/year	Liquid waste	Treatment and compliant discharge
Pigging waste*	Pipeline pigging/cleaning	5–30 tonnes/event	Potentially hazardous	Characterise and manage appropriately
Condensate/liquid hydrocarbons*	Pigging/draining/maintenance	1,000–10,000 L/event	Hazardous	Recovery and controlled disposal
Chemical containers/residues	Pipeline maintenance	0.5–2 tonnes/year	Hazardous/special	Approved hazardous-waste management
Vegetation waste	Periodic RoW maintenance	500–2,000 m³/year	Non-hazardous	Mulching/reuse/controlled disposal

Construction phase:
High-volume, short-term waste generation → vegetation, excavated soil, construction debris, hydrotest water, drilling waste, scrap metal and domestic waste.

Operational phase:
Low-volume, recurring waste generation → maintenance oils, filters, contaminated materials, scrap metal, pigging wastes, domestic waste and periodic vegetation management waste.

Storage yards

No construction camps to accommodate workers along the RoW are envisaged. Temporary storage yards shall be created within the acquired ROW for accommodating only equipment and materials such as pipes and machines for safekeeping, especially overnight when workers have closed for the day. Workers shall be accommodated in hired houses or hotels located in large communities to reduce the workforce impact to the barest minimum in rural communities.

3.7 Manpower Requirements

Construction Phase: The construction phase of the proposed project is expected to engage approximately 100 personnel over an estimated period of 18 months. The workforce will comprise skilled, semi-skilled and unskilled personnel, including project engineers, pipeline construction specialists, welders, equipment operators, technicians, HSE officers, environmental personnel, surveyors, security personnel and general labourers. The actual workforce may vary depending on the construction schedule, work packages and project activities. Where practicable, qualified personnel will be recruited from host and neighbouring communities to promote local employment, skills development and socioeconomic benefits.

The indicative breakdown of the peak construction workforce by skill level and the local-recruitment targets are given in Table 3.5. The final numbers will be confirmed in the EPC contractor's manpower histogram and the Project local recruitment plan.

Table 3.5: Indicative construction workforce and local-recruitment targets

Skill level	Typical roles	Indicative number at peak	Host-community target
Skilled	Project/pipeline engineers, surveyors, HSE and E&S officers, welders, NDT technicians, coating specialists, equipment operators, supervisors	25	Where qualified candidates are available (minimum 20%)
Semi-skilled	Pipe fitters, welding assistants, riggers, drivers, coating assistants, store keepers, security personnel	30	At least 50%
Unskilled	General labourers, flagmen, RoW clearing and reinstatement crews, cleaners	45	100% where available
Total		**100**	**At least 50% of total workforce**

Operational Phase: During the operational phase, IFF is expected to employ approximately five personnel to support relevant gas supply and associated facility operations, subject to the final operational arrangement. Their responsibilities may include routine facility monitoring, gas flow and pressure monitoring, equipment inspection, preventive maintenance, operational reporting and implementation of health, safety and environmental procedures. Existing personnel or specialist contractors may provide additional technical and maintenance support, depending on the facility's operational requirements.

3.8 Project Schedule

The pipeline project is being implemented in two phases. Phase 1 (11 km x 20-inch) was implemented between October 2024 and March 2026, with handover in January–February 2026, and is completed and in use. Phase 2 (65 km x 24-inch) is scheduled from October 2026 to September 2028: regulatory approvals and alignment sheets October 2026 – January 2027; contractor mobilisation June – August 2027; pipeline laying July 2027 – June 2028; tie-in with the 11 km pipeline and pre-commissioning June – July 2028; handover August 2028; and project close-out September 2028. The schedules of both phases are presented in Figure 3.9 (Phase 1, completed) and Figure 3.10 (Phase 2).

Figure 3.9: Project Schedule for First Phase

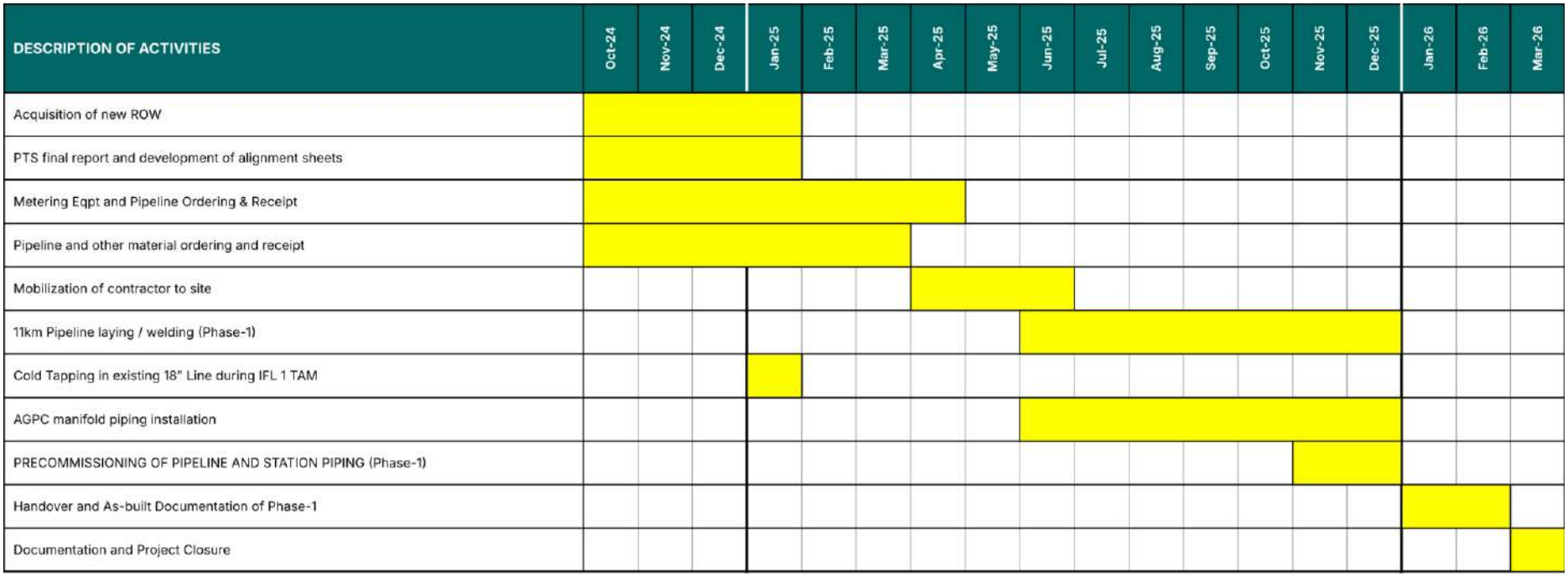
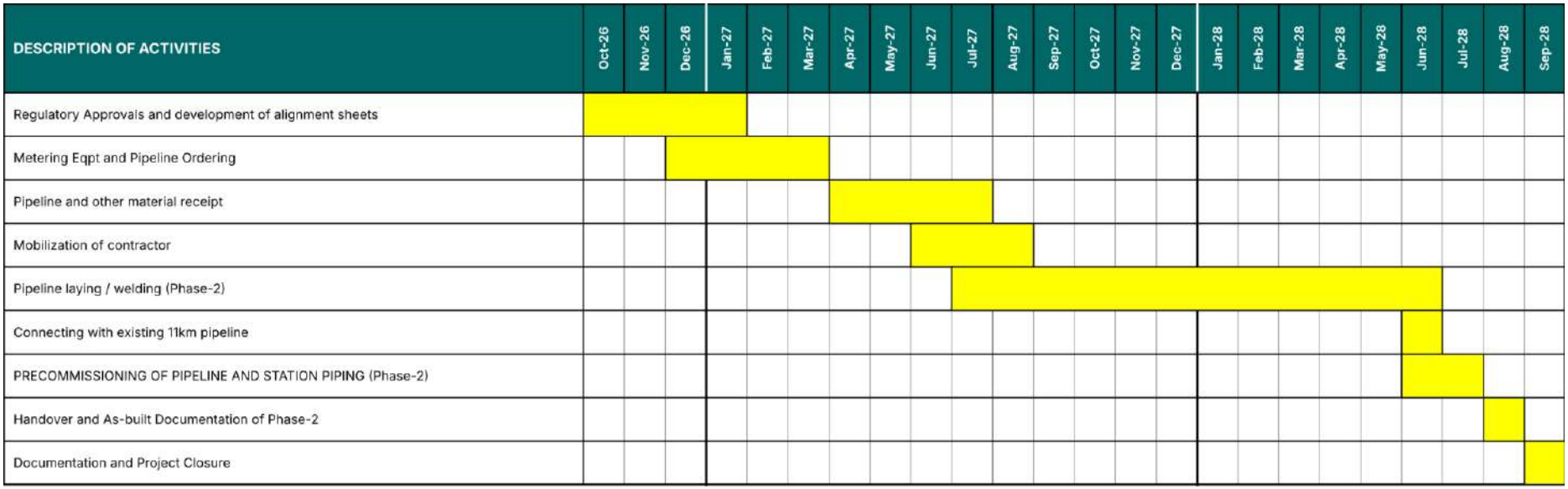


Figure 3.10: Project Schedule for Second Phase



CHAPTER FOUR

DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

It is important to gain an understanding of the physical, biological, and social attributes of the proposed 76km Right of Way (RoW) and its surroundings. The description of the baseline environment is essential in that it represents the conditions before the construction of the proposed Project. The description of the baseline environment therefore provides a description of the current or status quo environment against which social and environmental impacts of the proposed IFF pipeline Project are assessed and future changes monitored. Consequently, this chapter present both dry and wet season data. The dry season was conducted in December 2023 while the wet season was conducted in August 2026.

4.2 Study Area and Area of Influence

For the characterization of the physical, biological, and socio-economic baselines and associated impact assessments presented in Chapter 5, the definitions applicable to the Project Area are as follows –

- **Project Area** – defined as the IFF76km Right of Way, which is a 76km in length traversing 22 communities and two states Rivers and Imo state. The 65km right of way is already existing IFF, as such no new land acquisition is required for this, however for 11km RoW new land acquisition is required. The right of way is 15 m wide, giving a total land area of approximately 16.5 hectares for the 11km new RoW. The pipeline is being constructed as two separate sections. The 11 km section runs from the Anoh Gas Manifold at Assa in Ohaji/Egbema LGA, Imo State, to the tie-in at approximately KP17 near Awara community, Imo State, on newly acquired right of way. The 65 km section runs from that KP17 tie-in along the existing Oando right of way and terminates at the Indorama Complex battery limit at Akpajo in Eleme LGA, Rivers State, traversing about seventeen (17) communities in Rivers State through Etche, Ikwerre, Obio/Akpor and Eleme LGAs. The Study Area extends 2 km either side of the right of way, with control stations sited about 4 km beyond the start and end points.
- **Study Area** - the Study Area (or Area of Influence - 2km both side of the RoW) can be defined as the area likely to be affected by the Project activities during construction, operational and decommissioning phases of the Project. The Study Area includes:
  - The primary Project site and related facilities that IFF develops or controls.

- Additional areas in which aspects of the environment could conceivably experience significant impacts.
- Areas potentially affected by cumulative impacts resulting from other potential or known developments at the time of the ESIA, further planned phases of the Project or any other existing circumstances.
- Areas potentially affected by impacts from predictable (but unplanned) developments as a result of the Project (i.e., induced activities), occurring at a later stage or at a different location.

The study specific definitions for Study Area are provided in each aspect investigated (viz. air quality, noise, biodiversity, socio-economic, etc.).

4.3 Baseline Data Acquisition Methods

The information relating to this Chapter has been sourced from in-field dry and wet season baseline data commissioned by IFF in December 2023 and August 2026 undertaken by Safespace Resources Limited for the December 2023 dry season and by Environmental and Chemical Services Limited, Port Harcourt, for the August 2026 wet season, each an FMEnv-accredited Nigerian E&S consultant under the supervision of FMEnv. The collected samples were analysed in FMEnv accredited laboratory named Anal Concept Limited, Port Harcourt, for the dry season and M/s Adopt International Limited, Port Harcourt, an FMEnv/NMDPRA-accredited laboratory, for the wet season; the wet-season laboratory inspection was witnessed by representatives of FMEnv and the Rivers State Ministry of Environment on 10 August 2026. The quality assurance was undertaken against the requirements of National regulations and international guidelines, i.e., IFC PSs, AfDBs OSs, etc.

The baseline assessment has been undertaken over two seasons. Dry-season data were gathered in December 2023 in accordance with the one-season baseline data requirement approved by FMEnv, and wet-season data were gathered from 6 to 9 August 2026 under the supervision of representatives of FMEnv and the Rivers State Ministry of Environment, specifically to close the seasonal variation gap identified during the AfDB review. Both data sets are presented and discussed together for each environmental component in Sections 4.4 and 4.5, so that seasonal variation and trends are shown per component rather than in a standalone section. Regional secondary data have been retained only where they provide wider context for the biological environment, and the reports from which they were drawn are listed below.

The secondary data retained for regional context were extracted from the following approved ESIA reports: (i) ESIA Report of the proposed Construction of 24” x 5 km Gas Pipeline Project from Obigbo Compression Station at Oyigbo, Oyigbo LGA, to Obigbo Node

Pigging Station at Umuebulu, Etche LGA, Rivers State, 2019; (ii) ESIA Report of the proposed Port Harcourt Industrial Park, Ubima, Rivers State, 2020; and (iii) ESIA Report of the proposed Ohaji Autogas Compressed Natural Gas (CNG) Mother Station, Ohaji/Egbema Local Government Area, Imo State, 2025.

The Sections included in this Chapter are organised into a description of physical environment (Section 4.4), Biological environment (Section 4.5), Socio-economic Environment (including health) (Section 4.6), Cultural Heritage (Section 4.7), Stakeholder engagement (4.8) and Corporate Social Responsiveness of Indorama Nigeria (Section 4.9).

4.4 Physical Environment

This Section provides the baseline environmental conditions for the physical environment. It covers meteorology and climate, air quality, Greenhouse Gases (GHG) emissions, surface and groundwater, noise, geology, and soils.

4.4.1 Climate and Regional Meteorology

4.4.1.1 Overview of the Climate

Nigeria is characterised by four distinct climate zones: a tropical wet climate in the south, a tropical savannah climate for most of the central regions, and a Sahelian hot and semi-arid climate in the north of the Country. This leads to a gradient of declining precipitation from south to north. Figure 4.1 shows a breakdown of the climatic classification in Nigeria. The Project falls within the 'tropical monsoon climate' classification, highlighted in dark blue representing monsoon climate (Am). Nigeria is broken down into nine diverse ecological zones (extending from an arid north to a tropical south), the Project falls within the south.

The rainfall pattern in the Country varies by region and season. In the south, rainfall is experienced throughout the year with less rainfall between December and March.

Nigeria's mean annual temperature ranges between 17°C to 37°C in the south. During the dry season, Harmattan winds bring dry air from the Sahara Desert to Nigeria, while during the rainy season moist air is brought from the Atlantic Ocean (USAID, 2019).

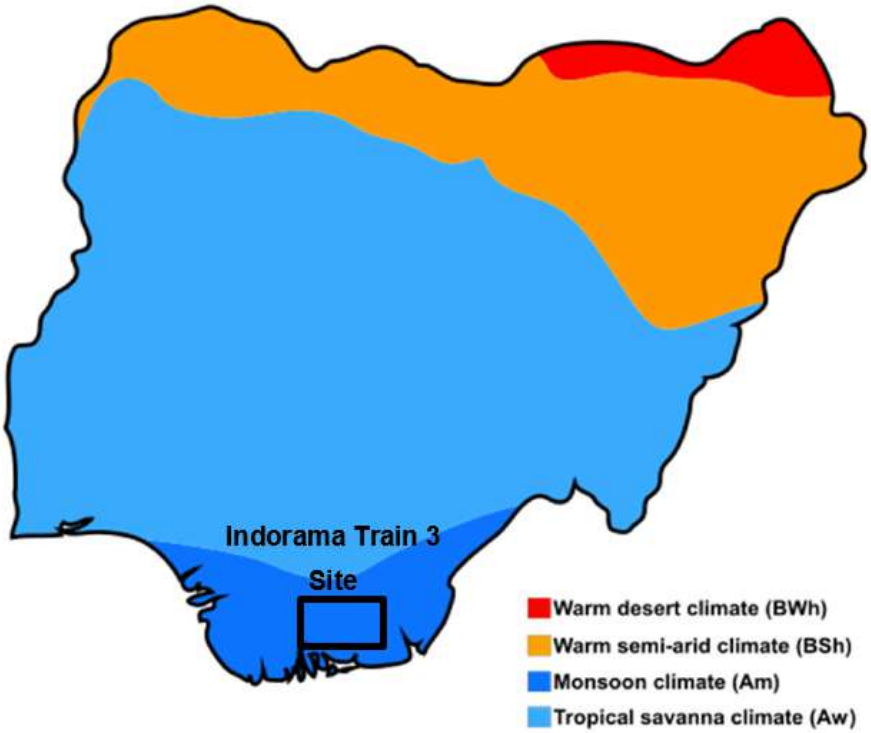


Figure 4.1: Map of Nigeria's Climate Classification

Source: Beck et al., 2018

The average weather trend for study area is shown in Table 4.1 below.

Table 4.1: Average Weather Trend within the study area (1990-2020)

S/No	Month	Average Temp (0C)	Rainfall (mm)	Cloud Cover (oktas)	Pressure (mbar)	R/H (%)	Wind Speed (m/s)	Wind Dir.
1	January	33.5	17.2	6.5	1007	74	2.9	NE
2	February	34.2	76.5	6.6	1007	79	2.8	SW
3	March	33.8	95.2	6.8	1006	83	3.6	SW
4	April	31.7	144.1	6.8	1007	83	3.7	SW
5	May	31.9	248.4	7	1007	87	3.8	SW
6	June	30.3	312.2	7	1009	91	3.9	SW
7	July	28.1	368	7	1010	92	4.3	SW
8	August	28.6	325.2	7	1010	92	4.3	SW
9	September	28.3	374.5	7	1009	92	4.4	SW
10	October	30.8	241.9	7	1009	89	3.8	SW
11	November	32.4	74	6.6	1007	84	2.9	SW
12	December	33.4	20.4	6.5	1007	73	2.6	NE

Source: NIMET, Port Harcourt Station

4.4.1.2Rainfall Pattern

The Project Area falls within the monsoon climatic zone (Figure 4.1). The annual distribution of rainfall in this climatic zone is characterised by two distinct seasons: wet

season that runs from mid-March through to November and a dry season that runs from December through to March. The mean annual rainfall for the Study Area is above 2,300 mm. The highest precipitation is experienced in September at 374.5 mm, while the lowest is experienced in January at 17.2 mm (refer to Figure 4.2).

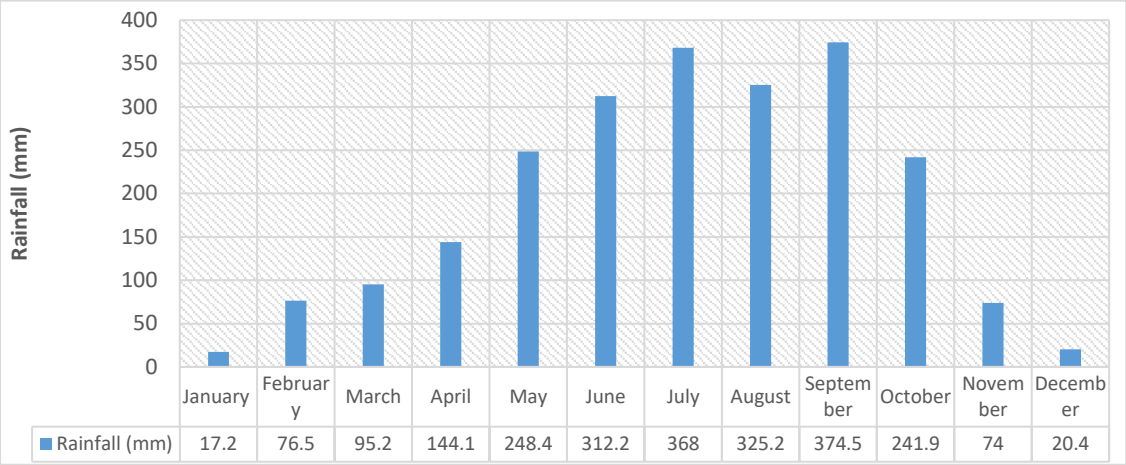


Figure 4.2: Monthly Rainfall Distribution in the Study Area

Source: Average Weather Trend with study area (1990-2020), NIMET[2]

4.4.1.3Air Temperature

The most significant temperature difference in Nigeria is between the coastal areas and its interior as well as between the plateau and the lowlands. On the plateau, the mean annual temperature varies between 21°C and 27°C, whereas in the interior lowlands, temperatures are generally over 27°C. The coastal fringes have lower means than the interior lowlands. Seasonal mean temperatures are consistently over 20°C throughout the country and diurnal variations are more pronounced than seasonal ones. Highest temperatures occur during the dry season and vary little from the coast to inland areas.

For the Project Area, Figure 4.3 below indicates that the months of July to September recorded lower temperatures (28°C) due to rainy periods, while the months of November to March recorded higher temperatures (32-34°C), due to increased solar radiation with low cloud cover dominant during the dry season. The Study Area is bounded to the east and south by open vegetation which creates a microclimate. During hotter days, the evapotranspiration creates a cooling effect that lowers surface temperature.

[2] Home - Nigerian Meteorological Agency (nimet.gov.ng)

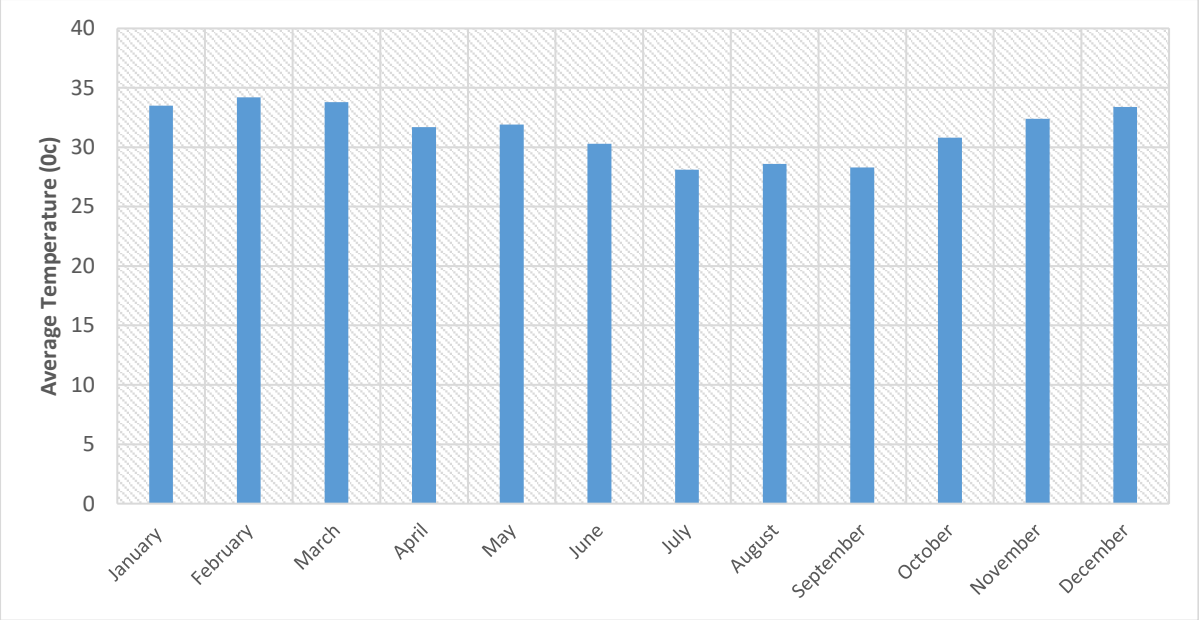


Figure 4.3: Mean Monthly Average Temperature

4.4.1.4Relative Humidity

According to 30 year (1990-2020) average weather data obtained from Nigerian Meteorological Agency (NIMET) for Port Harcourt, July, August, and September typically experience the highest relative humidity (92%), which corresponds to the highest atmospheric pressure at 1,010 millibar (mbar). Conversely, the periods that experience low atmospheric pressure correspond to low relative humidity with the lowest observed in December at 73% (refer to Figure 4.4). The high humidity and pressure at the Study Area is attributed to its proximity to a large water body hence moist air mass.

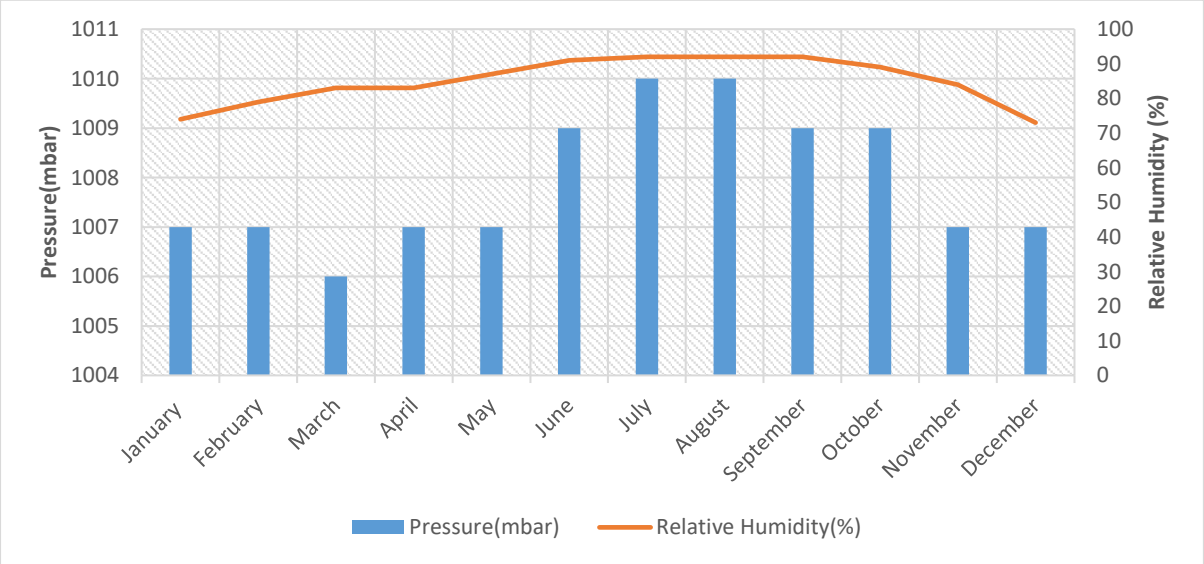


Figure 4.4: Average Relative Humidity and Pressure within the study area

4.4.1.5Wind Speed and Direction

According to the 30-year weather data for Port Harcourt, the Study Area depicts a wind speed range of 2.6 to 4.4m/s across the year (NIMET, 1990-2020) (Figure 4.5). The higest wind speed was recorded in July, August and September which are as seen as the peak of rainfall within region, revealing that the wind speed is greatly influenced by the rainfall within the study area. Furthermore, the wind direction was predominantly south westerly all through the month for the past 30 years.

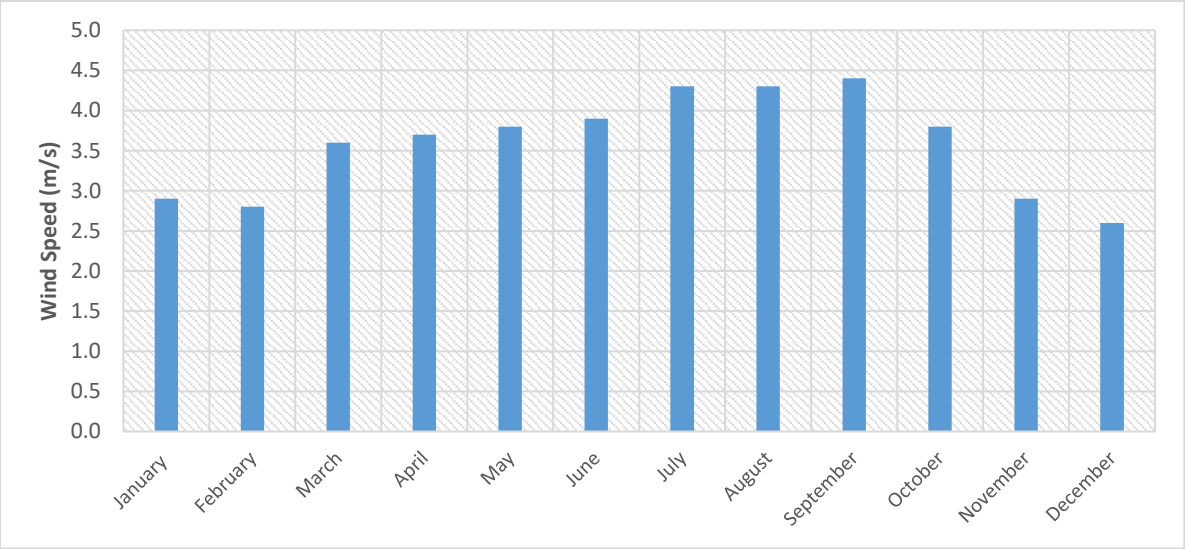


Figure 4.5: Average Wind speed within the study area

4.4.1.6Cloud Cover

According to the 30-year weather data for Port Harcourt, the Study Area depicts a cloud cover of over 6 oktas across the year (NIMET, 1990-2020) (Figure 4.6). Typically, sky conditions are estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 oktas (completely clear sky) through to 8 oktas (completely overcast). Therefore, with an average of over 6 oktas, the Study Area depicts a high rate of rising moist air mass due to the abundant water content, which gives rise to convective clouds. High amounts of cloud cover inhibit instability, which decreases the dispersion of plumes and lower amounts of cloud cover promote unstable conditions which enhance atmospheric dispersion of plumes. Cloud cover is prominent during rainy periods and minimal during dry seasons.

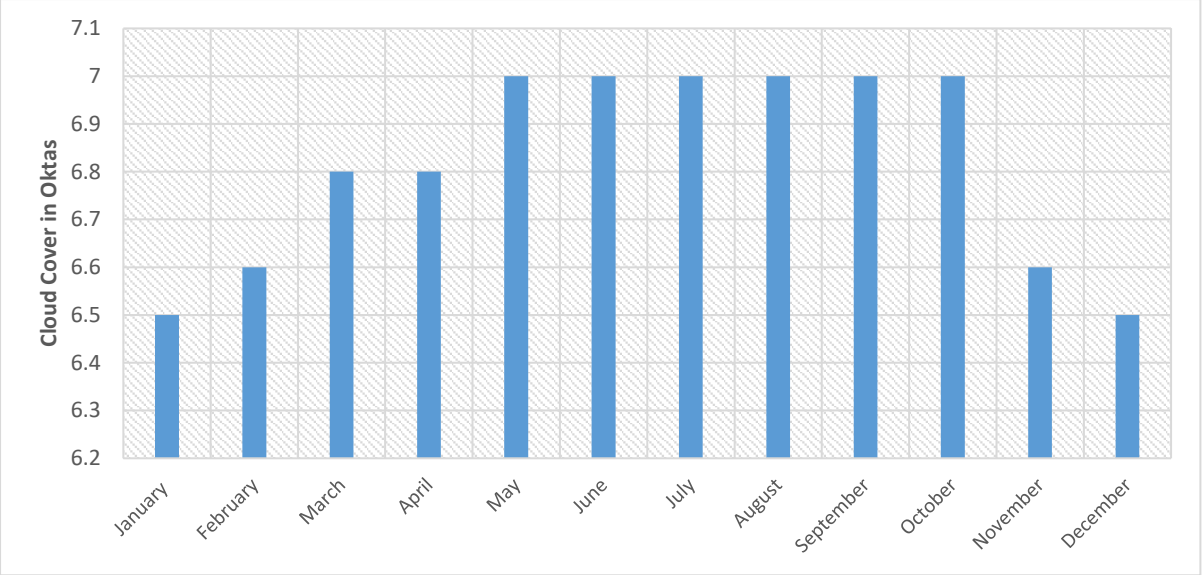


Figure 4.6: Average Monthly Cloud Cover in the Project Area

4.4.1.7Atmospheric Pressure

According to histroical weather data of 30-year from the Study Area revealed atmospheric pressure ranged between 1006 and 1010mbar across the year (NIMET, 1990-2020) (Figure 4.7). The highest atmospheric pressure of 1010 mbar was recorded in July and August being of peak of rain season within the study area indicating rainfall influence on the atmospheric pressure.

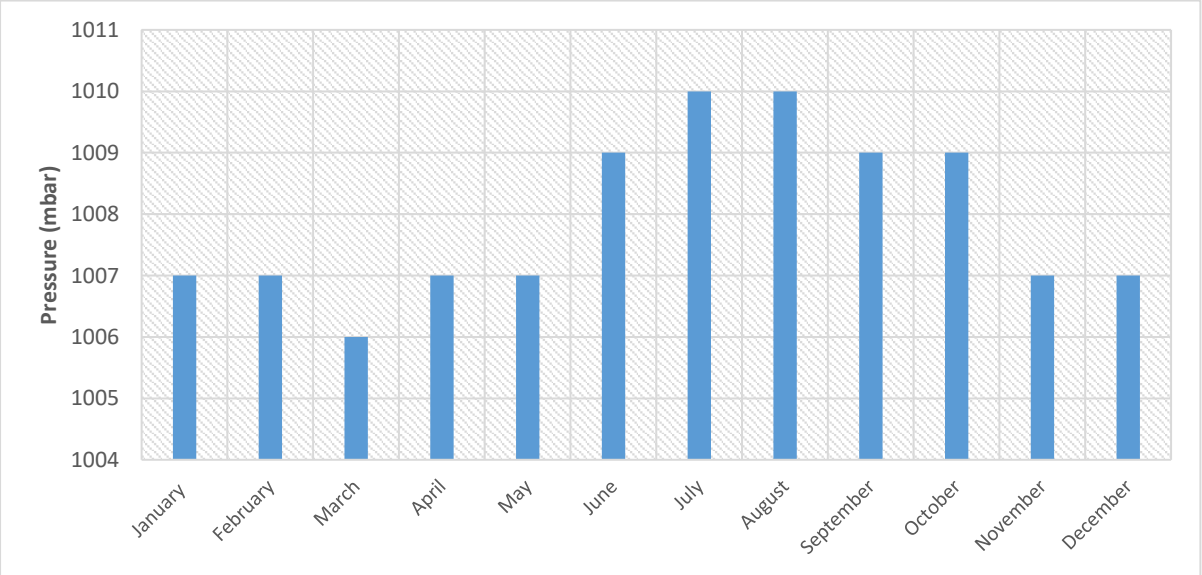


Figure 4.7: Average Monthly atmospheric pressure in the study Area

4.4.2 Meteorology

4.4.2.1 Fieldwork Approach

The fieldwork was carried out in the month of December 2023 and the weather station was installed at the study environment site on 17th December 2023 and 6th August 2026 to record weather variables for 24 hours. Six weather variables were recorded within the proposed project site to determine the diurnal weather pattern. These variables include air temperature, relative humidity, wind speed / direction, air pressure and cloud cover.

Vantage Pro2™ Plus (Davis) Weather Station having Integrated Sensor Suite (ISS), connected with console through WeatherLink software was mounted at 10m height aboveground of open terrain of proposed project site specifically at 5°04'42.00" N and 6°53'49.16"E. There was no obstruction up to 500m of the selected location. The weather station is solar powered and have Solid state magnetic sensor for wind speed, Wind vane with potentiometer for wind direction, PN Junction Silicon Diode for temperature, Film capacitor element for relative humidity, barometric pressure sensors and Tipping bucket type rain collector. Cloud cover was measured via visibility in oktas. The instrument specifications meet with WMO recommendations as detailed below.

Table 4.2: Weather Station Specifications

Variables	Unit	Range	Accuracy	Resolution	Averaging time
Air temperature	°C	-40 to 60	±0.1°C	0.1°C	1 minute
Relative humidity	%	0 to 100	±5%	1%	
Wind speed	m/s	0 to 67.0	±0.5m/s for ≤5m/s 10% for ≥5m/s	0.5	2 minutes
Wind direction	0	0 to 360	±5%	10°	2 minutes
Rainfall	Mm	0 to 999	3%	0.25mm	
Atmospheric pressure	mbar	610 to 1134	±0.1mbar	0.1mbar	1 minute

Field Data

Table 4.3 and 4.3a show the diurnal weather data recorded for the proposed study environment close to the Port Harcourt International Airport at Ipo Community (Cluster 3) of the pipeline route for the dry and wet seasons respectively.

Table 4.3: A Mean Diurnal Weather Pattern during Fieldwork (Dry season)

Diurnal Period (hour)	Temp (oC)	R/H (%)	WSP (m/s)	WDR (Deg)	ATM PP (mbar)	CC (oktas)
12:00	32.8	68	1.9	NE	1007	5
13:00	32.4	69	1.5	NE	1008	5
14:00	32.7	68	1.3	E	1008	5
15:00	32.1	69	2.2	E	1008	6

Diurnal Period (hour)	Temp (oC)	R/H (%)	WSP (m/s)	WDR (Deg)	ATM PP (mbar)	CC (oktas)
16:00	31.5	69.5	3.1	SW	1009	6
17:00	30.8	71	2.1	S	1009	6
18:00	29.5	71	1.5	S	1009	5
19:00	29.1	72	1.7	SW	1009	5
20:00	29	72	1.4	SW	1009	Nighttime
21:00	28.8	74	1.1	SW	1009	Nighttime
22:00	28.5	75	1	NE	1010	Nighttime
23:00	28.2	76	1	NE	1010	Nighttime
0:00	28.1	76	1	NE	1010	Nighttime
1:00	27.5	78	1.1	NE	1010	Nighttime
2:00	27.4	78	0.7	N	1010	Nighttime
3:00	27.4	78	1.1	S	1011	Nighttime
4:00	26.8	80	1.2	S	1011	Nighttime
5:00	26.6	80	1	E	1011	Nighttime
6:00	26.5	80	1.1	E	1011	Nighttime
7:00	27.1	79	1.3	E	1011	5
8:00	28.9	73	1.6	S	1011	5
9:00	29.4	71	1.5	S	1010	5
10:00	29.9	70	1.7	S	1009	6
11:00	30.7	69	1.6	E	1009	6
	29.2	**73.6**	**1.5**	**138.5**	**1009.5**	**5.4**

Table 4.3a: A Mean Diurnal Weather Pattern during Fieldwork (Wet season)

Diurnal Period (hour)	Temp (oC)	R/H (%)	WSP (m/s)	WDR (Deg)	ATM PP (mbar)	CC (oktas)
11:00	30.4	69.1	2.9	SSW	1009.0	6.2
12:00	30.9	66.2	3.0	SSW	1008.1	6.2
13:00	31.0	65.1	3.2	SSW	1007.0	6.2
14:00	30.8	65.9	3.6	SSW	1006.3	6.2
15:00	30.1	68.7	3.9	SSW	1006.0	6.4
16:00	29.5	72.3	4.0	SSW	1006.1	6.4
17:00	28.5	76.4	3.9	SSW	1006.5	6.3
18:00	27.6	79.9	3.9	SSW	1007.1	6.1
19:00	27.1	82.9	3.8	SSW	1007.8	6.0
20:00	26.4	85.2	3.7	SSW	1008.5	Nighttime
21:00	25.9	86.9	3.5	SSW	1009.1	Nighttime
22:00	25.3	87.6	3.1	SW	1009.2	Nighttime
23:00	25.1	88.9	2.9	SW	1009.0	Nighttime
0:00	24.8	90.1	2.8	SW	1008.6	Nighttime

Diurnal Period (hour)	Temp (oC)	R/H (%)	WSP (m/s)	WDR (Deg)	ATM PP (mbar)	CC (oktas)
1:00	24.6	91.3	2.7	SW	1008.0	Nighttime
2:00	24.4	92.2	2.6	SW	1007.7	Nighttime
3:00	24.2	92.8	2.4	SW	1007.6	Nighttime
4:00	24.1	93.2	2.3	SW	1007.8	Nighttime
5:00	24.2	93.4	2.2	SW	1008.2	Nighttime
6:00	24.6	93.6	2.2	SSW	1008.7	Nighttime
7:00	25.5	93.0	2.2	SW	1009.4	6.3
8:00	26.8	87.1	3.0	SW	1009.9	6.2
9:00	27.8	80.0	3.0	SW	1010.1	6.1
10:00	29.8	73.7	2.9	SSW	1009.8	6.2
	27.1	**82.3**	**3.1**	**SSW**	**1008.1**	**6.2**

Figures 4.8, 4.9 and 4.10 present Diurnal temperature, Wind Rose pattern and wind speed pattern as observed during the field sampling in December 2023 (dry season). Figures 4.11, 4.12 and 4.13 present Diurnal temperature, Wind Rose pattern and wind speed pattern as observed during the field sampling in August 2026 (wet season).

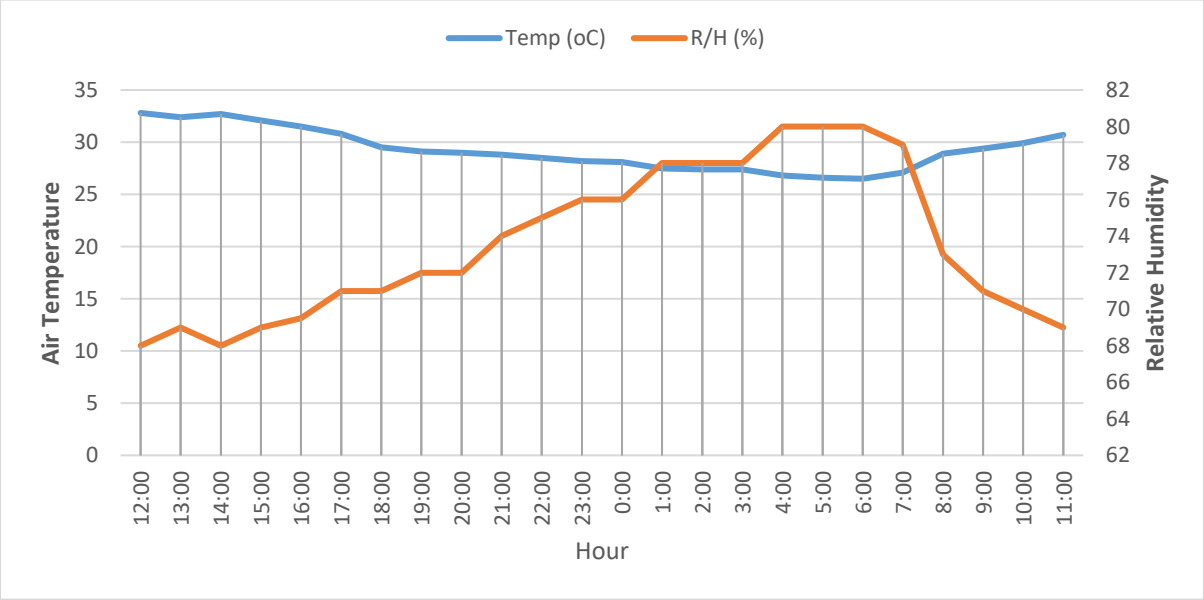


Figure 4.8: Diurnal temperature & relative humidity variations during field survey

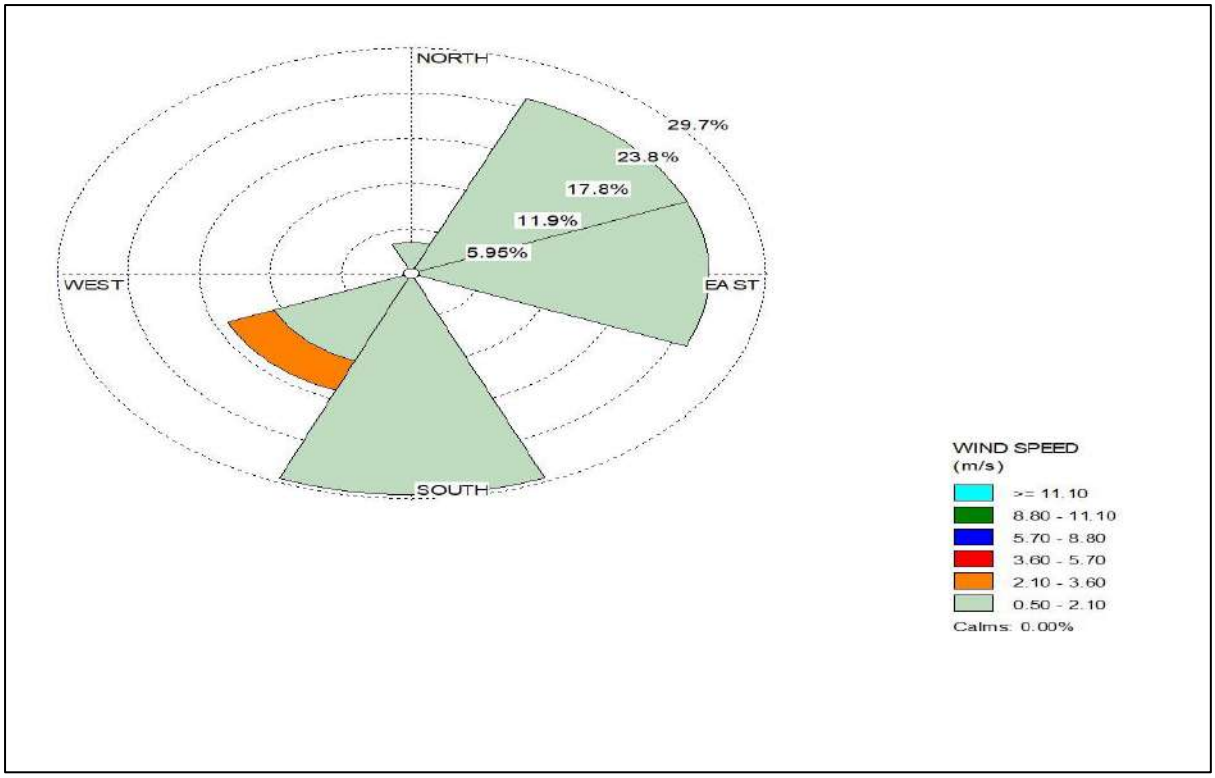


Figure 4.9: Diurnal Wind Rose Pattern during Fieldwork

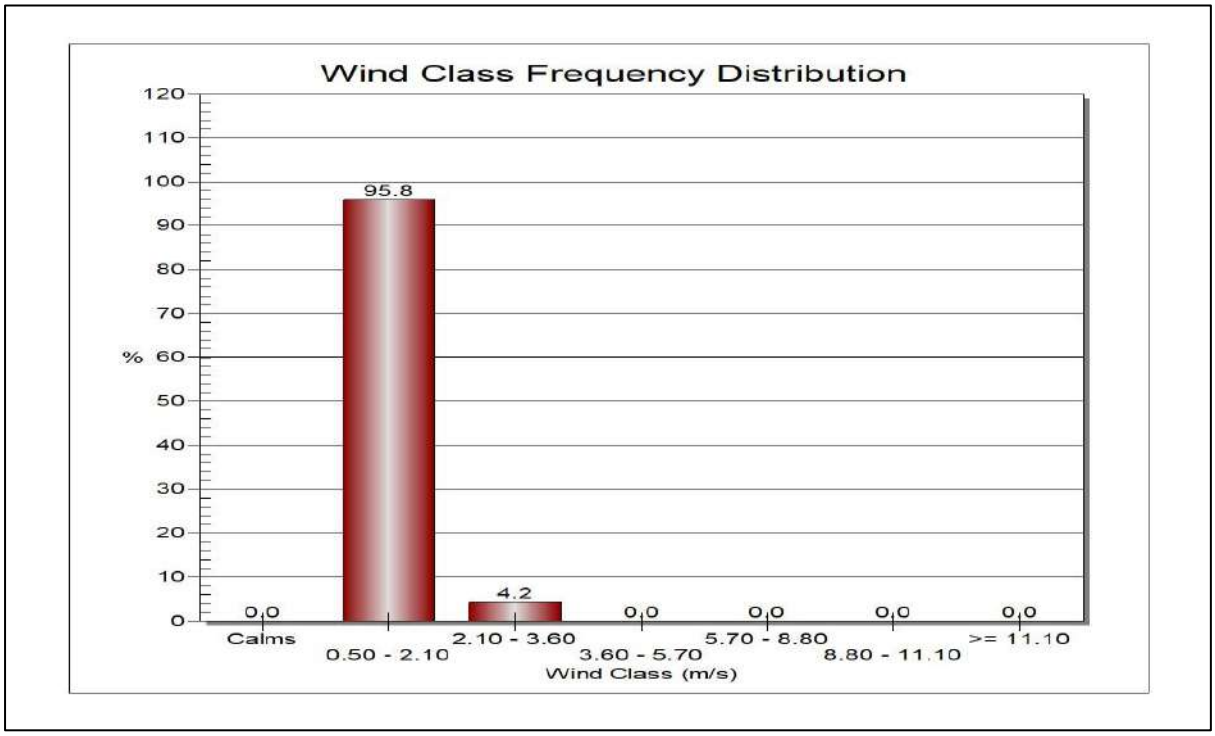


Figure 4.10: Diurnal Wind Speed Pattern during Fieldwork

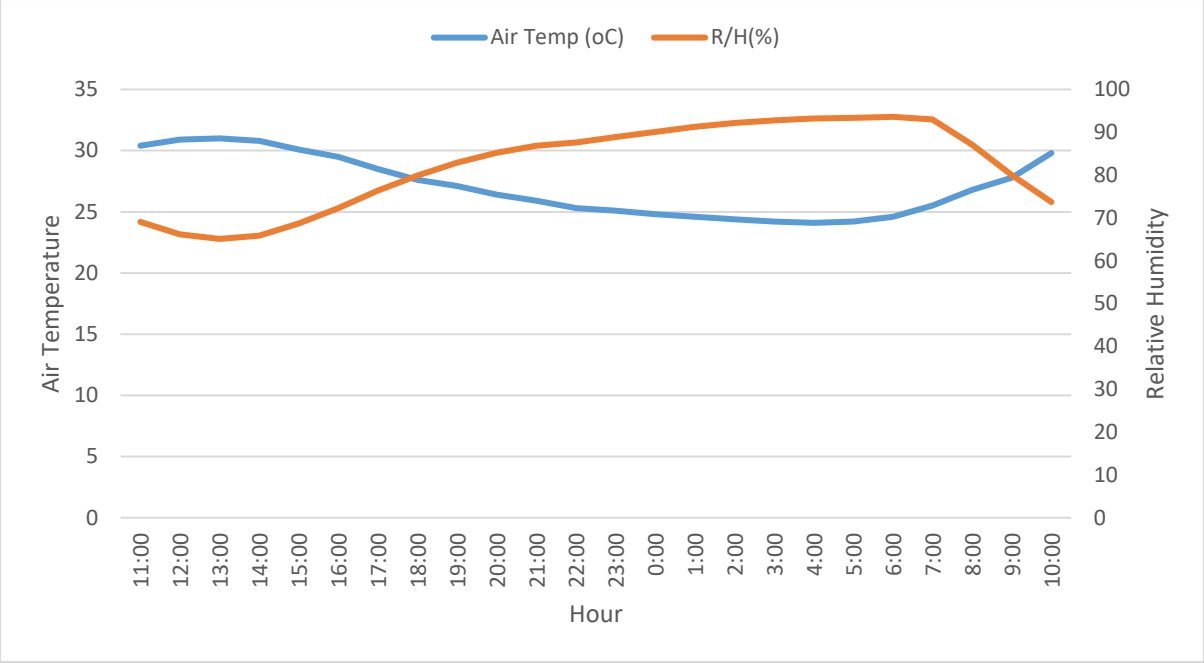


Figure 4.11: Diurnal temperature & relative humidity variations during field survey

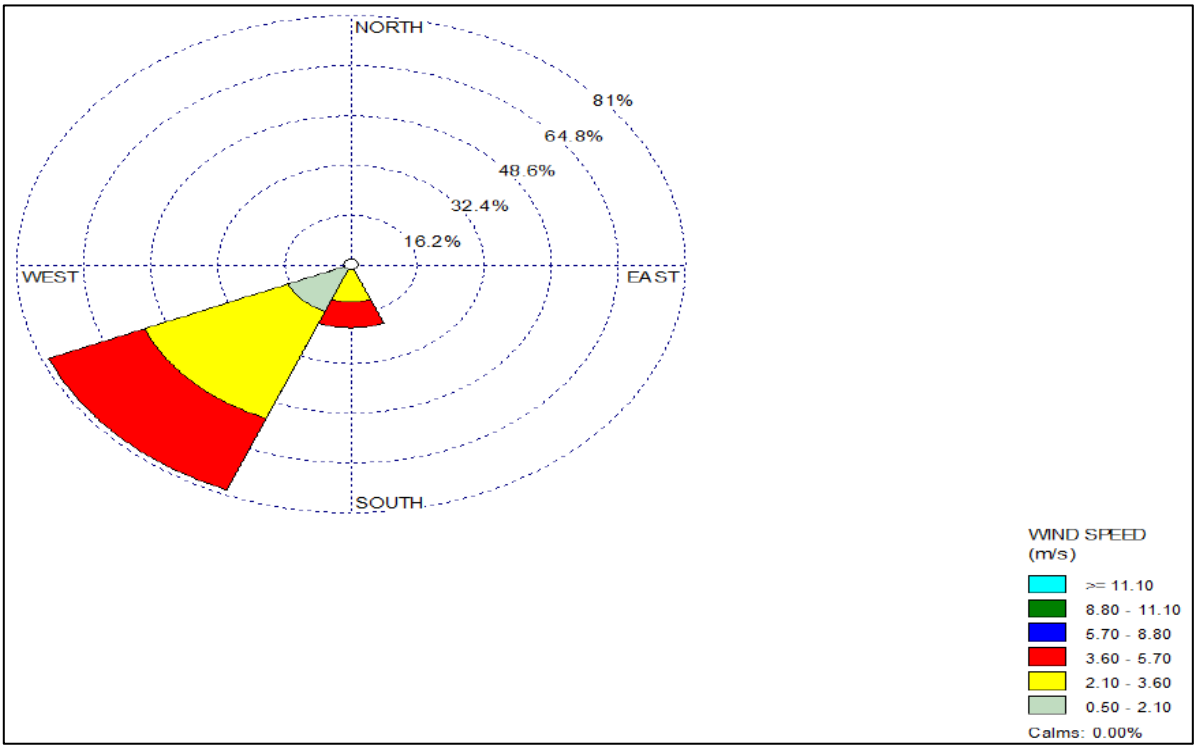


Figure 4.12: Diurnal Wind Rose Pattern during Fieldwork

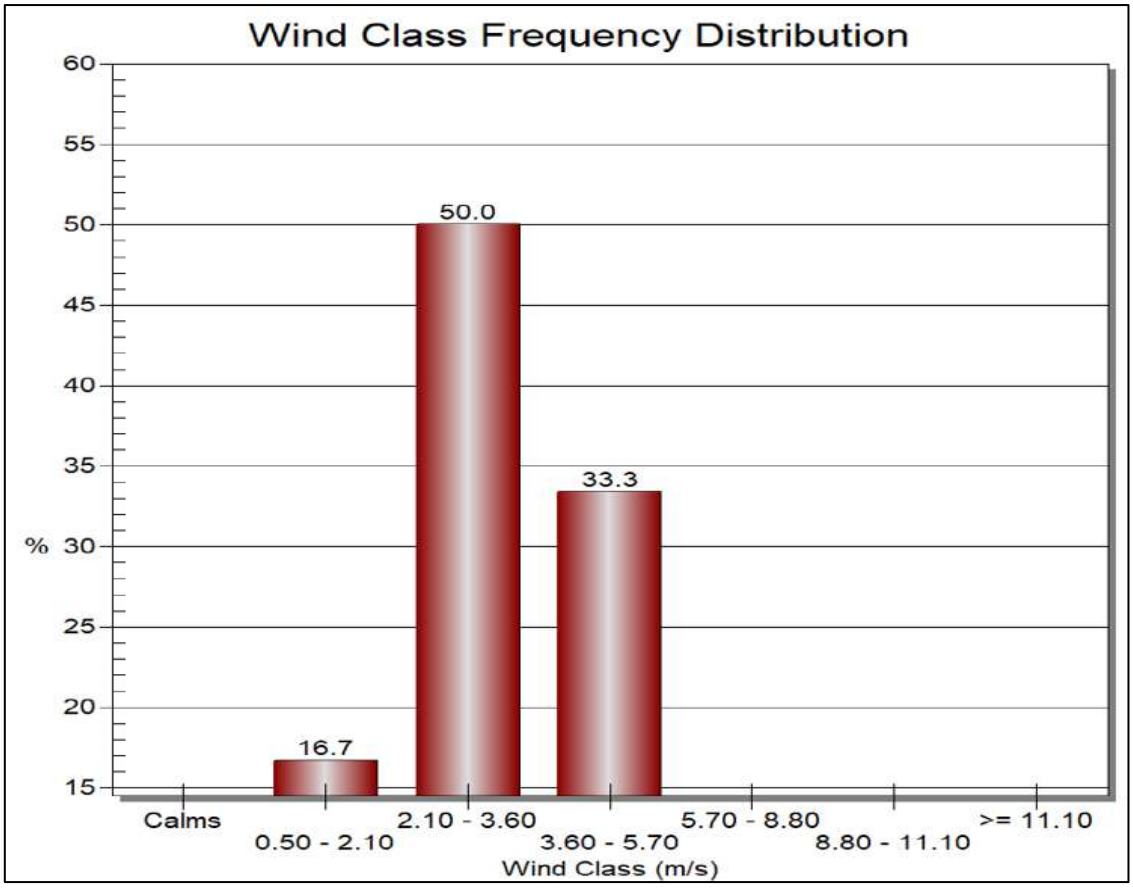


Figure 4.13: Diurnal Wind Speed Pattern during Fieldwork

The meteorological data were also collected at the ambient monitoring station during ambient air monitoring campaign along the pipeline ROW. Figures 4.13 – 4.13c showed the ambient wind speed, air temperature and relative humidity along pipeline sampling route for the dry season. Figures 4.13d – 4.13f showed the ambient wind speed, air temperature and relative humidity along pipeline sampling route for the wet season.

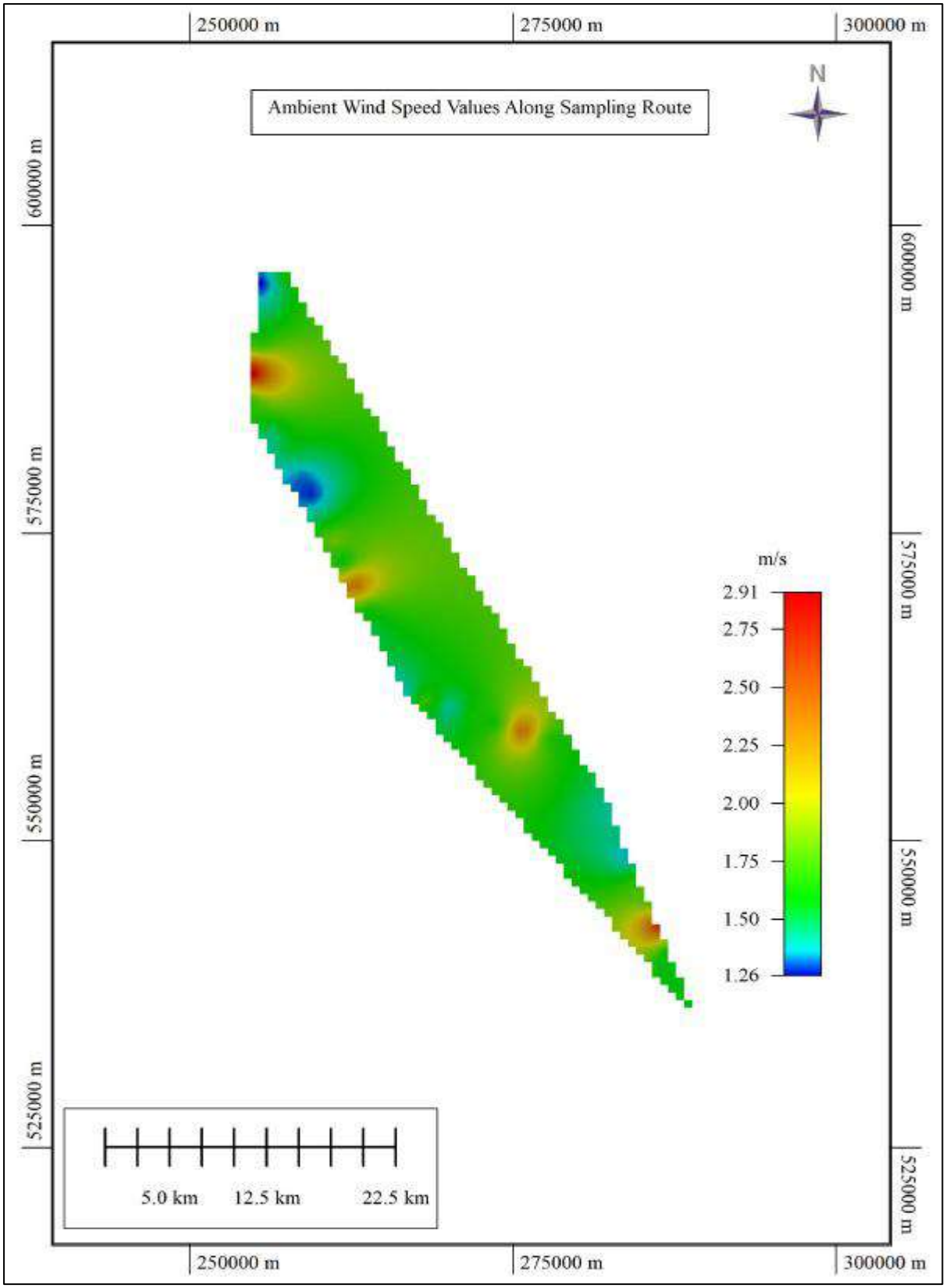


Figure 4.13a: Ambient Wind Speed Values along Pipeline Route -dry season

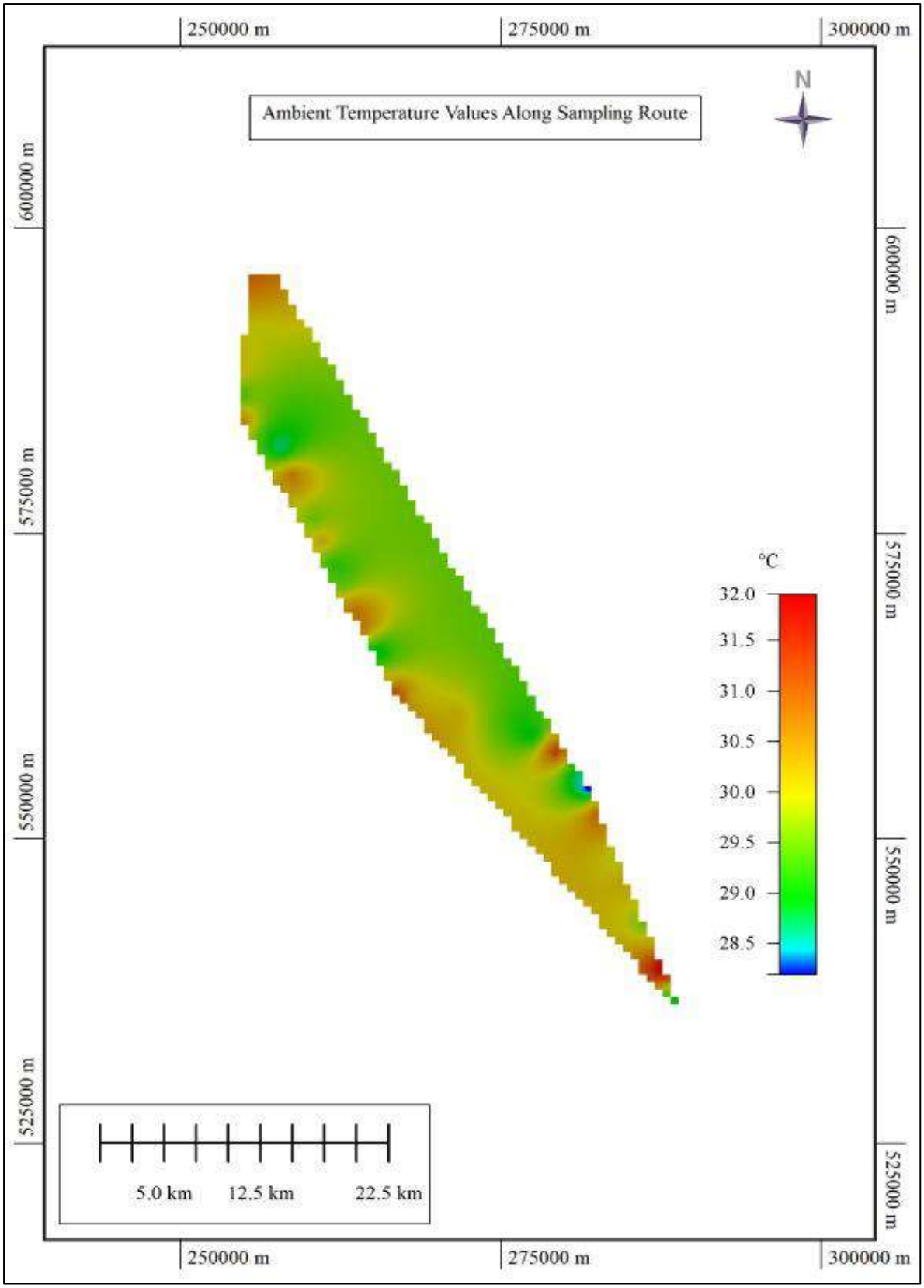

Ambient Temperature Values Along Sampling Route
N
250000 m
275000 m
300000 m
600000 m
575000 m
550000 m
525000 m
°C
32.0
31.5
31.0
30.5
30.0
29.5
29.0
28.5
5.0 km
12.5 km
22.5 km

Figure 4.13b: Ambient Air Temperature Values along Pipeline Route-dry season

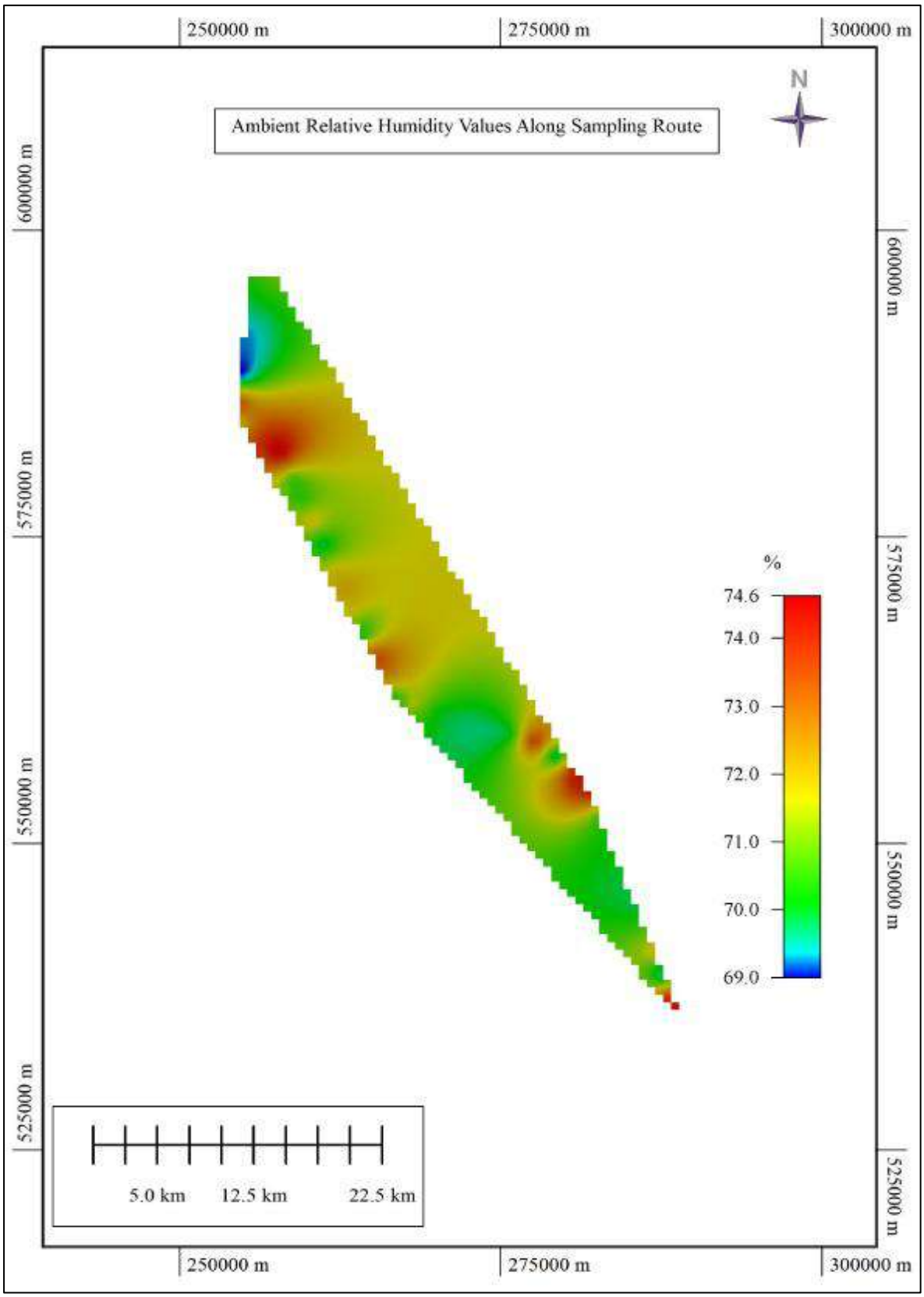


Figure 4.13c: Ambient Relative Humidity Values along Pipeline Route-dry season

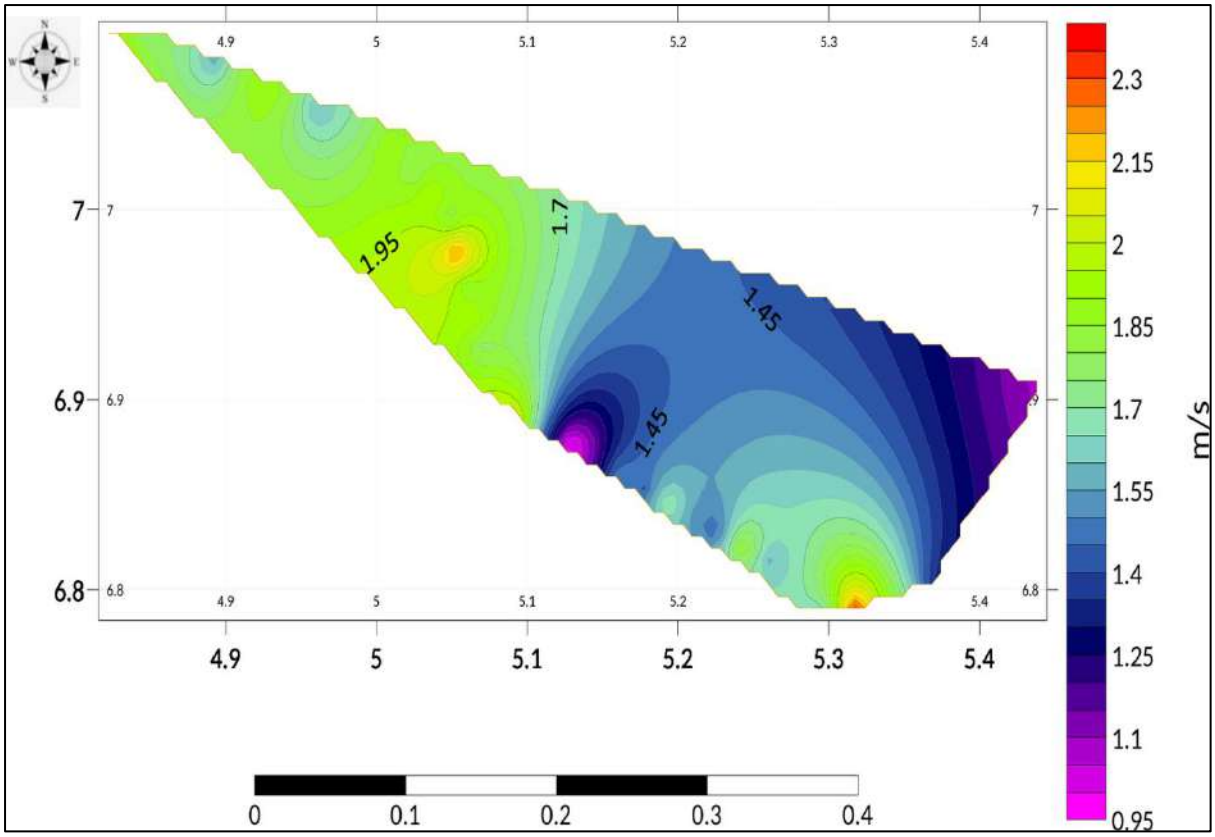


Figure 4.3d: Ambient Wind Speed Values along Pipeline Route-wet season

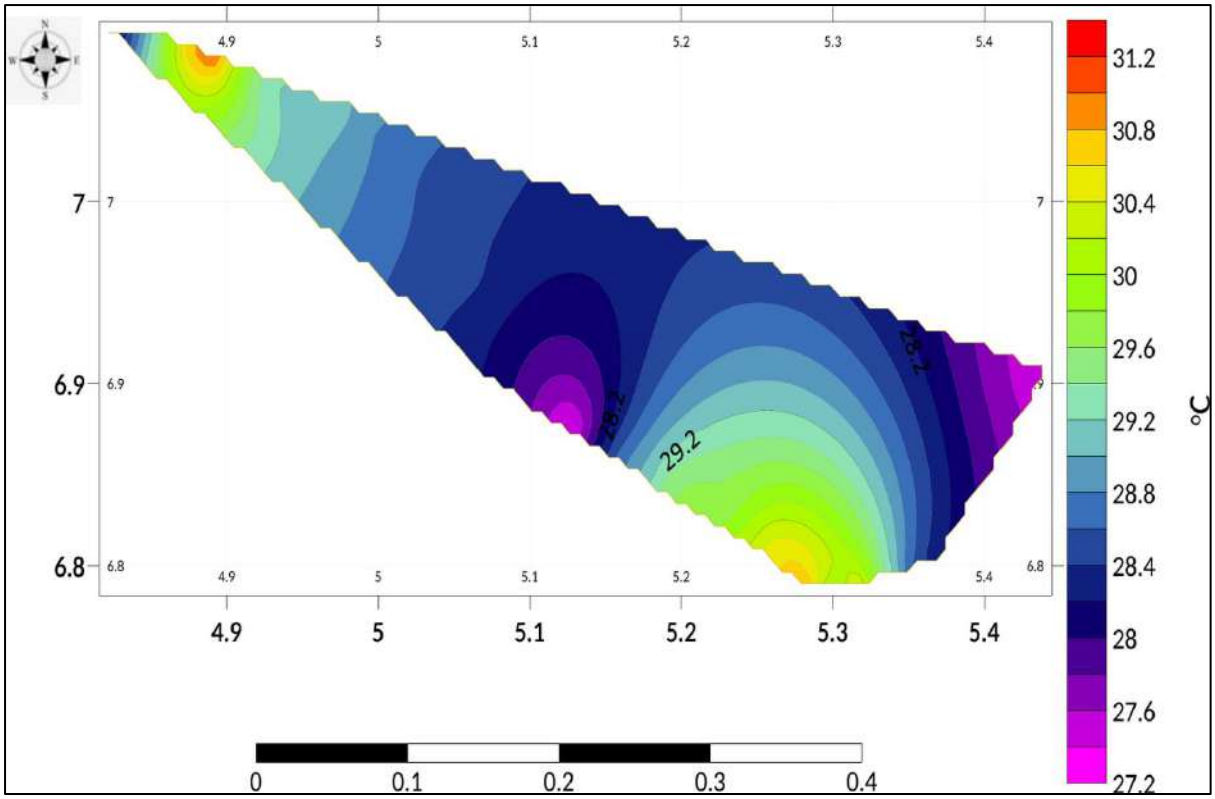


Figure 4.13e: Ambient Air Temperature Values along Pipeline Route-wet season

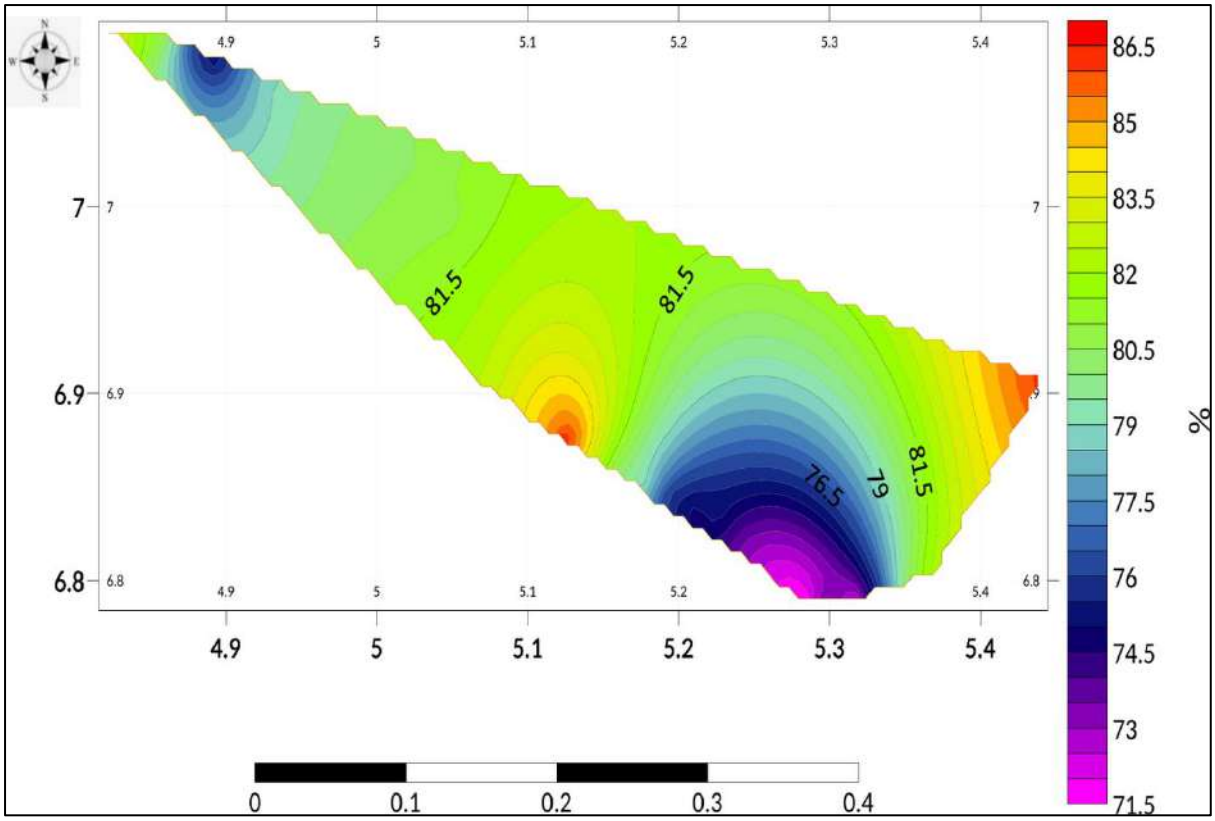


Figure 4.13f: Ambient Relative Humidity Values along Pipeline Route-wet season

4.4.3 Climate Risks

4.4.3.1Introduction

The potential physical impacts that climate change could have on the Project have been considered in this Section.

This has been undertaken through a high-level scenario analysis, which has assessed the impact of climate change on physical climate-related risks associated with a full list of ERM's identified hazard types (extreme heat, extreme cold, flooding, landslides, wildfires, coastal flooding, water stress & drought and tropical cyclones) in relation to the proposed Project. Only those hazards deemed applicable to the Project have been assessed.

The scenario analysis has utilised a range of the Intergovernmental Panel On Climate Change (IPCC) climate change scenarios under a range of future projected time horizons (2030 and 2050) – which have been selected based upon their relevance to the Project and in alignment with the guidance set out by the Task Force on Climate-Related Financial Disclosures (TCFD). This includes SSP1-2.6[3], which is most closely aligned with the targets

[3] Shared Socio-economic Pathways (SSPs) are scenarios of projected socio-economic global changes up to the year 2100. These scenarios are used to derive greenhouse gas emissions scenarios with different climate policies. SSP1-2.6 is a scenario that assumes low GHG emissions (i.e. CO_2 emissions are reduced to net zero by 2075).

made under the Paris Agreement (to aim to keep temperatures increases by 2100 at 2 deg. C or lower) and SSP5-8.5[4], which is a higher emissions scenario, also referred to as the Business-as-Usual scenario. As a part of this scenario analysis, climate-related risks have been identified under future projected timeframes and scenarios.

4.4.3.2Literature Review

According to research conducted by USAID in 2019, Nigeria's average temperatures may increase between 1.1°C and up to 2.5°C by 2060, with higher rates of warming in the north. Rainfall variability and extreme rainfall events are also projected to increase across most of the Country. Coastal areas are also expected to experience an increase of 0.4 - 1.0 metre (m) in mean sea level by 2100. In addition, there is a projection that the number of cold nights will decrease drastically, even with a projection of close to zero by 2090 while the number of extreme heat days is projected to increase by 2100 to 260 days (it was 10 days in 1990).

The World Bank Group (WBG) (2021) projects that temperatures will increase across the Country progressively through to the end of the century, with a potential increase in temperatures of between 2.9°C to 5.7°C, coupled with an increase in low temperatures and average temperatures are also expected to increase. Night-time temperatures are expected to increase by 4.7°C. By the 2100s, it is expected that the duration of heat waves will increase by an additional 8 to 55 days.

Additionally, there is a projection of heavy rainfall intensifying, in particular during the summer period. This in addition to an increase in the intensity and frequency of droughts may lead to an increase in natural disasters. Precipitation quantities are most likely to increase from the end of the rainy season up until the start of the dry season, which will be from September up until December (WBG, 2021).

"*Nigeria is at risk to numerous natural hazards and prone to floods, storms, ocean surges, droughts and wildfires. Nigeria's coastal states face extensive risks from storm surge along the entire coast, and inland flooding and wildfires in the Niger Delta region, and negative rainfall anomalies in the southeast*" (WBG, 2021, pg 11).

The Project Area falls within High Risk for both aspects of flooding and wildfires (Figure 4.14).

[4] SSP5-8.5 scenario assumes very high GHG emissions (i.e. – that CO_2 emissions will triple by 2075).

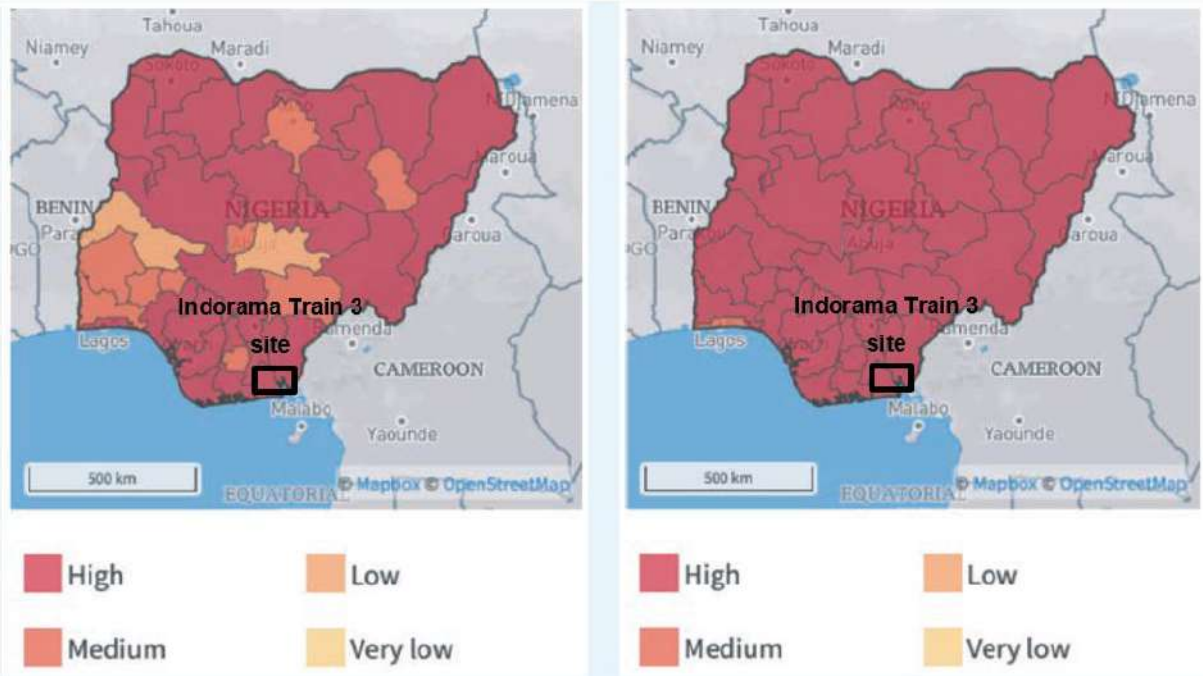


Figure 4.14: Nigeria's Risk of Urban Flood (left) and Risk of Wildfire (right)

Source: WBG, 2021

Moreover, the WRI Aqueduct offer projections to 2040 under a pessimistic[5] scenario. Results for the Project for drought risk / the projected change in water stress[6] is shown in Table 4.4 and Figure 4.15.

Table 4.4: Projected Water Stress for the Project

Climate Variable / Event	Projection
Drought Risk / Water Stress	Low to medium (10-20%) water stress

[5] *The "pessimistic" scenario represents a fragmented world with uneven economic development, higher population growth, lower GDP growth, and a lower rate of urbanization, all of which potentially affect water usage; and steadily rising global carbon emissions, with CO_2 concentrations reaching ~1370 ppm by 2100 and global mean temperatures increasing by 2.6–4.8°C relative to 1986–2005 levels.*

[6] *Water stress is an indicator of competition for water resources and is defined informally as the ratio of demand for water by human society divided by available water." (WRI Aqueduct 2015)*



Figure 4.15: Projected Water Stress for the Project Area

Source: WRI (Aqueduct 2015)

4.4.3.3Risk Scores

ASSET RISK SCORE

Climate impacts on the Project are considered based on scenario SSP1-2.6 and SSP5-8.5. Figure 4.16 and Figure 4.17 provide the 'Asset Risk Score' that identifies the potential change in risk profile for the Project. The Project Area is projected to experience a minimal increase in risk as a result of climate change across both scenarios and for both time horizons (2030 and 2050).

	Asset	Baseline	2030	2050
1	Indorama Train-3	0.44, Minimal Asset Risk	0.68, Minimal Asset Risk	0.74, Minimal Asset Risk

Where:

Climate Hazard	Significant Decrease	Moderate Decrease	Minimal Decrease	Minimal Increase	Moderate Increase	Significant Increase

Figure 4.16: Asset Risk Score, SSP1-2.6

	Asset	Baseline	2030	2050
1	Indorama Train-3	0.44, Minimal Asset Risk	0.64, Minimal Asset Risk	0.66, Minimal Asset Risk

Where:



Figure 4.17: Asset Risk Score, SSP5-8.5

RISK SCORE COMPOSITION

In addition to the above, the key climate change hazards deemed applicable to the Project under scenario **SSP1-2.6** are as follows (also refer to hazard distribution in for the 2030- and 2050-time horizons in Figure 4.18 and Figure 4.19 respectively):

- **Extreme Heat**: the biggest change from the baseline to 2030 and 2050 is a visible increase in extreme heat, with a baseline risk score of 0.24 and then an increase in risk by 2.28 for 2030 and 2.46 for 2050.
- **Extreme Cold**: extreme cold decreases quite drastically from the baseline (2.08) risk score to 2030 by -0.68 and for 2050 by -0.96.
- **Wildfires**: at the baseline wildfires are at a risk score of 0.88, it increases for 2030 by 0.24 and for 2050 by 0.08.
- **Water Stress and Drought:** increases quite a bit from the baseline risk score which is at 0.40 to 0.64 in 2030 and increases to 1.36 in 2050.
- **Extreme Rainfall Flooding**: increases by 0.08 for both 2030 and 2050 from the baseline risk score of 0.40.

The key climate change hazards deemed applicable to the Project under scenario **SSP5-8.5** are as follows (also refer to hazard distribution in for the 2030- and 2050-time horizons in Figure 4.20 and Figure 4.21 respectively):

- **Extreme Heat**: the same as in the previous scenario, the biggest change from the baseline to 2030 and 2050 is a significant increase in extreme heat, with a baseline risk score of 0.24 and then an increase in risk to 2.76 for 2030 and 4.44 for 2050.
- **Extreme Cold**: there is a significant decrease in extreme cold from a 2.08 risk score at the baseline to a 1.04 risk score for 2030 and no risk score for 2050.
- **Wildfires**: same as above, wildfires baseline risk score is 0.88, it increases for 2030 by 0.16, while 2050 has no risk score.
- **Water Stress & Drought**: for baseline has a risk score of 0.40 and 2030, it increases by 0.16 for 2030 and by quite a bit by 0.64 in 2050.

- **Extreme Rainfall Flooding**: is the same for baseline and 2030 with risk score of 0.40, it then increases by 0.08 in 2050.

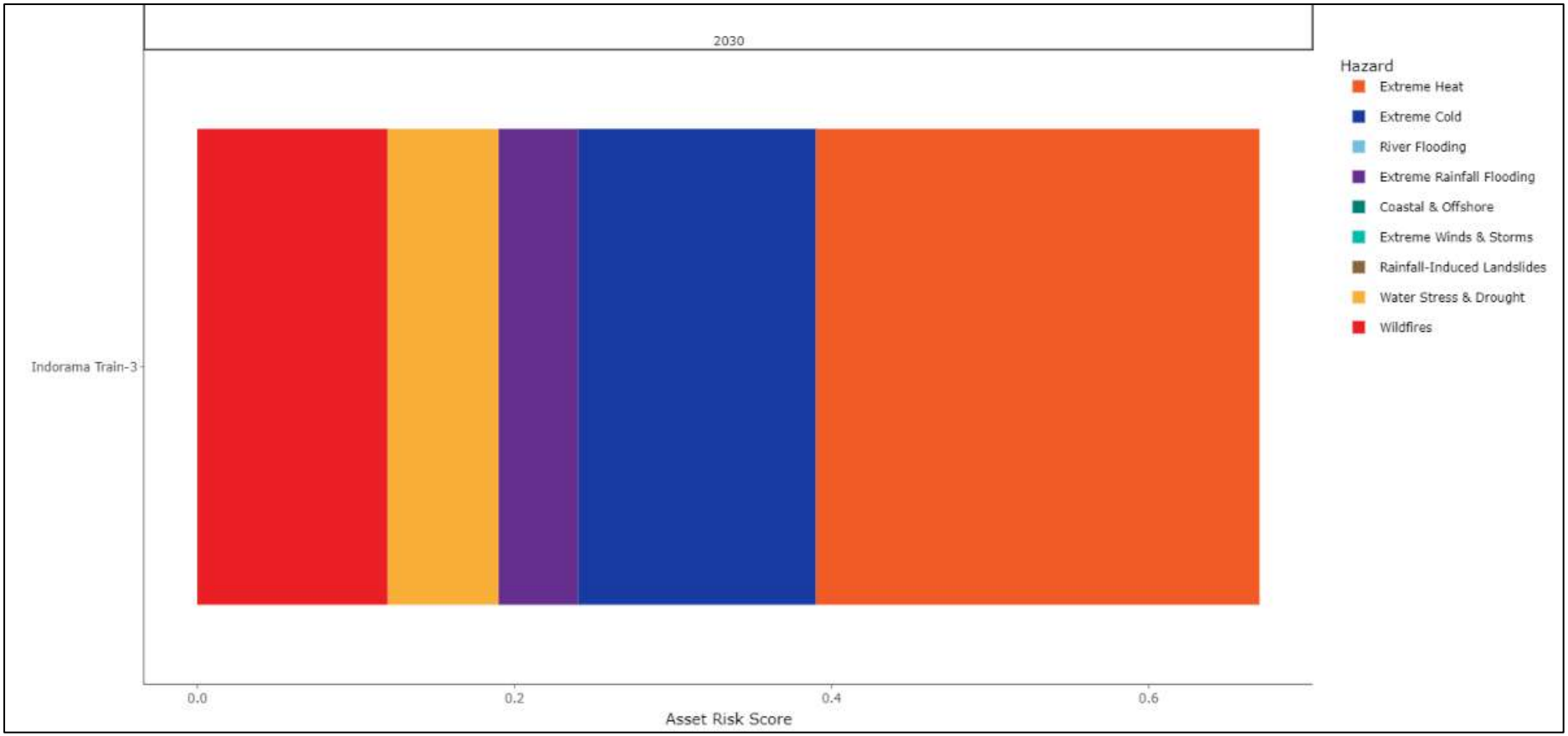


Figure 4.18: Projection Risk Score Composition: SSP1-2.6, 2030

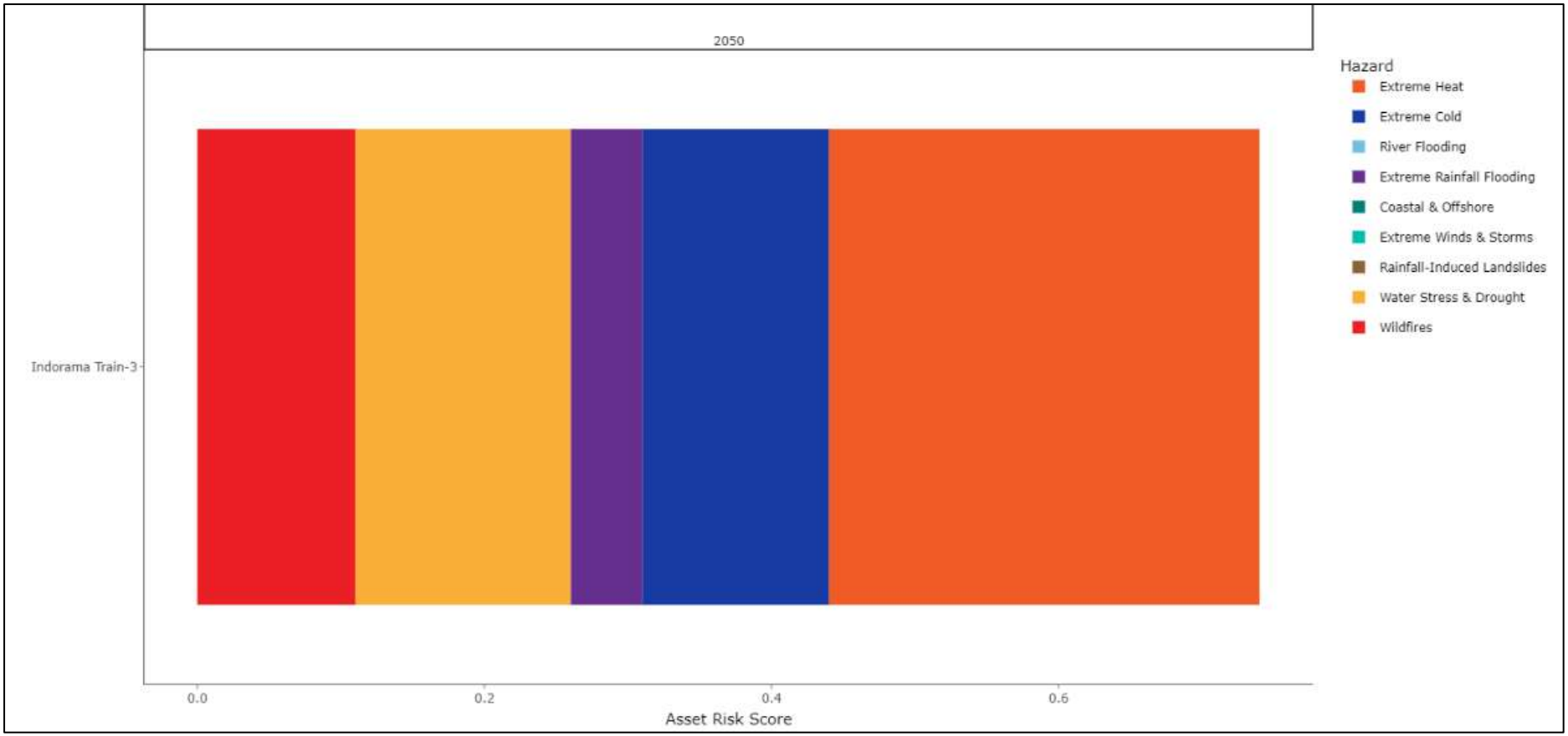


Figure 4.19: Projection Risk Score Composition: SSP1-2.6, 2050

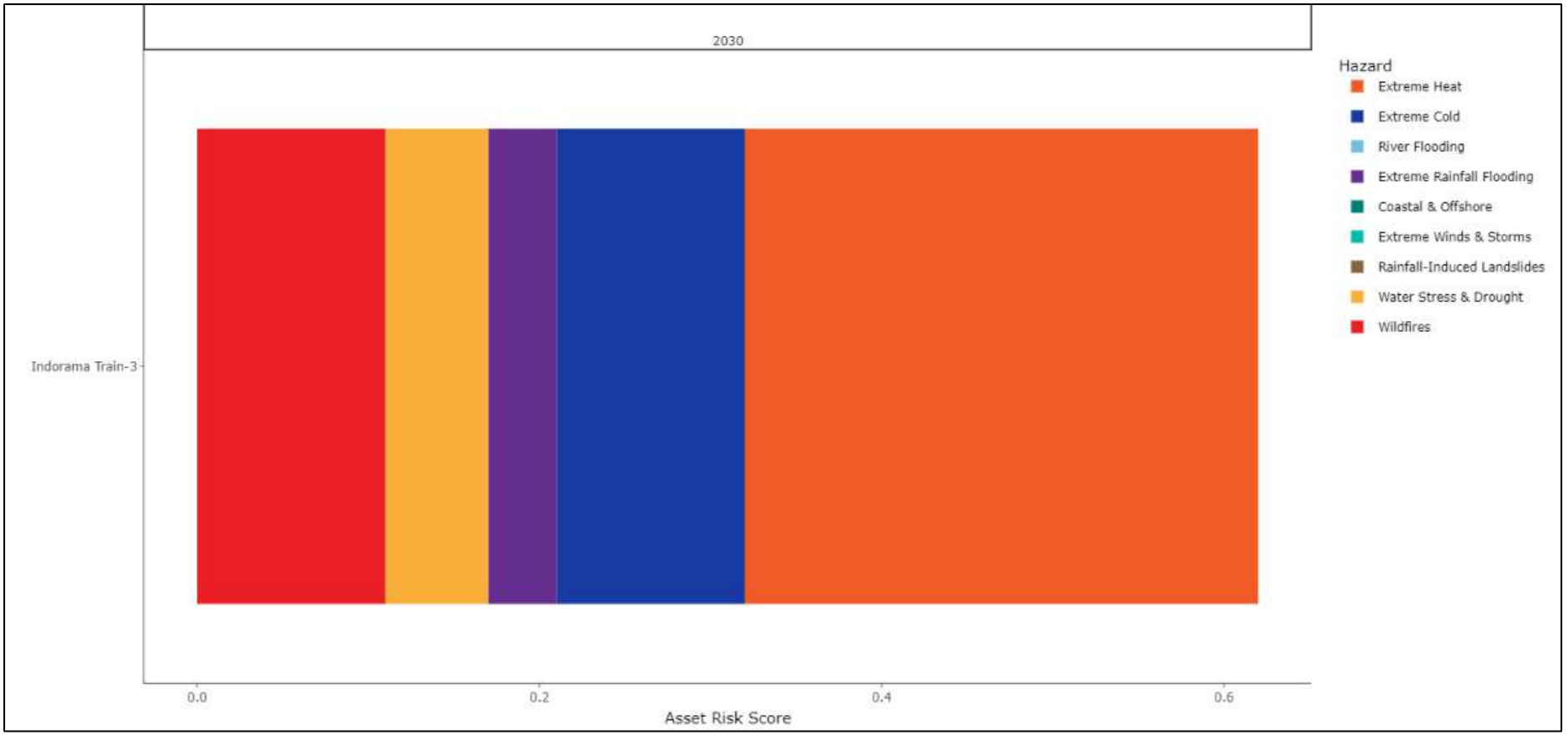


Figure 4.20: Projection Risk Score Composition: SSP5-8.5, 2030

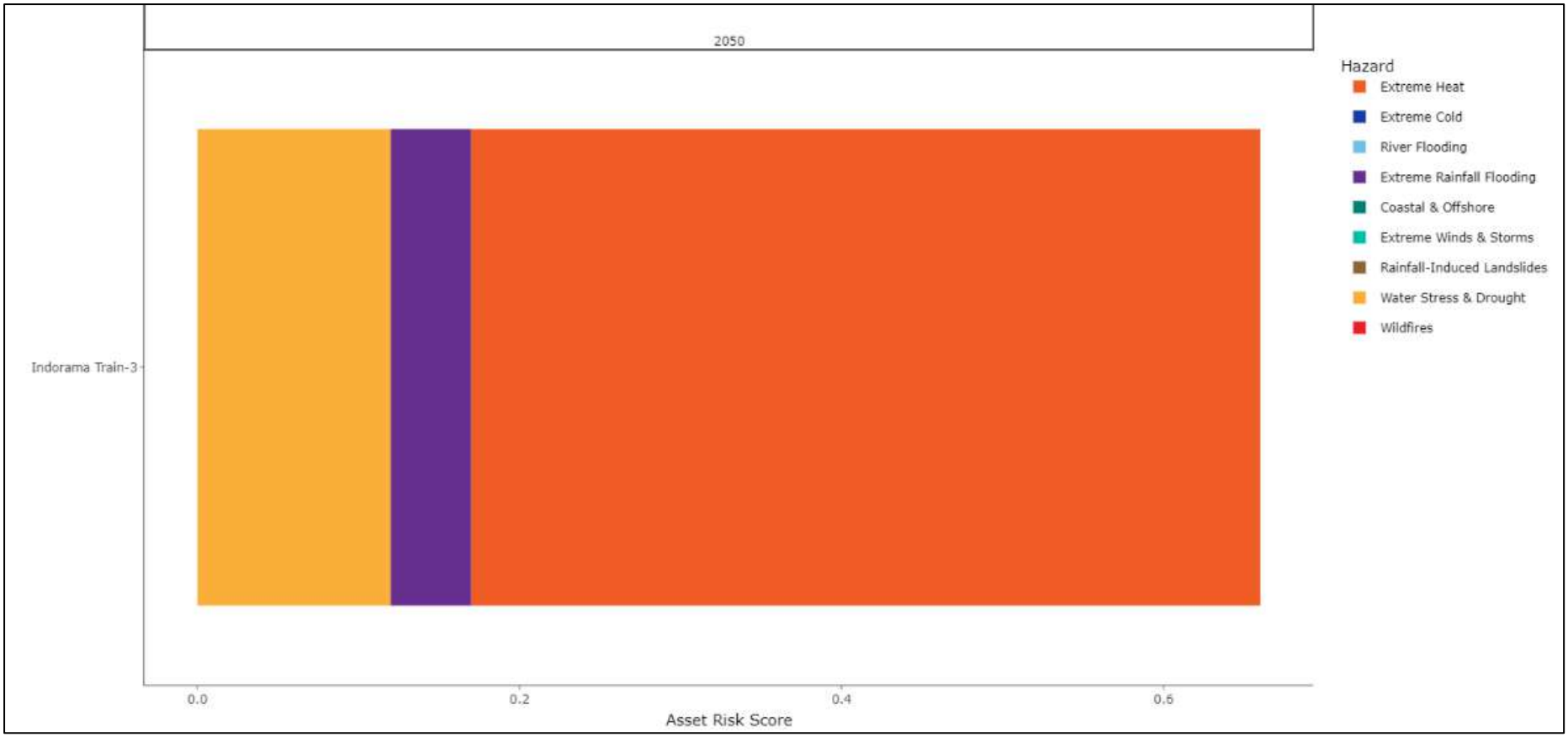


Figure 4.21: Projection Risk Score Composition: SSP5-8.5, 2050

4.4.3.4Summary of Key Climate Change Hazards Applicable to the Project

Table 4.5 presents a summary of the potentially material hazards for the Project. Material hazards include:

- Increased extreme heat;
- Increased water stress and drought; and
- Increase in both flooding and wildfire events.

Table 4.5: Summary of Prominent Hazards for Baseline and Projections

Asset: Indorama Pipeline	Period	
	Baseline	Projection
	Prominent Hazards	
SSP1-2.6 & SSP5-8.5		
SSP1-2.6 - 2030		I
SSP1-2.6 - 2050		I
SSP5-8.5 - 2030		I
SSP5-8.5 - 2050		I

Key:

Wildfires	Water Stress and Drought	Extreme Rainfall Flooding	Extreme Cold	Extreme Heat

I – Increase in Hazard for 2030 and 2050

Note – although wildfires and flooding events have been flagged as a potentially material hazard for the broader Project area it must be noted that the risk of wildfires is not material in that the actual Project site is situated in an area where year-round relative humidity is in excess of 70% and in an area that has a high annual rainfall (above 2,300 mm). Moreover, although portions of the broader Study Area will be susceptible to risks of flooding, the Project area is located at a higher elevation (approximately 10m) from the nearby waterbodies. As such, the risk associated with flooding of the Project area is not considered a material risk.

4.4.4 GHG Emission

The increasing concentration of greenhouse gases (GHGs) in the atmosphere has contributed to a gradual rise in the Earth's average surface temperature. Scientific observations and extensive research confirm that climate change is occurring globally, with human activities identified as the primary driver of the observed warming. These activities release heat-trapping gases into the atmosphere, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other GHGs, which trap heat and contribute to

changes in the global climate system. This assessment estimates the GHG emissions associated with the consumption of 248,000 litres of diesel during the 76 km natural gas pipeline construction from AGPC to the Indorama complex. It quantifies emissions from diesel combustion, primarily carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and expresses the combined emissions as carbon dioxide equivalent (CO_2e). The assessment supports environmental reporting, greenhouse gas inventory preparation and Environmental and Social Impact Assessment (ESIA) documentation. The calculation assumes that the stated diesel volume represents fuel consumed during the reporting period, rather than fuel purchased or stored.

The global standard for GHG reporting—known as the WRI/WBCSD GHG Protocol methodology—divides emissions into three 'Scopes' defined as follows:

- **Scope 1** – direct emissions from sources owned or under the operational control of the company.
- **Scope 2** – indirect emissions from the consumption of purchased electricity (and other energy); and
- **Scope 3** – indirect or supply chain emissions, both upstream and downstream, from the reporting entity (e.g., indirect emissions from purchased goods).

For the purposes of this ESIA, emission estimates for the future activities of the Project cover those activities that are under its direct operational control of the project developer. IFC PS3 states that *'the client will quantify direct emissions from the facilities owned or controlled within the physical project boundary, as well as indirect emissions associated with the off-site production of energy used by the project'* and therefore this study will focus upon Scope 1 and Scope 2 emissions only, during the operational phase of the Project.[7]

Scope and Methodology

The assessment uses a fuel-based calculation approach consistent with the general principles of the Intergovernmental Panel on Climate Change (IPCC) GHG inventory methodology (2006). The estimate covers emissions from fuel combustion. It does not include emissions associated with diesel extraction, refining, transportation or distribution, nor does it include other project emission sources.

$$\textbf{Carbon footprint emissions} = \textbf{Activity data x Emissions factor x Global warming potential}$$

Where:

Activity data (AD): relates to the emission-causing activity, e.g., the consumption of electricity or the on-site combustion of fossil fuels.

[7] IFC. Performance Standards on Environmental and Social Sustainability: Performance Standard 3 Resource Efficiency and Pollution Prevention. Page 2. January 1, 2012.

Emission factors (EFs): convert the activity data into estimates of GHG emissions (e.g., CO2 per litre of diesel fuel consumption); and

Global warming potentials (GWPs): convert different GHG emissions to a common metric: carbon dioxide equivalent (CO2e).

Emission Factor and Calculation

This assessment adopts a diesel combustion emission factor of 2.68 kg CO_2e per litre from the IPCC greenhouse gas reporting conversion factors. This factor provides a practical screening estimate but should be replaced by an applicable Nigeria-specific or project-required factor where available.

GHG Emissions during construction phase

Parameter	Value
Fuel type	Diesel
Total diesel consumed	248,000 litres
Emission factor	2.68 kg CO_2e/litre
Global warming potential	1
Total estimated GHG emissions	664,640 kg CO_2e
Total emissions in tonnes	664.64 tCO_2e
Emission scope	Scope 1 — direct combustion

The estimated direct greenhouse gas emissions from burning 248,000 litres of diesel are approximately 664.64 tonnes of CO_2 equivalent.

This estimate represents combined greenhouse gas emissions expressed as CO_2e; it does not separately quantify CO_2, CH_4, and N_2O. The precise contribution of each gas depends on the applicable emission factors and combustion equipment.

Based on the stated diesel consumption of 248,000 litres and the adopted emission factor of 2.68 kg CO_2e/litre, the estimated greenhouse gas emissions are 664.64 tCO_2e. These emissions are reported under Scope 1, where the diesel is combusted in equipment.

The project is a natural gas transporting pipeline and as such no GHG emission is expected during normal operation. GHG emission may occur during unforeseen events like vandalization or gas leakage.

4.4.5 Air Quality

4.4.5.1 Field Sampling

The ambient air quality monitoring survey was kick-off on 16th December 2023 and carried out at 40 locations (Table 4.6) including controls within the proposed project geographical zone. The concentration levels of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), Ozone (O3), hydrocarbons (CxHy), Volatile organic compounds (VOCs), ammonia (NH_3), Suspended particulate matter (SPM), particulate matter (PM_{10}), &

particulate matter ($PM_{2.5}$) were monitored and expressed in microgram per cubic meter ($\mu g/m^3$), which gives an understanding of the baseline existing environmental setting and condition of the project area. The noise levels were also measured alongside ambient air quality monitoring, which is presented in the separate report.

Table 4.6 below show the ambient air quality monitoring stations with respective GPS coordinates and location on the map is shown in Figure 4.22.

Table 4.6: Air Quality Monitoring Stations

S/No	Latitude	Longitude	S/No	Latitude	Longitude
1	4°50'31.70"	7° 5'55.98"	21	5° 5'41.31"	6°53'22.51"
2	4°51'32.24"	7° 5'31.93"	22	5° 6'40.68"	6°52'55.86"
3	4°52'32.72"	7° 5'7.88"	23	5° 7'39.63"	6°52'29.25"
4	4°53'33.19"	7° 4'43.82"	24	5° 8'39.04"	6°52'2.59"
5	4°54'33.60"	7° 4'19.83"	25	5° 9'38.11"	6°51'35.97"
6	4°55'34.17"	7° 3'55.70"	26	5°10'37.16"	6°51'9.48"
7	4°56'34.64"	7° 3'31.61"	27	5°11'36.33"	6°50'43.09"
8	4°57'35.01"	7° 3'7.61"	28	5°12'34.95"	6°50'16.95"
9	4°58'35.39"	7° 2'43.61"	29	5°13'33.86"	6°49'50.06"
10	4°59'35.76"	7° 2'19.68"	30	5°14'33.10"	6°49'23.27"
11	5° 0'37.17"	7° 1'55.15"	31	5°15'37.83"	6°48'54.18"
12	5° 1'26.48"	7° 1'12.91"	32	5°16'19.34"	6°48'3.78"
13	5° 2'15.80"	7° 0'30.30"	33	5°17'0.16"	6°47'13.74"
14	5° 2'52.55"	6°59'39.20"	34	5°17'55.31"	6°47'1.37"
15	5° 3'13.06"	6°58'37.66"	35	5°18'58.66"	6°47'16.14"
16	5° 3'33.50"	6°57'36.58"	36	5°20'1.43"	6°47'31.05"
17	5° 3'54.07"	6°56'35.17"	37	5°21'5.07"	6°47'45.92"
18	5° 4'14.51"	6°55'33.89"	38	5°22'14.06"	6°48'2.98"
19	5° 4'32.76"	6°54'29.37"	AQC1	4º48’ 57.37’’	7º 5’ 45.75’’
20	5° 4'42.00"	6°53'49.16"	AQC2	5º 26’ 40.0’’"	6º 54’ 30.0’’"

The digital AEROQUAL 500 series monitor with sensor heads were used to monitor and record the priority parameters of ambient air quality. The different and calibrated sensor heads were used for the specific gases and particulate matter monitored. The battery-operated monitor has on-board diagnostics, which will inform the user about the functionality of sensor head. The monitor can log up to 8188 data points. The data can be downloaded to a PC or can also be logged directly to a PC via a serial connection while displaying real time data on the monitor screen. The data logging interval can be set in one-minute increments from either the monitor or the PC. The suspended particulate matter was monitored using battery operated mini-volume sampler whereas PM10, PM2.5

and gases were monitored by using AEROQUAL 500 series monitors fixed with sensor heads. The details of sensors heads used are shown below in Table 4.7.

Table 4.7: Sensor details

Sensor	Sensor type	Range	Minimum detection limit	Accuracy	Resolution
Nitrogen dioxide (NO2)	GSE (Gas Sensitive Electrochemical)	0-1ppm	0.005ppm	<±0.02ppm 0-0.2ppm <±10% 0.2-1ppm	0.001ppm
Sulphur dioxide (SO2)	GSE (Gas Sensitive Electrochemical)	0-10ppm	0.04ppm	<±0.05ppm 0-0.5ppm <±10% 0.5-10 ppm	0.01ppm
Carbon Monoxide (CO)	GSE (Gas Sensitive Electrochemical)	0-25ppm	0.05ppm	<±0.5ppm 0-5ppm <±10% 5-25 ppm	0.01ppm
Ozone (O3)	GSE (Gas Sensitive Electrochemical)	0-10ppm	0.01ppm	<±0.01ppm + 7.5%	0.01ppm
Ammonia (NH3)	GSE (Gas Sensitive Electrochemical)	0-25ppm	0.05ppm	<±0.5ppm 0-5ppm <±10% 5-25 ppm	0.01ppm
Hydrocarbons (CxHy)	GSS (Gas Sensitive Semiconductor)	0-25ppm	0.1ppm	<±0.1ppm +10%	0.1ppm
Volatile organic compounds (VOCs)	PID (Photo Ionization Detector)	0-20ppm	0.01ppm	<±0.02ppm +10%	0.01ppm
Particulate Matter (PM2.5 & PM10)	LPC (Laser Particle Counter)	0.001-1000 mg/m3	0.001mg/m3	±0.005 mg/m3 +15%	0.001 mg/m3

The sampling period of ambient air quality within the project area and its environs was varied from minimum eight hours to twenty hours depending on sampling location and security of equipment & personnel. At each location the readings of all the parameters taken every hour. The monitoring period was carried out from day to day so that reading could be taken from early morning to late at night over the monitoring period. The series of monitors with specific sensors head are fixed in a stand about 2-3m above the ground level in open space and allowed to run for an hour to determine the values. After recording the values, the instrument was allowed to run for suitable period with recording values every hour.

4.4.5.2Air Quality Study Area

The assessment of the air quality of the proposed project environment is vital to establish baseline air quality and the parameters determined were mainly those of public and health concern. Forty (40) sampling stations including control staions were established for air

quality measurement as shown in figure 4.22 and the monitored values are represented on Table 4.8 compared with statutory limits, revealing compliance to these limits.

4.4.5.3Baseline Environment

The baseline environmental conditions vary across the Study Area considering the natural baseline, regional and local pollutant sources. Within the Study Area, the main sources of air pollution are:

- Nearby residential areas that include household heating fires, cooking.
- Agriculture- from slash and burning.
- Dust from nearby paved and unpaved roads.
- Urban Traffic.

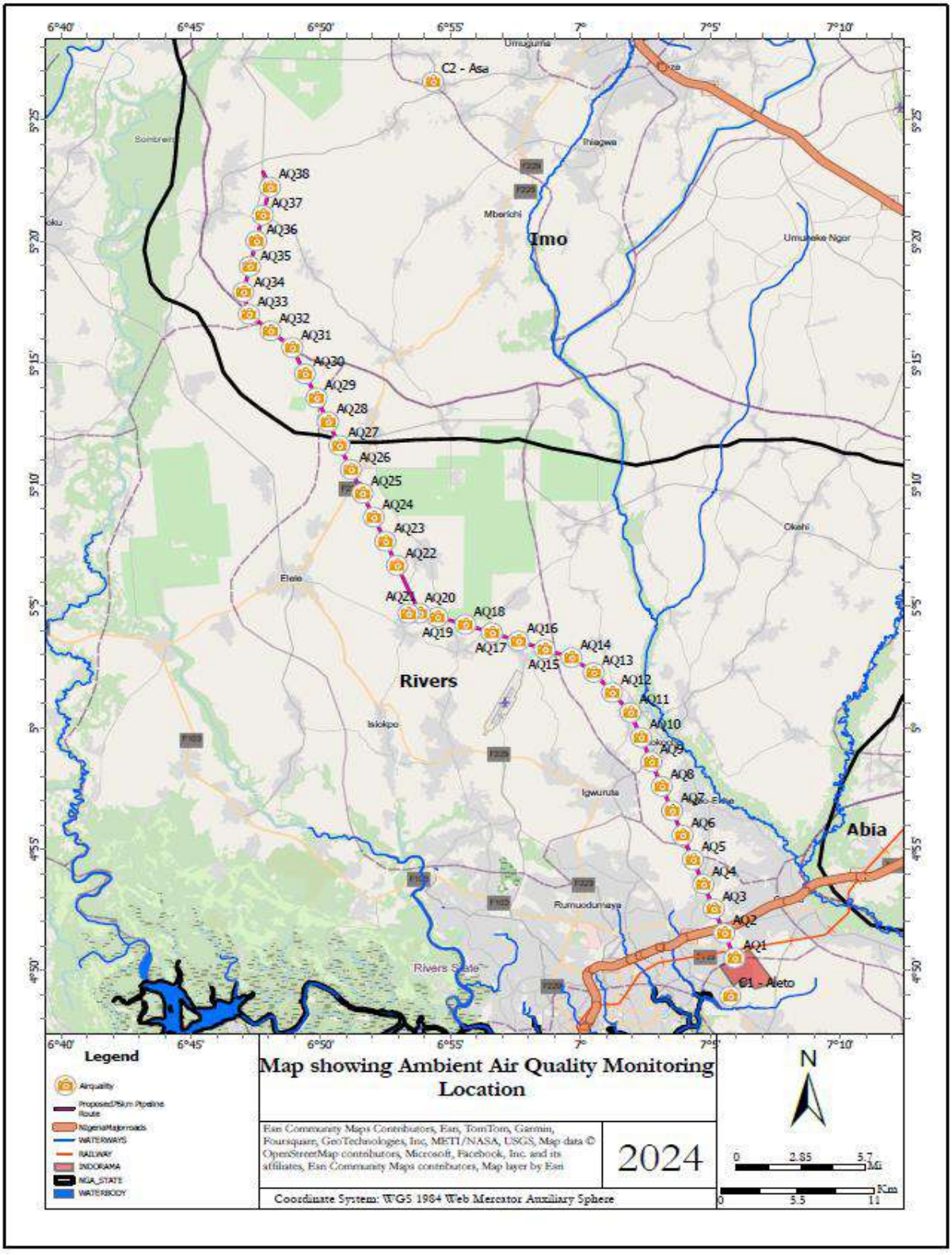


Figure 4.22: Map showing ambient air quality monitoring stations

4.4.6 Ambient Air Quality Monitoring Campaign

Records show that ground-level pollutant concentrations for SO2, NO2, CO, and O3 during the dry and wet seasons ranged between 2.18-6.98 µg/m3; 21.0-34.49 µg/m3; 3.05-7.82

µg/m3 and 8.83-18.98 µg/m3, as well as 1.31-9.60 µg/m3; 10.03-48.59 µg/m3; 3.24-23.28 µg/m3 and 7.52-49.73 µg/m3, respectively. Other pollutants, such as SPM, PM10, and PM2.5, for the respective seasons ranged between 75.67-144.50 µg/m3; 29.17-73.33 µg/m3 and 27.17-36.17 µg/m3, as well as 40.33-83.33 µg/m3; 13.67-49.17 µg/m3 and 7.50-31.50 µg/m3. Monitored CxHy, VOC and NH3 were below the detection limit (BDL). All results for the criteria pollutants were below the National and International acceptable limits. Values of sampled particulate matter at study locations were lower within vegetative areas and higher where human activities are prevalent. The range of particulate values depends on the time of day, season, intensity of human activities, and proximity to emission sources (Ede and Edokpa, 2015). Existing reports show that particulate matter concentrations range from 0-44 µg/m3, while other criteria pollutants were minimal.

Figures 4.23-4.28 show the contour trends of the air quality parameters' concentrations across the sampled stations for the dry season, while Figures 4.28a-4.28f shows that for the wet season. The monitored results for the dry and wet seasons are presented in Tables 4.8 and 4.8a respectively and the detailed monitoring values are appended as Annexure-4.1.

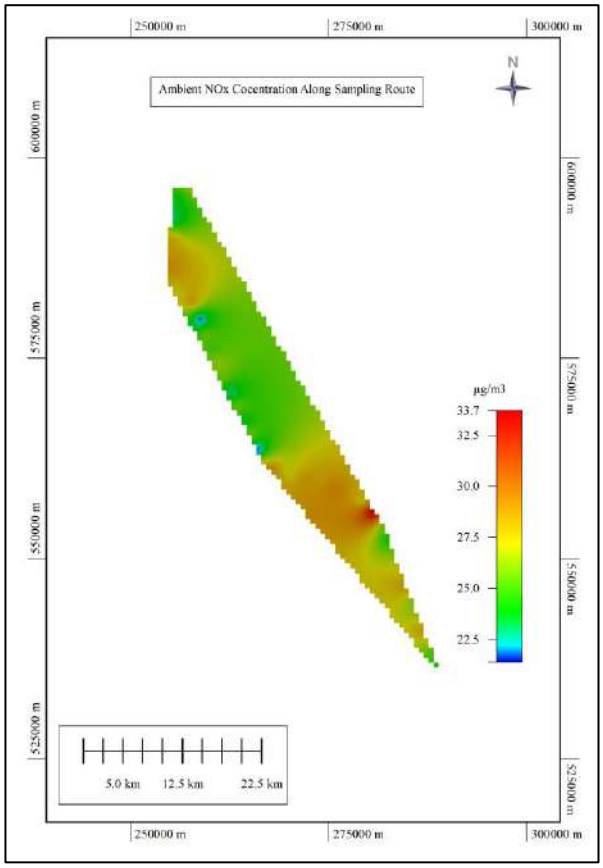


Figure 4.23: Contour Trend of NO_2 (Dry)

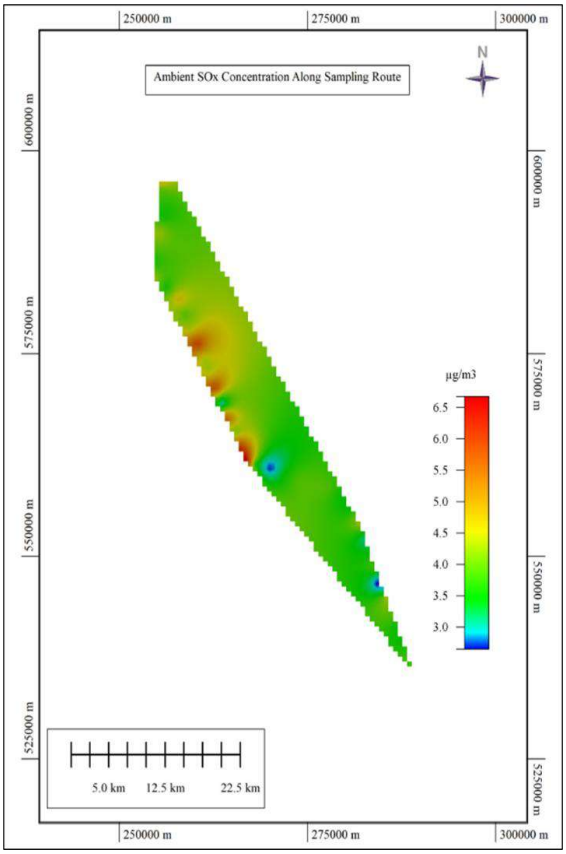


Figure 4.24: Contour Trend of SO_2 (Dry)

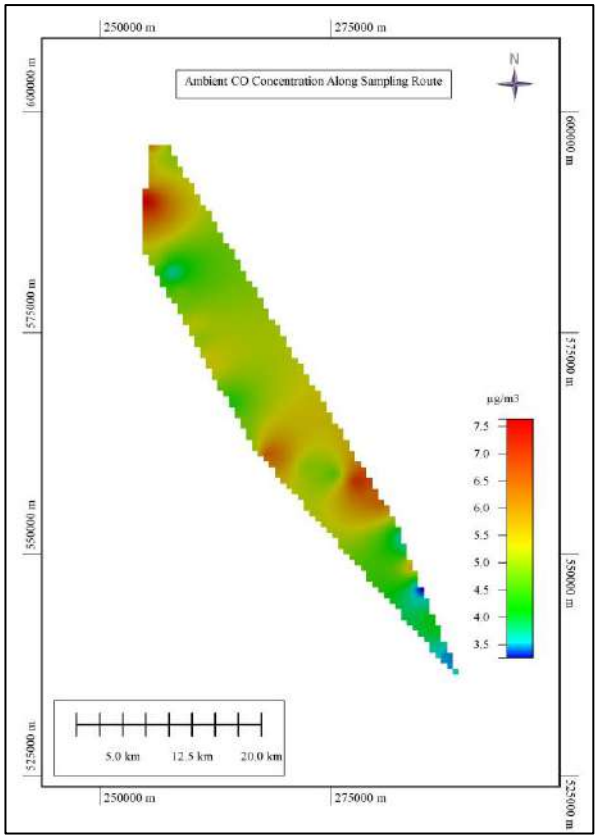


Figure 4.25: Contour Trend of CO (Dry)

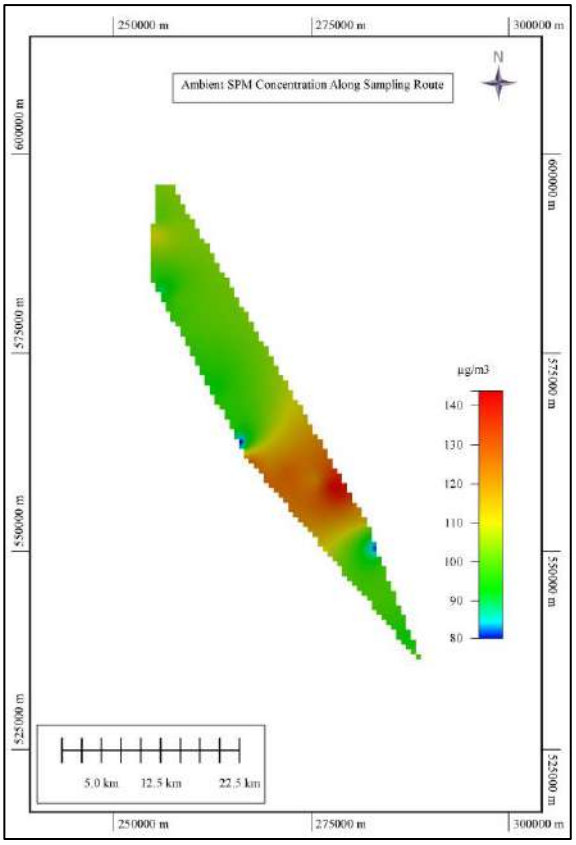


Figure 4.26: Contour Trend of SPM (Dry)

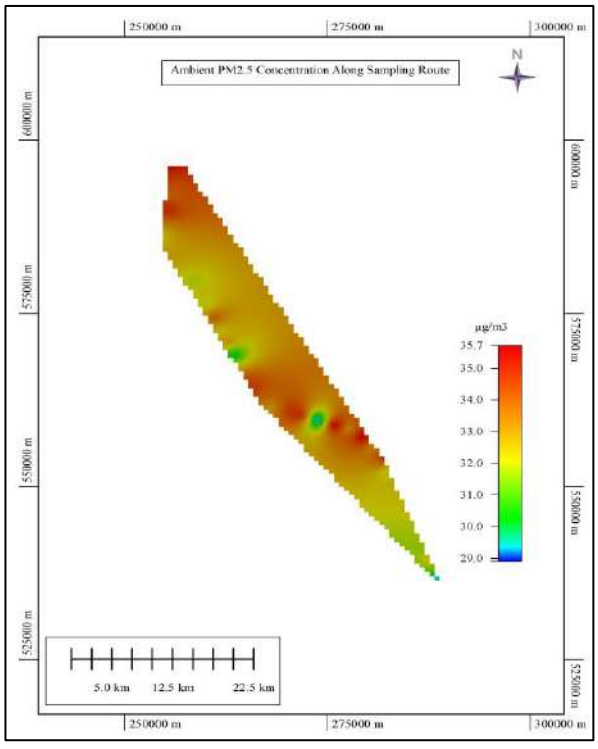


Figure 4.27: Contour Trend of $PM_{2.5}$ (Dry)

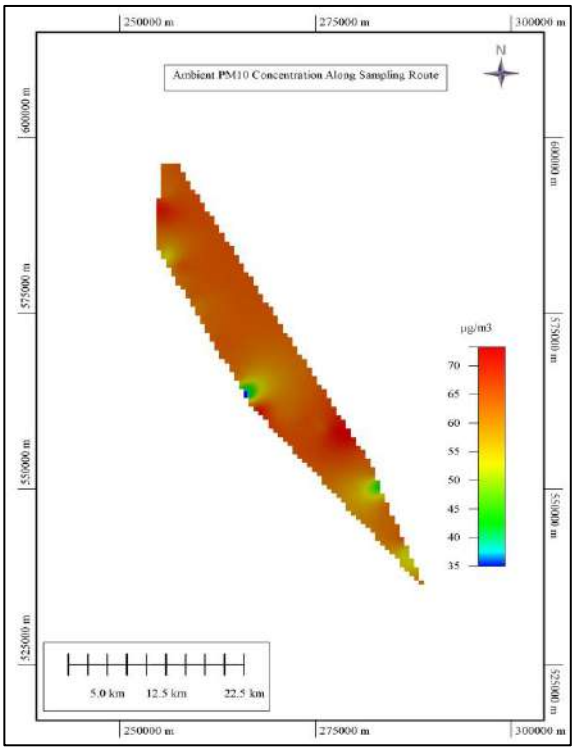


Figure 4.28: Contour Trend of PM_{10} (Dry)

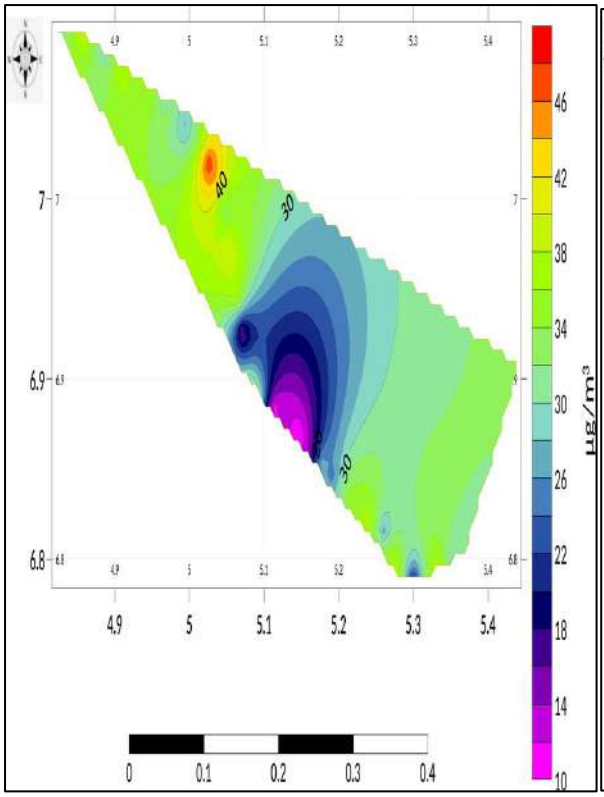


Figure 4.28a: Contour Trend for NO_2 (wet)

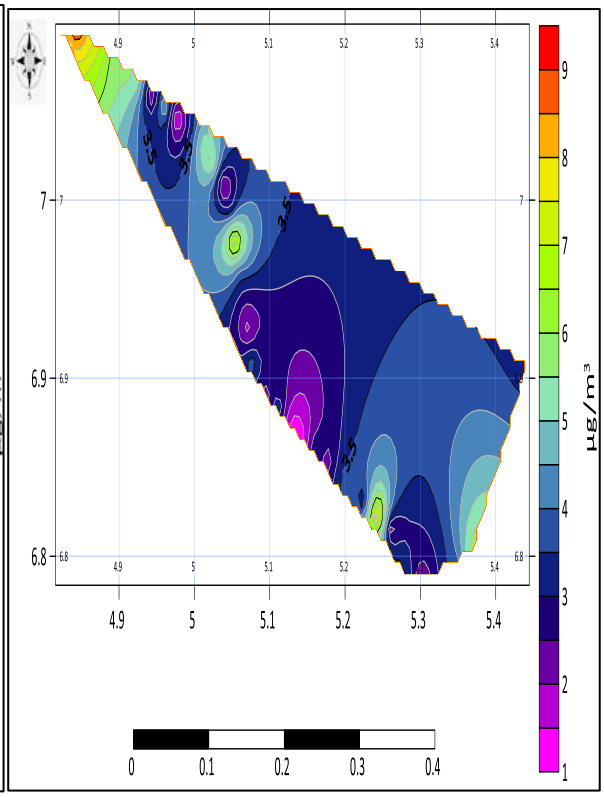


Figure 4.28b: Contour Trend for SO_2 (wet)

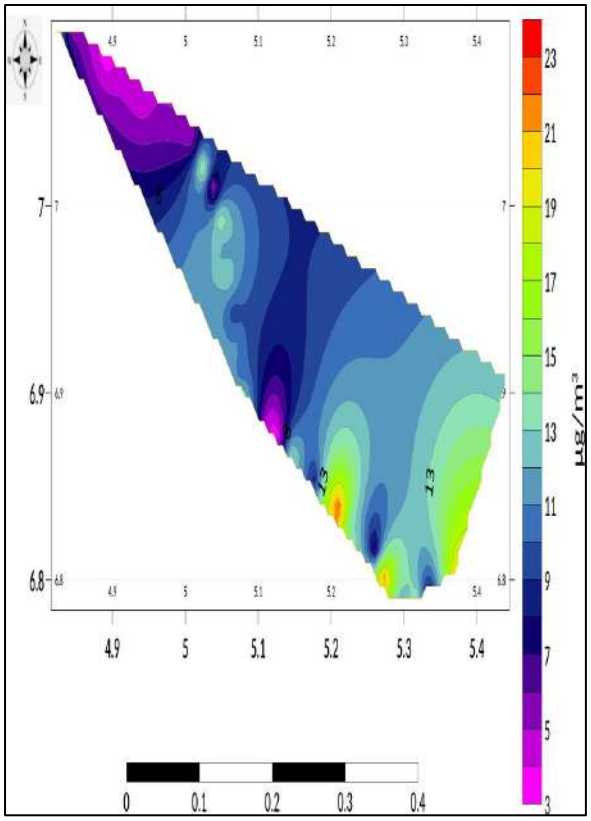


Figure 4.28c: Contour Trend for CO (wet)

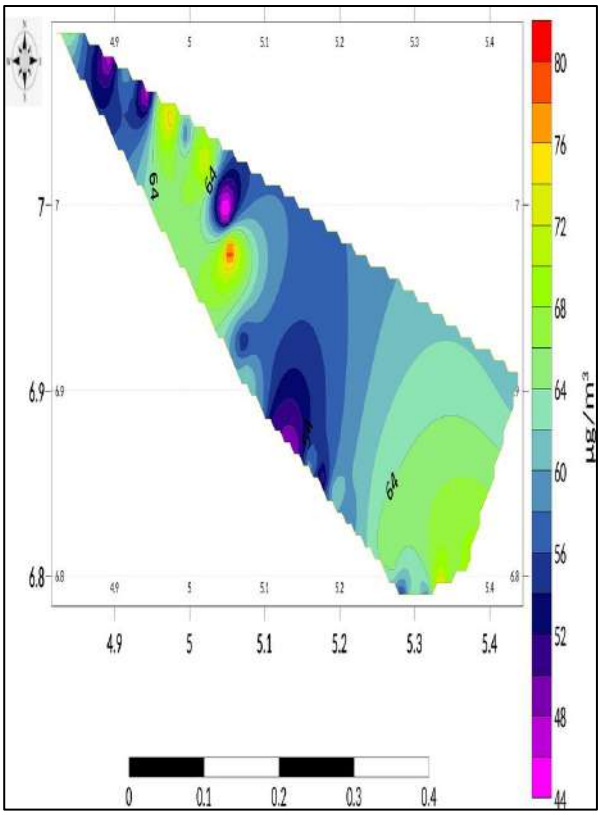


Figure 4.28d: Contour Trend for SPM (wet)

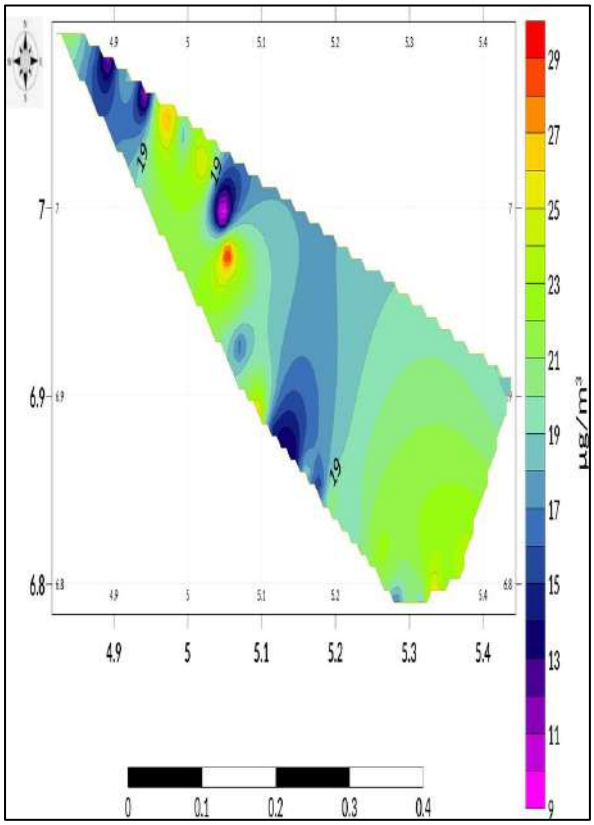


Figure 4.28e: Contour Trend for $PM_{2.5}$ (wet)

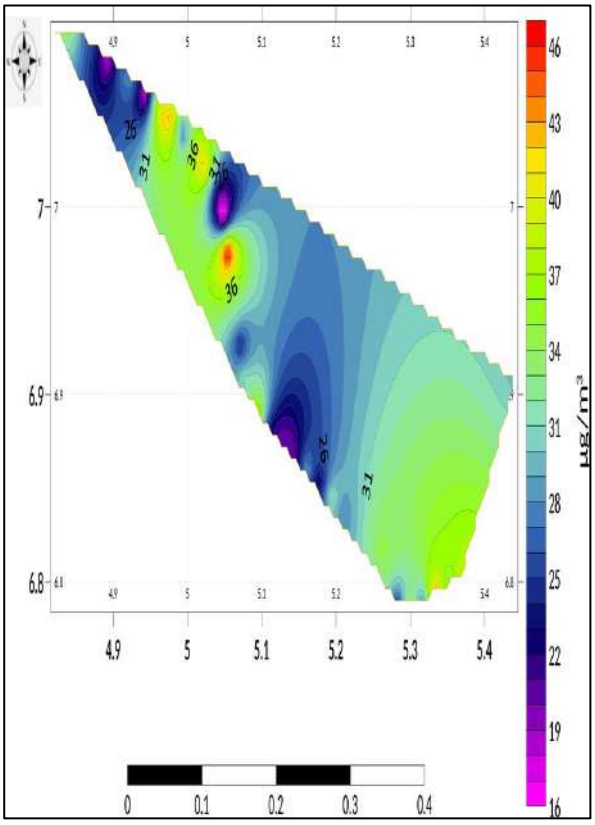


Figure 4.28f: Contour Trend for PM_{10} (wet)

Table 4.8: Air Quality Monitoring Results During the Dry Season

Station ID	SO2 µg/m³	NO2 µg/m³	CO µg/m³	O3 µg/m³	CXHY µg/m³	VOC µg/m³	NH3 µg/m³	SPM µg/m³	PM10 µg/m³	PM2.5 µg/m³	WIND SPD m/s	TEMP oC	REL HM %
AQ1	3.49	22.57	3.82	8.83	BDL	BDL	BDL	98.67	62.83	27.17	1.57	29.4	72.7
AQ2	3.93	24.77	3.44	9.16	BDL	BDL	BDL	99.00	60.83	30.33	1.58	28.8	75.0
AQ3	3.49	26.02	3.44	14.72	BDL	BDL	BDL	92.00	53.17	32.50	1.57	32.4	69.0
AQ4	3.49	28.84	4.01	18.98	BDL	BDL	BDL	95.67	50.67	31.50	1.52	30.4	72.0
AQ5	3.93	26.33	4.20	16.03	BDL	BDL	BDL	98.33	65.50	31.83	2.73	29.5	70.7
AQ6	4.36	26.02	3.63	13.74	BDL	BDL	BDL	99.00	62.50	31.83	1.78	30.0	69.9
AQ7	2.18	29.16	3.05	16.03	BDL	BDL	BDL	98.83	63.50	32.33	1.75	30.3	69.9
AQ8	3.93	27.27	6.11	12.11	BDL	BDL	BDL	98.67	61.50	32.17	1.30	29.7	70.1
AQ9	3.49	26.33	3.82	13.09	BDL	BDL	BDL	78.67	38.33	32.67	1.47	30.4	70.2
AQ10	3.05	23.83	3.63	11.78	BDL	BDL	BDL	94.50	62.67	31.67	1.40	31.0	70.6
AQ11	4.36	25.39	5.15	15.05	BDL	BDL	BDL	117.50	64.00	34.83	1.47	28.0	74.2
AQ12	3.49	34.49	6.49	14.07	BDL	BDL	BDL	123.67	66.67	33.00	1.55	29.0	74.3
AQ13	3.49	27.27	6.49	16.69	BDL	BDL	BDL	140.33	73.00	35.83	1.62	31.5	69.5
AQ14	3.93	28.84	7.25	14.72	BDL	BDL	BDL	144.50	73.33	32.83	1.65	28.8	74.1
AQ15	3.93	29.47	4.58	17.01	BDL	BDL	BDL	121.33	63.83	36.17	2.50	29.2	69.9
AQ16	3.93	28.53	4.96	13.74	BDL	BDL	BDL	125.67	66.50	28.17	1.60	29.6	69.7
AQ17	3.49	28.84	4.96	13.74	BDL	BDL	BDL	128.50	63.17	35.00	1.65	30.2	69.8
AQ18	2.62	26.65	6.11	16.69	BDL	BDL	BDL	121.67	63.00	34.67	1.38	30.1	70.1
AQ19	3.49	29.16	6.68	16.69	BDL	BDL	BDL	125.17	71.33	32.83	1.75	30.2	71.6
AQ20	6.98	28.53	4.96	14.72	BDL	BDL	BDL	128.67	67.50	33.50	1.35	31.4	69.9
AQ21	6.11	21.00	4.77	12.43	BDL	BDL	BDL	75.67	29.17	34.50	1.43	29.9	72.7
AQ22	3.93	26.02	4.77	13.09	BDL	BDL	BDL	96.17	60.00	34.50	1.53	28.6	73.6
AQ23	5.67	23.51	4.20	15.70	BDL	BDL	BDL	95.67	63.50	32.83	1.52	30.7	70.1
AQ24	2.62	25.71	4.77	13.74	BDL	BDL	BDL	96.67	63.83	29.83	1.62	30.7	71.7
AQ25	6.11	22.57	5.34	14.07	BDL	BDL	BDL	92.33	65.00	33.17	2.53	29.4	72.3

Station ID	SO2 µg/m³	NO2 µg/m³	CO µg/m³	O3 µg/m³	CXHY µg/m³	VOC µg/m³	NH3 µg/m³	SPM µg/m³	PM10 µg/m³	PM2.5 µg/m³	WIND SPD m/s	TEMP oC	REL HM %
AQ26	4.36	25.71	5.34	11.78	BDL	BDL	BDL	95.33	63.33	32.00	1.53	29.1	71.7
AQ27	4.36	26.33	4.96	16.03	BDL	BDL	BDL	96.67	63.50	34.17	1.87	30.3	69.7
AQ28	6.11	24.77	5.34	16.36	BDL	BDL	BDL	97.83	61.33	31.83	1.50	29.4	72.0
AQ29	4.36	25.71	4.77	12.43	BDL	BDL	BDL	99.83	64.67	32.33	1.27	30.1	70.4
AQ30	3.93	21.32	4.77	12.11	BDL	BDL	BDL	98.17	62.83	31.67	1.33	30.8	70.6
AQ31	4.80	28.84	3.44	14.07	BDL	BDL	BDL	99.50	65.83	32.50	1.57	28.5	75.0
AQ32	3.49	27.27	4.96	13.09	BDL	BDL	BDL	88.67	51.83	32.83	1.43	29.3	73.8
AQ33	4.36	27.90	5.15	17.34	BDL	BDL	BDL	98.00	61.17	32.83	1.68	30.8	71.9
AQ34	3.49	29.78	6.11	15.05	BDL	BDL	BDL	97.83	62.00	31.83	1.58	29.1	74.1
AQ35	3.93	28.53	6.68	18.32	BDL	BDL	BDL	105.33	67.83	33.50	3.05	30.0	68.9
AQ36	4.36	28.22	7.82	13.41	BDL	BDL	BDL	111.33	72.17	35.17	1.70	30.0	69.2
AQ37	3.49	23.20	5.73	16.69	BDL	BDL	BDL	99.83	62.00	33.83	1.55	29.9	69.3
AQ38	3.93	23.51	5.34	17.01	BDL	BDL	BDL	102.83	64.00	34.83	1.25	30.8	70.2
AQC1	4.36	26.33	4.96	13.74	BDL	BDL	BDL	104.50	65.33	35.17	1.65	30.8	70.9
AQC2	5.24	25.71	6.68	13.74	BDL	BDL	BDL	102.17	62.00	36.17	1.37	31.1	70.5
FMEnv[8]	26	75-113	10**	160	-	-	-	250	-	-	-	-	-
EGASPIN[9]	150	150	10**	-	-	-	-	90	-	-	-	-	-
NESREA[10]	120	120	5**	100	-	-	600	-	150	40	-	-	-
Applicable limit	20	75	5000	100	-	-	180	90	150	40	-	-	-
Source	IFC	FMEnv	NESREA	NESREA	-	-	EAE	NMDPRA	NMDPRA	NMDPRA	-	-	-

[8] FEPA Guideline and Standards for Environmental Pollution Control in Nigeria Table 3.4 Page 63
[9] DPR Environmental Guidelines and Standards For the Petroleum Industry In Nigeria Table III-3
[10] NESREA National Environmental (Air Quality control) Regulations 2021 Schedule XIII

**mg/m3
* Annual average value

Table 4.8a: Air Quality Monitoring Results During the Wet Season

Station ID	SO2 µg/m³	NO2 µg/m³	CO µg/m³	O3 µg/m³	CXHY µg/m³	VOC µg/m³	NH3 µg/m³	SPM µg/m³	PM10 µg/m³	PM2.5 µg/m³	WIND SPD m/s	TEMP oC	REL HM %
AQ1	9.60	33.23	4.39	9.82	BDL	BDL	BDL	67.33	35.83	22.67	1.75	28.6	81.5
AQ2	7.85	40.76	5.34	12.76	BDL	BDL	BDL	57.17	27.50	18.50	1.75	29.7	81.0
AQ3	6.98	31.04	4.39	30.10	BDL	BDL	BDL	53.83	24.67	16.50	1.72	30.8	76.5
AQ4	5.67	31.04	3.24	15.38	BDL	BDL	BDL	45.83	17.50	10.83	1.55	31.0	75.0
AQ5	5.67	38.87	4.58	23.23	BDL	BDL	BDL	59.00	27.00	18.17	1.82	29.9	77.1
AQ6	5.24	34.49	4.39	30.43	BDL	BDL	BDL	57.50	27.67	18.00	1.90	29.3	78.8
AQ7	1.75	36.68	4.01	40.24	BDL	BDL	BDL	44.50	16.17	9.50	1.82	29.2	79.3
AQ8	4.80	31.66	5.15	42.20	BDL	BDL	BDL	70.33	39.33	25.00	1.58	29.1	79.8
AQ9	1.31	32.29	5.34	40.57	BDL	BDL	BDL	76.33	43.50	27.83	1.68	29.1	80.0
AQ10	3.05	26.96	5.53	11.78	BDL	BDL	BDL	56.33	26.50	17.50	1.78	28.8	80.2
AQ11	5.24	33.54	5.53	15.05	BDL	BDL	BDL	69.17	37.83	23.83	1.92	28.8	80.4
AQ12	5.67	48.59	15.65	41.88	BDL	BDL	BDL	73.83	42.67	25.83	1.78	28.6	80.5
AQ13	1.75	42.95	4.20	44.17	BDL	BDL	BDL	52.50	23.17	15.33	1.97	28.5	81.0
AQ14	3.05	32.29	14.50	43.84	BDL	BDL	BDL	40.33	13.67	7.50	1.80	28.6	80.8
AQ15	7.42	39.19	11.45	48.42	BDL	BDL	BDL	83.33	49.17	31.50	2.27	28.5	81.3
AQ16	3.93	38.56	12.98	44.49	BDL	BDL	BDL	68.67	37.33	22.67	1.85	28.5	81.7
AQ17	2.62	36.37	9.16	38.61	BDL	BDL	BDL	62.50	31.67	21.17	1.95	28.4	82.0
AQ18	1.75	14.42	11.26	39.59	BDL	BDL	BDL	53.00	23.83	16.00	1.77	28.2	82.3
AQ19	3.93	25.71	10.31	27.15	BDL	BDL	BDL	63.00	31.67	20.50	1.93	28.2	82.7
AQ20	3.05	34.17	13.74	31.41	BDL	BDL	BDL	60.50	29.50	20.00	1.98	28.1	83.0
AQ21	2.18	30.41	9.73	25.19	BDL	BDL	BDL	59.33	39.00	28.00	2.05	27.9	83.8
AQ22	3.49	10.35	4.01	15.70	BDL	BDL	BDL	51.17	22.33	14.83	1.45	27.6	84.8

Station ID	SO2 µg/m³	NO2 µg/m³	CO µg/m³	O3 µg/m³	CXHY µg/m³	VOC µg/m³	NH3 µg/m³	SPM µg/m³	PM10 µg/m³	PM2.5 µg/m³	WIND SPD m/s	TEMP oC	REL HM %
AQ23	1.31	13.79	3.44	7.52	BDL	BDL	BDL	49.50	20.17	13.33	0.93	27.3	86.3
AQ24	1.31	10.03	13.55	21.27	BDL	BDL	BDL	48.67	20.00	12.83	1.15	28.1	83.2
AQ25	3.05	14.11	11.45	28.79	BDL	BDL	BDL	60.17	29.17	19.33	1.52	28.7	80.3
AQ26	2.18	27.27	8.02	38.93	BDL	BDL	BDL	50.17	21.17	14.50	1.43	29.1	79.2
AQ27	3.49	24.77	16.41	45.15	BDL	BDL	BDL	62.67	32.00	21.00	1.72	29.5	76.0
AQ28	3.93	34.17	23.28	47.77	BDL	BDL	BDL	58.50	27.67	19.17	1.53	29.7	74.9
AQ29	3.05	34.80	13.74	41.22	BDL	BDL	BDL	60.33	29.67	19.17	1.45	29.7	75.1
AQ30	8.29	37.31	11.83	46.13	BDL	BDL	BDL	63.00	32.17	20.83	1.88	30.0	73.7
AQ31	2.18	26.65	6.49	41.22	BDL	BDL	BDL	65.50	34.33	22.50	1.58	30.4	72.7
AQ32	3.49	37.62	22.90	35.33	BDL	BDL	BDL	64.00	32.83	21.17	1.67	30.6	72.0
AQ33	3.49	36.68	14.69	49.73	BDL	BDL	BDL	52.17	23.17	15.17	1.68	30.8	71.4
AQ34	1.75	12.54	9.54	29.45	BDL	BDL	BDL	68.67	37.67	22.83	1.58	29.7	74.6
AQ35	2.62	33.23	15.08	38.61	BDL	BDL	BDL	56.00	26.17	17.50	2.38	30.5	72.1
AQ36	3.49	39.19	6.49	29.12	BDL	BDL	BDL	77.83	45.00	28.00	1.95	29.5	76.0
AQ37	3.93	28.53	13.55	37.95	BDL	BDL	BDL	63.67	32.83	20.67	1.72	28.6	80.5
AQ38	6.11	31.35	20.61	37.95	BDL	BDL	BDL	70.17	39.17	24.33	1.32	28.2	82.3
AQC1	5.67	29.47	15.84	40.57	BDL	BDL	BDL	59.17	29.17	18.17	2.15	27.6	85.3
AQC2	3.05	32.29	12.02	29.77	BDL	BDL	BDL	60.00	29.33	18.33	1.07	27.3	86.4
FMEnv[11]	26	75-113	10**	160	-	-	-	250	-	-	-	-	-
EGASPIN[12]	150	150	10**	-	-	-	-	90	-	-	-	-	-
NESREA[13]	120	120	5**	100	-	-	600	-	150	40	-	-	-

[11] FEPA Guideline and Standards for Environmental Pollution Control in Nigeria Table 3.4 Page 63
[12] DPR Environmental Guidelines and Standards For the Petroleum Industry In Nigeria Table III-3
[13] NESREA National Environmental (Air Quality control) Regulations 2021 Schedule XIII

Station ID	SO2 µg/m³	NO2 µg/m³	CO µg/m³	O3 µg/m³	CXHY µg/m³	VOC µg/m³	NH3 µg/m³	SPM µg/m³	PM10 µg/m³	PM2.5 µg/m³	WIND SPD m/s	TEMP oC	REL HM %
Applicable limit	20	75	5000	100	-	-	180	90	150	40	-	-	-
Source	IFC	FMEnv	NESREA	NESREA	-	-	EAE	NMDPRA	NMDPRA	NMDPRA	-	-	-

**mg/m3
* Annual average value

4.4.7 Noise

4.4.7.1Introduction

Ambient noise increased levels contribute to environmental deprivation and pose a risk to human and terrestrial lives. In most urban areas, high noise levels either are from community activities or industrial activities. Noise pollution is ranks third as the most hazardous form of nuisance followed by air and water contamination (Ibekwe *et la*. 2016). Sources of high noise levels include road traffic, anthropogenic activities in communities, air traffic, construction activities, industrial activities, marketplaces etc. Noise has adverse impact on the physical, social, and emotional wellbeing of humans and can lead to either temporary or permanent hearing loss. Other impact that could results from extreme noise values are acoustic trauma, tympanic membrane perforations and ossicular chain disarticulations (Ibekwe *et la*. 2016). Hearing loss could be as a result of sustained exposure to noise beyond the physiological recovery and reversible point of hearing apparatus beyond the temporary threshold point. This report resents the baseline noise study of the proposed project environment.

4.4.7.2Noise Monitoring Locations and Measurement

The noise-level monitoring survey was kicked off on 16th December 2023 for the dry season and in August 2026 for the wet season, and was carried out at twenty-forty (40) locations within the proposed project environment, alongside air quality monitoring. The noise monitoring and ambient air quality monitoring locations were the same, as shown in Table 4.6 and are shown in Figure 4.22 above.

Noise levels were measured using the CYGNET Integrating Datalogging Sound Level Metre 2001 across the study environment. This datalogging Sound Level Meter is Type 1 accuracy (Precision grade) instrument conforming to IS 9779:1981 and Class 1 IEC 61672:2013 with built-in smart integrating algorithms. The equipment has a measuring range of 34-134 dB in three scales, each with a dynamic range of 50 dB. The scales are 34-84 dB, 54-104 dB, 84-134. It also measures noise with A, C and Lin weightings. A slow, fast, and impulse time response is provided on the equipment, it can store up to 128K readings in its memory and the time interval between readings may be set between 0.025 seconds and 9999 seconds. It was calibrated with a digital Multi- Range Sound Acoustic Calibrator. The instrument measure noise levels via a microphone probe that generates signals appropriately proportional to sound waves. The sensor of the noise meter was directed up wards and the reading taken over a period of one hour during daytime and five-minute interval during night periods for one hour. The noise levels were measured with accuracy of ±1.0 dB and resolution 0.1 dB. The instrument was placed approximately 2-3 m above the ground level in open terrain and no closer than 3 m to any reflecting surface.

4.4.7.3Noise Monitoring Results

Tables 4.9 and 4.9a show the ambient monitoring noise values across the entire proposed pipeline route for the study environment, while Figure 4.29 shows the contour display for the monitored existing pipeline route.

Ambient noise levels in the monitored environment during the field survey for the dry and wet seasons ranged from 50.3 dB(A) to 63.2 dB(A) and from 49.1 dB(A) to 67.1 dB(A), respectively. Details of the noise level measurements captured during fieldwork are provided in Tables 4.9 and 4.9a. It is shown that, for the dry and wet seasons, about 90% and 72.5% of noise observations for the sample environment fell within 50-53 dB(A) for the period of monitoring, respectively, while 10% and 7.5% of overall observations were 55 dB(A) and above. The ambient noise levels with the following variables Lmin, Lmax, Lav, L1, L10, L50 and L90 across the study environment were: 50.3 dB(A), 63.2 dB(A), 52.6 dB(A), 50.3 dB(A), 50.9 dB(A), 52.0 dB(A) and 55.5 dB(A), respectively. Higher noise levels were recorded during daytime hours due to anthropogenic activities, and vice versa. Generally, ambient noise levels for the project environment did not exceed the IFC standards of 70 dB(A) for the entire monitored periods.

According to Berglund et al. (1999), exposure to high levels of noise results in hearing impairment, and this causes vibration inside the ear that could lead to permanent damage. Also, insomnia and tiredness can result from high noise exposure. Noise affects wildlife in a variety of ways. High levels can cause the temporary and permanent displacement of animals and birds from particular environments. It can also have physiological effects that are detrimental to wildlife health. Figures 4.29 and 4.29a show ambient noise trends for the proposed pipeline in the project environment for the dry and wet seasons, respectively.

Table 4.9: Dry Season Ambient Noise Pattern across Residential Receptors for Day Time

Station ID	NOISE (dB)	WIND SPD m/s	TEMP °C	REL HM %
AQ1	62.9	1.57	29.4	72.7
AQ2	63.2	1.58	28.8	75.0
AQ3	50.9	1.57	32.4	69.0
AQ4	51.1	1.52	30.4	72.0
AQ5	51.3	2.73	29.5	70.7
AQ6	52.4	1.78	30.0	69.9
AQ7	51.9	1.75	30.3	69.9
AQ8	52.3	1.30	29.7	70.1
AQ9	53.9	1.47	30.4	70.2
AQ10	50.4	1.40	31.0	70.6
AQ11	52.2	1.47	28.0	74.2
AQ12	51.2	1.55	29.0	74.3
AQ13	51.0	1.62	31.5	69.5

Station ID	NOISE (dB)	WIND SPD m/s	TEMP °C	REL HM %
AQ14	51.4	1.65	28.8	74.1
AQ15	51.2	2.50	29.2	69.9
AQ16	51.6	1.60	29.6	69.7
AQ17	52.0	1.65	30.2	69.8
AQ18	52.7	1.38	30.1	70.1
AQ19	51.5	1.75	30.2	71.6
AQ20	51.4	1.35	31.4	69.9
AQ21	53.0	1.43	29.9	72.7
AQ22	51.7	1.53	28.6	73.6
AQ23	50.3	1.52	30.7	70.1
AQ24	51.4	1.62	30.7	71.7
AQ25	50.6	2.53	29.4	72.3
AQ26	52.0	1.53	29.1	71.7
AQ27	53.0	1.87	30.3	69.7
AQ28	55.3	1.50	29.4	72.0
AQ29	50.7	1.27	30.1	70.4
AQ30	50.3	1.33	30.8	70.6
AQ31	51.1	1.57	28.5	75.0
AQ32	52.2	1.43	29.3	73.8
AQ33	51.6	1.68	30.8	71.9
AQ34	52.1	1.58	29.1	74.1
AQ35	56.4	3.05	30.0	68.9
AQ36	52.8	1.70	30.0	69.2
AQ37	52.8	1.55	29.9	69.3
AQ38	52.6	1.25	30.8	70.2
AQC1	53.6	1.65	30.8	70.9
AQC2	52.9	1.37	31.1	70.5
FMEnv[14]	90	-	-	-
EGASPIN[15]	90	-	-	-
NESREA[16]	85	-	-	-
Applicable limit	75/55	-	-	-
Source	IFC	-	-	-

Note: IFC Noise limits 70 dB(A) for Commercial locations and 55dB(A) for day & 45dB(A) for night for residential locations

[14] FEPA Guideline and Standards for Environmental Pollution Control in Nigeria Table 3.4 Page 63
[15] DPR Environmental Guidelines and Standards For the Petroleum Industry In Nigeria Table III-3
[16] NESREA National Environmental (Air Quality control) Regulations 2021 Schedule XIII

Table 4.9a: Wet Season Ambient Noise Pattern across Residential Receptors for Day Time

Station ID	NOISE (dB)	WIND SPD m/s	TEMP °C	REL HM %
AQ1	63.4	1.75	28.6	81.5
AQ2	67.1	1.75	29.7	81.0
AQ3	49.9	1.72	30.8	76.5
AQ4	49.1	1.55	31.0	75.0
AQ5	50.5	1.82	29.9	77.1
AQ6	53.5	1.90	29.3	78.8
AQ7	50.3	1.82	29.2	79.3
AQ8	53.6	1.58	29.1	79.8
AQ9	55.8	1.68	29.1	80.0
AQ10	50.5	1.78	28.8	80.2
AQ11	53.7	1.92	28.8	80.4
AQ12	52.9	1.78	28.6	80.5
AQ13	51.0	1.97	28.5	81.0
AQ14	53.5	1.80	28.6	80.8
AQ15	52.8	2.27	28.5	81.3
AQ16	51.7	1.85	28.5	81.7
AQ17	51.0	1.95	28.4	82.0
AQ18	51.4	1.77	28.2	82.3
AQ19	50.3	1.93	28.2	82.7
AQ20	51.8	1.98	28.1	83.0
AQ21	52.4	2.05	27.9	83.8
AQ22	50.3	1.45	27.6	84.8
AQ23	49.3	0.93	27.3	86.3
AQ24	50.8	1.15	28.1	83.2
AQ25	49.8	1.52	28.7	80.3
AQ26	51.7	1.43	29.1	79.2
AQ27	52.5	1.72	29.5	76.0
AQ28	52.3	1.53	29.7	74.9
AQ29	50.7	1.45	29.7	75.1
AQ30	49.9	1.88	30.0	73.7
AQ31	50.0	1.58	30.4	72.7
AQ32	51.2	1.67	30.6	72.0
AQ33	50.7	1.68	30.8	71.4
AQ34	50.9	1.58	29.7	74.6
AQ35	54.6	2.38	30.5	72.1
AQ36	54.1	1.95	29.5	76.0
AQ37	53.9	1.72	28.6	80.5
AQ38	52.2	1.32	28.2	82.3
AQC1	53.0	2.15	27.6	85.3
AQC2	54.0	1.07	27.3	86.4

Station ID	NOISE (dB)	WIND SPD m/s	TEMP °C	REL HM %
FMEnv[17]	90	-	-	-
EGASPIN[18]	90	-	-	-
NESREA[19]	85	-	-	-
Applicable limit	75/55	-	-	-
Source	IFC	-	-	-

Note: IFC Noise limits 70 dB(A) for Commercial locations and 55dB(A) for day & 45dB(A) for night for residential locations

[17] FEPA Guideline and Standards for Environmental Pollution Control in Nigeria Table 3.4 Page 63
[18] DPR Environmental Guidelines and Standards For the Petroleum Industry In Nigeria Table III-3
[19] NESREA National Environmental (Air Quality control) Regulations 2021 Schedule XIII

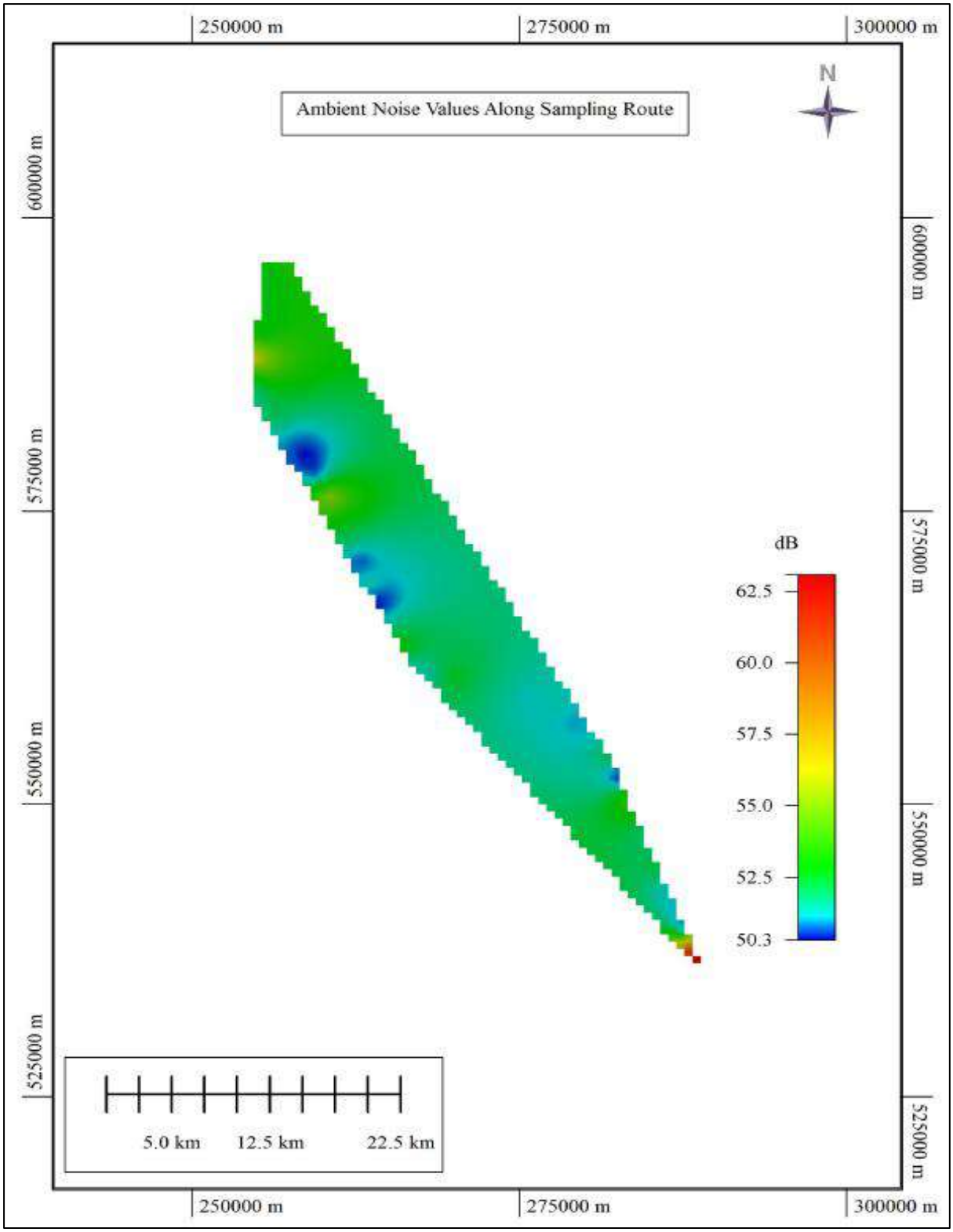


Figure 4.29: Contour Trend of Noise Values within Study Environment (Dry)

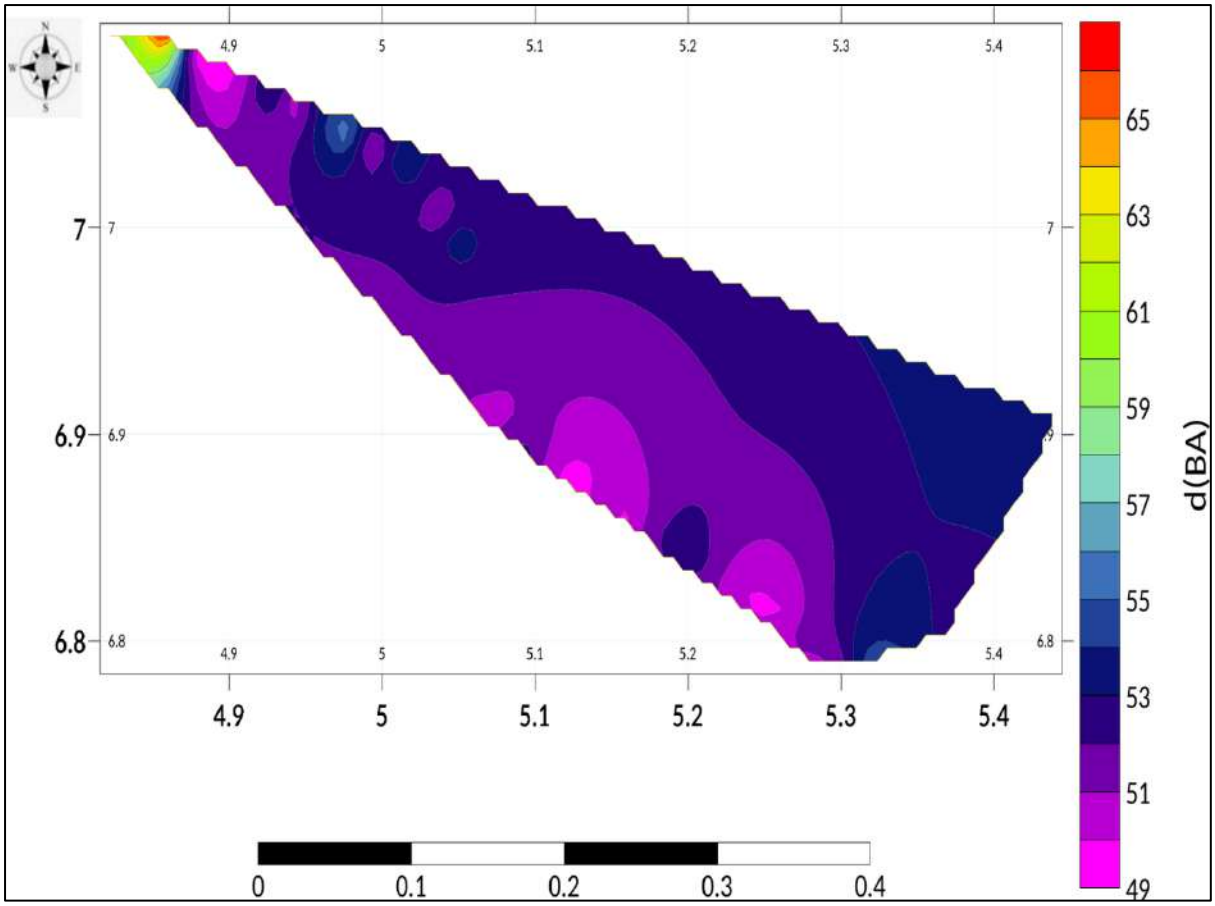


Figure 4.29a: Contour Trend of Noise Values within Study Environment (Wet)

4.4.8 Geology

This Section presents the regional and local geological setting for the Project Area.

4.4.8.1 Regional Geology

Regionally, the Project Area is situated within the greater Niger Delta. The formation of the present-day Niger Delta started in the early Palaeocene era and resulted in the build-up of fine-grained sediments eroded and transported by River Niger and its tributaries. A regional geological map of the Niger Delta is shown in Figure 4.30 with a description of the various lithological units discussed below.

The subsurface geology of the Niger Delta consists of three lithostratigraphic units (Akata, Agbada and Benin Formations), which are in turn overlain by various types of quaternary deposits. The Benin Formation, which is the continental mega-facies of the tertiary Niger Delta, comprises about 6,000 m thick successions of unconsolidated sands with thin clay and lignite interbeds. The Benin formation grade very gently downwards into the paralic delta front mega-facies, represented by the Agbada Formation. The unit consists of an interbedded sequence of sands and shales about 3,150 m thick on the average. All the hydrocarbon reserves of the Niger Delta accumulate in the sands of the Tertiary Niger

Delta. Consequently, it is dominated by shales of more than 1,380 m thick. Sands constitute the major aquiferous layer in the Niger Delta and is dominated by sands, and gravelly sands.

The overlying Quaternary deposits (40-150 m thick) generally consist of rapidly alternating sequences of sand and silt/clay with the latter becoming increasingly more prominent seawards. The Quaternary (neogene) and Tertiary stratigraphy of parts of the Niger Delta is shown in Table 4.10.

Geomorphologically, the Niger Delta can be subdivided into three major inter-gradational units from land to sea (north to south), these are:

- Dry deltaic plain with rare freshwater swamps.
- Extensive freshwater swamps and meander belts; and
- Saltwater mangrove swamps, estuaries, creeks, and lagoons.

The dry deltaic plain is a geographically extensive low-lying area dominated by fluvial systems, some with braided characteristics. Few meander belts occur within this deltaic plain. Raffia palms dominate flood plains while palm trees are most common in the inter-fluvial settings. Extensive lateritic soil (approximately 12 m in thickness) underlies this unit.

Table 4.10: Geological and Lithological Units of the Niger Delta

Geologic Unit	Lithology	Age
Alluvium	Gravel, sand, clay silt	Quaternary
Freshwater back-swamp	Sand, clay, some silt, and gravel	
Meander belt		
Mangrove and salt Water/ backswamps	Medium-fine sand, clay and some silt	
Active/abandoned beach ridges	Sand, clay and some silt	
Benin Formation (Coastal Plain Sand)	Coarse to medium sand with Subordinate silt and clay lenses	Tertiary
Agbada Formation	Mixture of sand, silt and shale	
Akata Formation	Shale, sandy in some places	

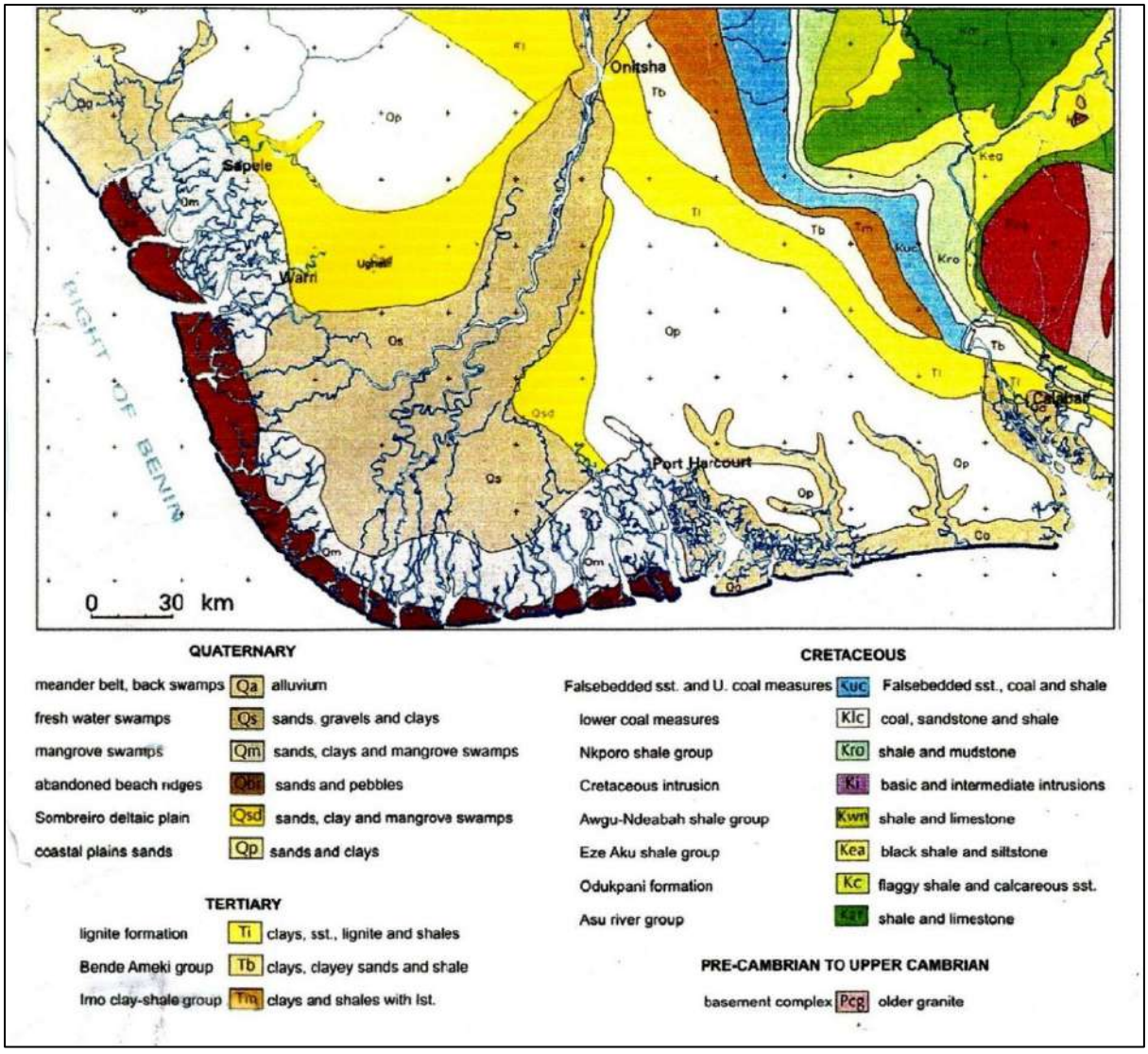


Figure 4.30: Geological Characteristics of the Niger Delta

4.4.8.2Local Geology

The lithologies identified in the study area are predominantly sandy clay, clay, clayey sand and minor sand from the surface to a maximum investigation depth of 3.0m (Figure 4.31). Sandy clay accounts for over 70% of the lithologies encountered based on soil auger holes data. Similar lithologies were identified using the resistivity method for lithologic identification to a maximum investigation depth of 5.0m. Figures 4.32 – 4.34 shows soil lithologic sections for 1.0m depth, 2.0m depth and 3.0m depth encountered across the project site. The predominance of continuous sandy clays at the shallow subsurface suggest a decrease in soil permeability and decrease in overall groundwater recharge from surface precipitation. Abam (2016) encountered similar lithologic units across the Niger Delta shallow subsurface as those recorded from site investigations.

The topography across the project site is undulating and ranges from 15.93m to 47.05m (Figure 4.35). Generally, the highest elevation is recorded towards the northern section of

the site (ANOH Gas Plant) and lowest towards the southern section of the proposed pipeline path (Indorama Complex) towards the Mangrove Swamp Forest. Similar mapping was achieved by Abam (2006) whose studies in the Niger Delta showed a gradual topographic decent towards the coastal limit of the Coastal plain sediments, where it meets the Mangrove swamp sediments.

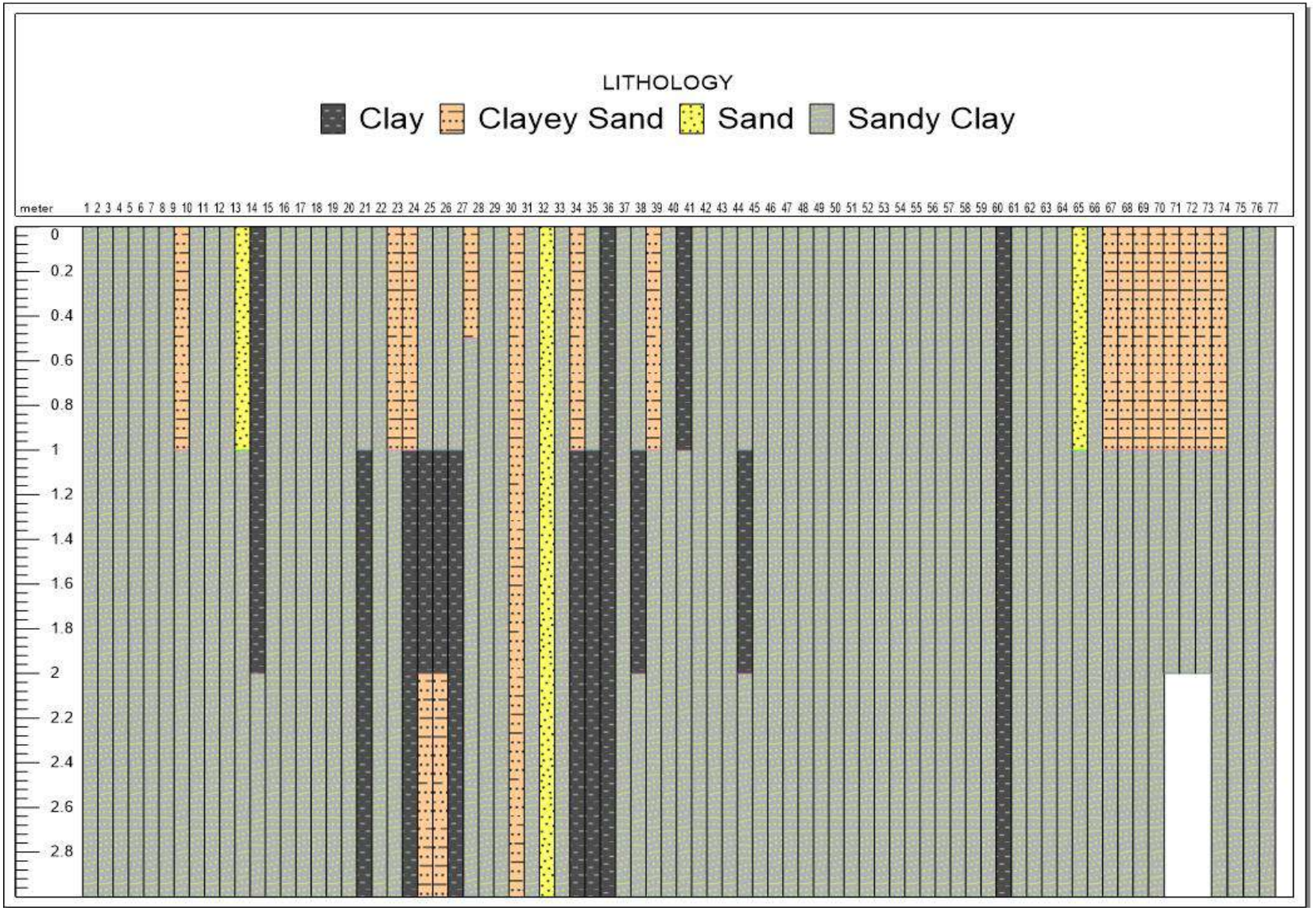


Figure 4.31: Lithologies encountered across the project site

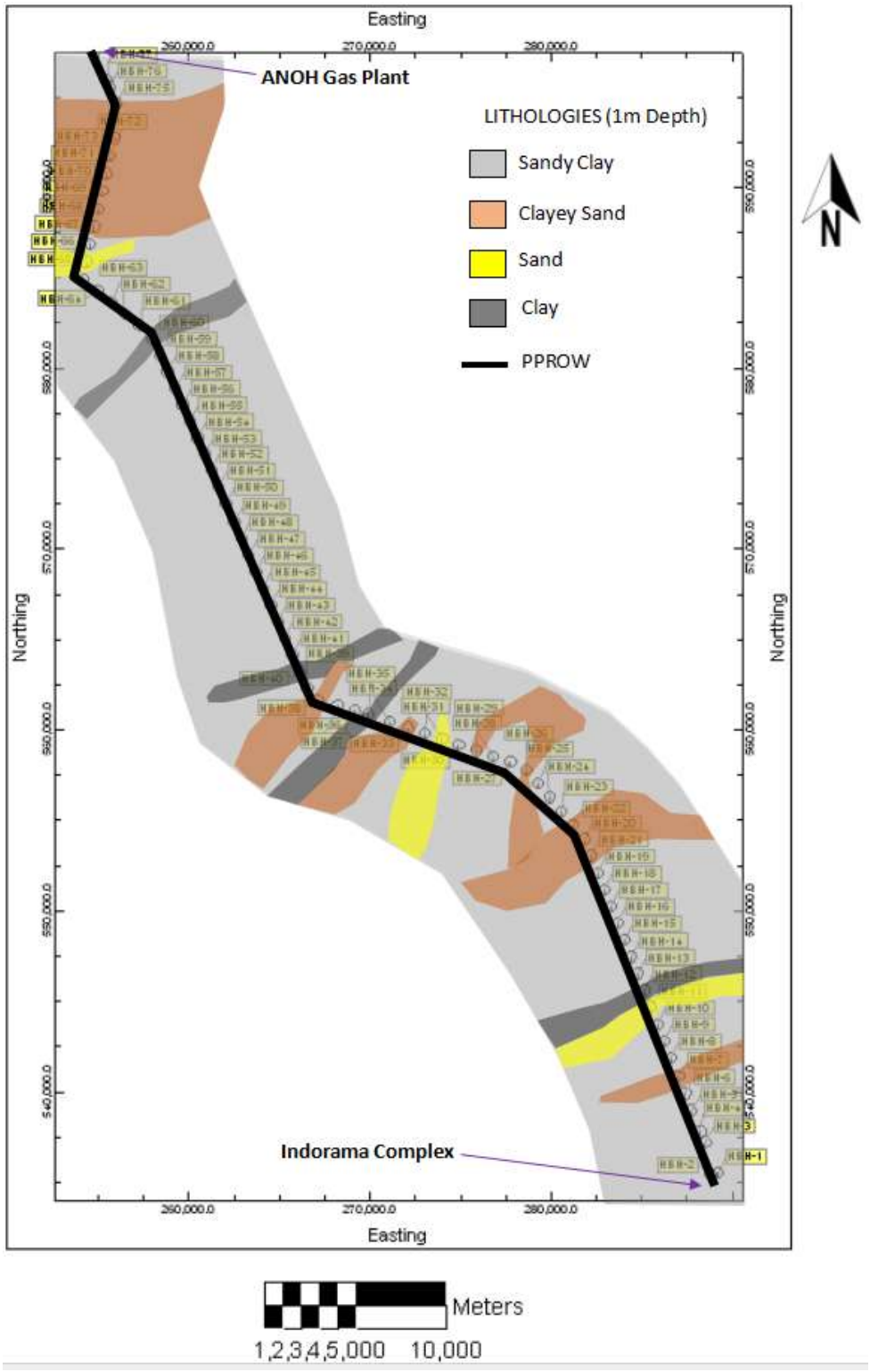


Figure 4.32: Depth slice at 1.0m showing the variations in lithologies across the site

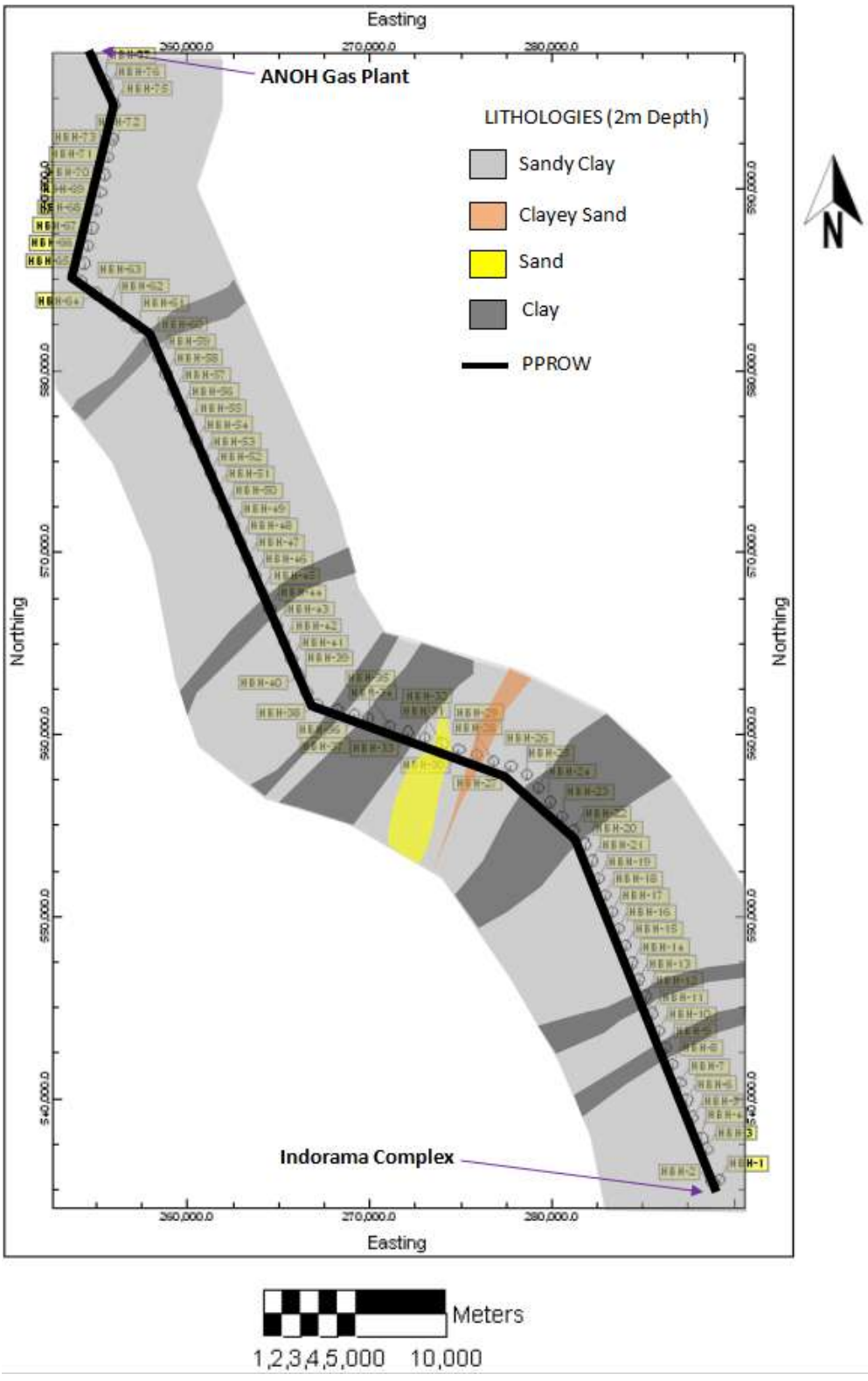

Easting
ANOH Gas Plant
LITHOLOGIES (2m Depth)
Sandy Clay
Clayey Sand
Sand
Clay
PPROW
N
Northing
Indorama Complex
Easting
Meters
1,2,3,4,5,000 10,000

Figure 4.33: Depth slice at 2.0m showing the variations in lithologies across the site

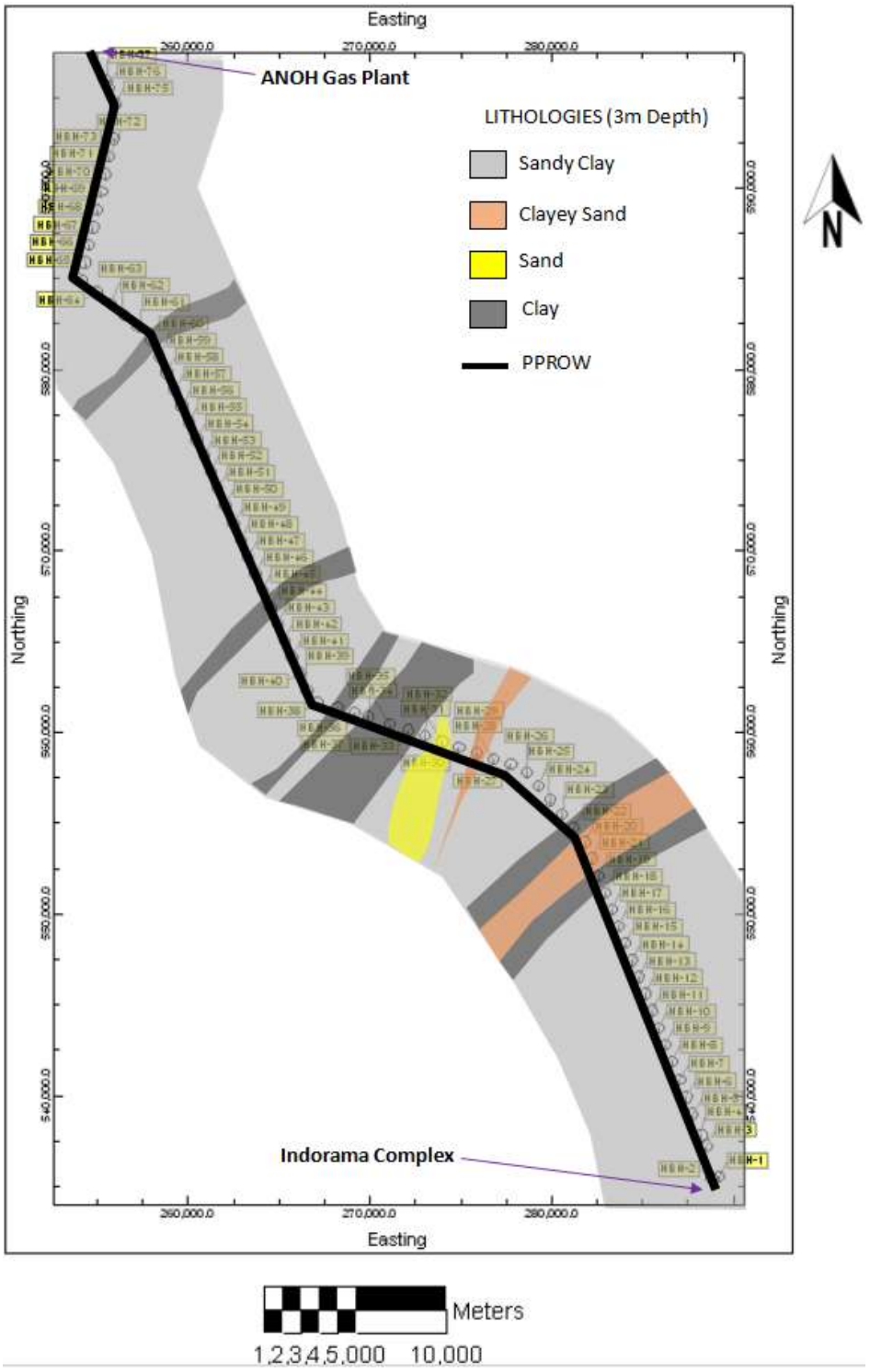


Figure 4.34: Depth slice at 3.0m showing the variations in lithologies across the site

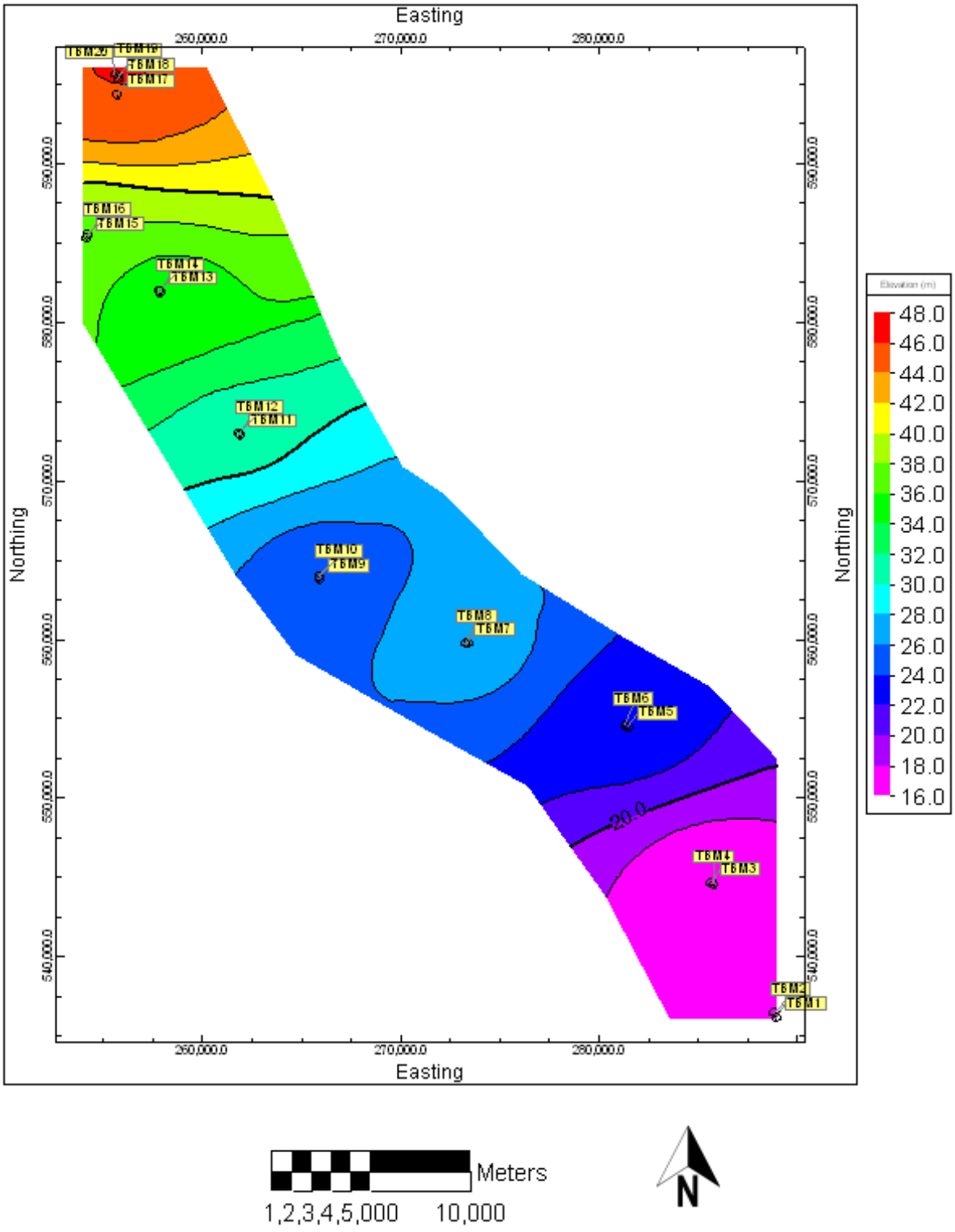


Figure 4.35: Map showing topography across the proposed pipeline right of way

4.4.8.3Soil Resistivity and Corrosivity

Soil resistivity is a parameter commonly used to evaluate the corrosivity of soil. Soil resistivity investigation was conducted at seventy (70) stations. The survey array method adopted was the Wenner array configuration with a maximum investigation depth of 5.0m.

The results of soil resistivity measured from field investigations along the gas pipeline ROW is presented in Table 4.11.

Resistivity depth profile diagrams are presented in Annexure 4.2. The soil resistivities recorded from 0m to 5.0m depth across the proposed ROW were variable ranging from 2.78Ωm to 7500.58Ωm, with a mean 2255.02Ωm indicating generally very mildly corrosive soils. Apart from ERT-1 sounding station where the soil was classed as extremely corrosive soil, all other locations revealed soils that are very mildly corrosive. Soil corrosivity rating was based on ASTM G187-12a classification scheme which classed soils having resistivity of 0 – 10 Ohm.m as extremely corrosive, 10 – 20 Ohm.m (severely corrosive), 20 – 50 Ohm.m (moderately corrosive), 50 – 100 (mildly corrosive), and >100 Ohm.m (very mildly corrosive soils).

Soil resistivity was also used to determine the subsurface lithologic units to a depth of 5.0m. Predominant lithologies determined using the resistivity values obtained from site investigations were sandy clay (250 – 1500 Ohm.m), with minor occurrences of clayey sand (1500 - 1900 Ohm.m), clay (<120 Ohm.m) and sands (>1900 Ohm.m) at some parts of the pipeline ROW.

Table 4.11: Summary of resistivity measurements along the proposed pipeline ROW

a	ERT-1	ERT-2	ERT-3	ERT-4	ERT-5	ERT-6	ERT-7	ERT-8	ERT-9	ERT-10
m	*Ohm -m*									
1.00	144.28	91.24	1546.49	1508.16	4056.32	172.24	711.35	1292.62	963.34	1073.31
2.00	7.36	245.83	2851.68	397.78	1089.39	233.89	1085.12	1124.46	769.41	895.22
3.00	2.78	385.15	1791.32	467.15	552.93	284.10	614.01	745.41	692.06	455.46
5.00	5.59	690.61	4163.15	422.60	498.95	239.61	861.22	673.64	654.48	609.55

a	ERT-11	ERT-12	ERT-13	ERT-14	ERT-15	ERT-16	ERT-17	ERT-18	ERT-19	ERT-20
m	*Ohm -m*									
1.00	1263.08	988.47	1007.33	178.47	282.65	963.34	2135.93	266.19	1227.27	3166.51
2.00	1072.05	645.24	730.95	246.33	7500.58	562.80	1622.53	167.28	721.28	851.36
3.00	669.25	732.21	512.77	302.76	3182.22	1153.55	1728.54	231.88	751.63	1156.38
5.00	926.58	972.45	759.42	271.00	5941.52	1221.92	1536.75	316.71	1004.50	1002.61

a	ERT-21	ERT-22	ERT-23	ERT-24	ERT-25	ERT-26	ERT-27	ERT-28	ERT-29	ERT-30
m	*Ohm -m*									
1.00	3150.17	749.68	717.63	918.72	614.64	740.70	925.00	2465.21	3384.56	3195.41
2.00	818.68	708.08	582.15	691.49	638.08	962.21	1111.01	1576.03	4651.42	3258.88
3.00	1192.20	752.95	503.35	576.12	352.72	783.68	1224.06	1531.16	3974.00	2900.19
5.00	984.39	1894.00	791.16	718.89	732.09	743.40	1509.42	1687.57	1785.91	3051.51

a	ERT-31	ERT-32	ERT-33	ERT-34	ERT-35	ERT-36	ERT-37	ERT-38	ERT-39	ERT-40
m	*Ohm -m*									
1.00	2395.46	1464.17	640.97	2243.39	3485.73	2516.11	3948.87	647.88	205.30	5438.17
2.00	318.98	1270.62	536.40	1976.95	812.90	2331.36	2699.61	549.10	756.34	4246.73
3.00	383.26	802.72	565.56	1645.59	1107.74	686.21	1679.90	568.20	880.95	3061.57
5.00	1093.10	854.62	658.56	1290.11	1061.37	638.77	1379.02	684.33	807.18	2284.86

a	ERT-41	ERT-42	ERT-43	ERT-44	ERT-45	ERT-46	ERT-47	ERT-48	ERT-49	ERT-50
m	*Ohm -m*									
1.00	4170.69	5723.47	3618.96	5171.73	3035.80	5292.38	5514.21	4417.65	1951.81	1971.29
2.00	2636.77	3105.55	2293.66	3003.75	2470.87	2152.90	3143.26	3586.91	1850.01	1710.50
3.00	2134.05	2801.41	1245.17	1605.44	2414.94	2565.76	1809.60	2946.57	1517.77	1674.06
5.00	1868.55	1855.98	1302.36	1264.66	1680.97	1897.77	1093.10	2307.17	1493.71	1642.95

a	ERT-51	ERT-52	ERT-53	ERT-54	ERT-55	ERT-56	ERT-57	ERT-58	ERT-59	ERT-60
m	*Ohm -m*									
1.00	1958.09	2967.30	3023.23	3821.93	3276.48	2490.98	2059.90	2771.56	617.97	5692.05
2.00	1762.03	3424.78	3485.11	3619.58	3767.89	2901.95	2255.96	2762.45	616.08	2876.82
3.00	1526.82	1700.83	2034.13	2452.65	3517.78	2262.24	2469.61	2414.94	663.59	1722.70
5.00	1342.89	1909.39	2049.84	2446.68	2704.32	2148.19	1689.45	2021.25	354.73	1213.75

a	ERT-61	ERT-62	ERT-63	ERT-64	ERT-65	ERT-66	ERT-67	ERT-68	ERT-69	ERT-70
m	*Ohm -m*									
1.00	2940.91	2908.86	288.37	226.29	341.60	2332.62	5296.78	5387.27	5241.48	453.20
2.00	2625.46	2433.16	362.46	277.50	360.95	2876.82	2688.30	2915.78	2954.74	797.31
3.00	1487.23	1144.13	355.55	479.03	469.60	390.80	1344.52	1705.73	1015.37	348.95
5.00	1264.97	1385.62	574.99	709.78	304.24	1572.89	971.82	1312.41	1004.50	427.63

4.4.8.4Soil Thermal Conductivity

Thermal conductivity of soil affects the rate at which heat is transferred from buried pipelines to the surrounding soil. In this study, the results of soil thermal conductivity ranges from 1.183 to 1.531 W/mK with an average of 1.393 W/mK (Figure 4.36). This shows the thermal resistivity of the soil are considerably high. Soils with high thermal are considered good conductors of heat, while soils with low thermal conductivities are considered poor conductors of heat.

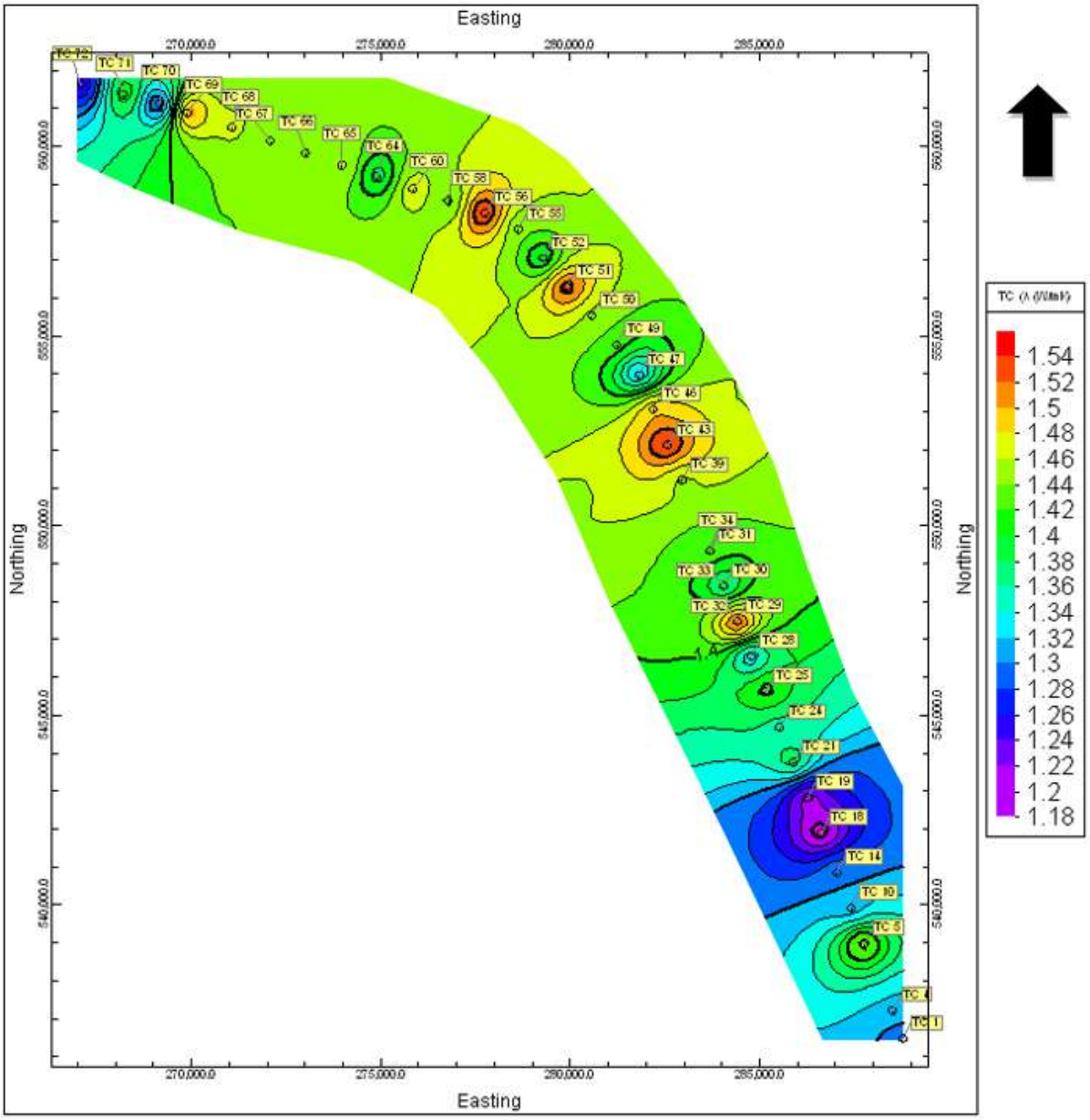


Figure 4.36: Thermal conductivity of soil along the proposed pipeline ROW

4.4.8.5Soil Geotechnical Properties

The results of grain size analysis conducted on soil samples obtained from pits dug to depths of 1.50m along the proposed pipeline ROW is summarized in Table 4.12. No gravel sized particles were identified on the grain size analysis curves. Meanwhile, sands and fines (silts and clay) ranged from 44.51 to 78.12% and 20.87 to 54.92%. On average, sands and fines are 65.32% and 34.49% respectively. This result shows that the shallow 1.50m topsoils in the area are predominantly sandy soils with some silty and clayey fractions. This results also accounts for the significantly high soil thermal conductivity recorded in this study because sands are good conductors of heat.

The summary of index properties of the soils has been presented in this section. The identification and classification system follows the Procedures provided in BS EN ISO 14688-1:2018, BS EN ISO 14688-2:2018. Soil classification based on Plasticity was carried out using the Casangrande chart and indicates that the soils at 0 to 1.50m depth are of low plasticity, while from 2.0m to 3.0m depth, the soils are of high plasticity (Table 4.13). The clayey fractions encountered within the sands are of soft to firm consistency. The liquid limit value ranged between 24.0% and 66.0%, with an average of 37.94%, while the plastic limit ranged between 11% and 39% with an average of 20.45% (Table 4.13). The liquid limit obtained in the study is relatively high and adequate measures be put in place because the soils may pose a challenge during construction due to its tendency to become unstable and can potentially lead to settlement due to the high plastic limit values recorded.

Similarly, the plastic limit is moderately low and precautionary measures should be taken during construction phases because of the shrink and swell potential associated with clayey soils of low plastic limit. The Plasticity Index ranged from 11 to 28% with an average of 17.50% which is generally low (Table 4.13).

Table 4.12: Results of grain size analysis conducted on soil samples obtained from excavated pits dug to 1.50m depth

Borehole ID/Pit ID	Depth (m)	Grain Size (%)		
		Gravel	Sand	Fines
PIT1	0 - 1.50	0.00	64.89	35.11
PIT4	0 - 1.50	0.00	65.04	34.85
PIT5	0 - 1.50	0.00	64.32	35.68
PIT10	0 - 1.50	0.00	66.11	33.89
PIT14	0 - 1.50	0.00	67.82	32.18
PIT18	0 - 1.50	0.00	55.74	44.26
PIT19	0 - 1.50	0.00	65.16	34.84
PIT21	0 - 1.50	0.00	67.67	31.94
PIT24	0 - 1.50	0.00	54.66	45.34

Borehole ID/Pit ID	Depth (m)	Grain Size (%)		
		Gravel	Sand	Fines
PIT25	0 - 1.50	0.00	67.29	32.71
PIT28	0 - 1.50	0.00	60.71	39.29
PIT29	0 - 1.50	0.00	68.47	31.53
PIT30	0 - 1.50	0.00	68.90	30.83
PIT31	0 - 1.50	0.00	78.12	20.87
PIT32	0 - 1.50	0.00	71.20	28.41
PIT33	0 - 1.50	0.00	62.31	37.58
PIT34	0 - 1.50	0.00	66.38	33.62
PIT39	0 - 1.50	0.00	64.47	35.45
PIT43	0 - 1.50	0.00	75.37	24.63
PIT46	0 - 1.50	0.00	44.51	54.92
PIT47	0 - 1.50	0.00	55.04	44.83
PIT49	0 - 1.50	0.00	70.89	29.11
PIT50	0 - 1.50	0.00	73.39	26.61
PIT51	0 - 1.50	0.00	68.27	31.73
PIT52	0 - 1.50	0.00	63.42	36.46
PIT55	0 - 1.50	0.00	68.22	30.11

Table 4.13: Results of Atterberg limit for soil samples obtained from selected boreholes and excavated pits dug to 1.50m depth

Borehole ID/Pit ID	Depth (m)	Atterberg Limits			USCS
		Liquid Limit	Plastic Limit	Plasticity Index	
BH68	0.10	35	17	18	CL
	1.00	34	16	18	CL
	2.00	66	39	27	CH
	3.00	34	18	16	CL
BH69	0.10	34	18	16	CL
	1.00	48	24	24	CL
	2.00	56	28	28	CH
	3.00	37	19	18	CL
BH70	0.10	38	23	15	CL
	1.00	39	22	17	CL
	2.00	60	33	27	CH
	3.00	54	30	24	CH
PIT1	0 - 1.50	39	21	18	CL
PIT4	0 - 1.50	34	19	15	CL
PIT5	0 - 1.50	33	18	15	CL
PIT10	0 - 1.50	36	20	16	CL
PIT14	0 - 1.50	30	18	12	CL
PIT18	0 - 1.50	43	20	23	CL
PIT19	0 - 1.50	32	17	15	CL
PIT21	0 - 1.50	32	18	14	CL
PIT24	0 - 1.50	40	22	18	CL
PIT25	0 - 1.50	34	17	17	CL
PIT28	0 - 1.50	41	19	22	CL

Borehole ID/Pit ID	Depth (m)	Atterberg Limits			USCS
		Liquid Limit	Plastic Limit	Plasticity Index	
PIT29	0 - 1.50	34	17	17	CL
PIT30	0 - 1.50	30	17	13	CL
PIT31	0 - 1.50	24	11	13	CL
PIT32	0 - 1.50	25	14	11	CL
PIT33	0 - 1.50	36	21	15	CL
PIT34	0 - 1.50	37	21	16	CL
PIT39	0 - 1.50	33	18	15	CL
PIT43	0 - 1.50	27	12	15	CL
PIT46	0 - 1.50	50	26	24	CL
PIT47	0 - 1.50	45	27	18	CL
PIT49	0 - 1.50	33	19	14	CL
PIT50	0 - 1.50	34	18	16	CL
PIT51	0 - 1.50	35	18	17	CL
PIT52	0 - 1.50	32	20	12	CL
PIT55	0 - 1.50	38	22	16	CL

Soils with high plasticity index are more susceptible to shrink-swell behaviour and will require special consideration during construction to mitigate potential issues such as differential settlement or pipe deformation. The moisture content of the clayey fractions between 0 – 3.0m depth varied between 12.20% and 16.10% while the bulk density and dry unit weight ranged from 1.81g/cm^3 to 2.04g/cm^3 and 15.70kN/m^3 to 18.70kN/m^3 (Table 4.14).

Table 4.14: Results of moisture content, density and unit weight for soil samples obtained from selected boreholes within the vicinity of the proposed pipeline path

Borehole ID/Pit ID	Depth (m)	Moisture Content (%)	Bulk density (g/cm3)	Bulk unit weight (KN/m3)	Dry unit weight (KN/m3)
BH68	0.10	12.20	1.81	17.70	15.70
	1.00	14.90	2.14	21.00	17.40
	2.00	16.10	2.04	20.00	17.20
	3.00	13.50	2.14	21.00	18.00
BH69	0.10	12.20	1.88	18.50	16.70
	1.00	16.00	2.06	20.20	16.40
	2.00	15.20	2.19	21.50	18.70
	3.00	14.50	2.09	20.50	17.70
BH70	0.10	13.00	1.88	18.50	16.70
	1.00	15.00	2.14	21.00	18.20
	2.00	15.30	2.11	20.70	17.90
	3.00	14.80	2.04	20.00	17.50

4.4.9 Soil Quality

This Section presents the baseline / existing soil conditions in the Project Area and provides a benchmark of the conditions against any potential future impacts associated with the Project.

4.4.9.1Soil Sampling Locations

Soil samples were collected from 40 sampling positions situated both within the Project Area as well as from off-site locations within the larger Study Area. At each sampling location, two samples were collected, which included a topsoil sample (0 – 15 cm) and a sub-soil sample (15 – 30 cm). The collected samples were analysed by FMEnv accredited laboratory, M/s Anal Concept Limited, Port Harcourt.

Table 4.15 provides a description of the various soil sampling locations, which are shown on Figure 4.37.

Table 4.15: Soil Sampling Positions

S/No	Latitude	Longitude	S/No	Latitude	Longitude
1	4°50'31.70"	7° 5'55.98"	21	5° 5'41.31"	6°53'22.51"
2	4°51'32.24"	7° 5'31.93"	22	5° 6'40.68"	6°52'55.86"
3	4°52'32.72"	7° 5'7.88"	23	5° 7'39.63"	6°52'29.25"
4	4°53'33.19"	7° 4'43.82"	24	5° 8'39.04"	6°52'2.59"
5	4°54'33.60"	7° 4'19.83"	25	5° 9'38.11"	6°51'35.97"
6	4°55'34.17"	7° 3'55.70"	26	5°10'37.16"	6°51'9.48"
7	4°56'34.64"	7° 3'31.61"	27	5°11'36.33"	6°50'43.09"
8	4°57'35.01"	7° 3'7.61"	28	5°12'34.95"	6°50'16.95"
9	4°58'35.39"	7° 2'43.61"	29	5°13'33.86"	6°49'50.06"
10	4°59'35.76"	7° 2'19.68"	30	5°14'33.10"	6°49'23.27"
11	5° 0'37.17"	7° 1'55.15"	31	5°15'37.83"	6°48'54.18"
12	5° 1'26.48"	7° 1'12.91"	32	5°16'19.34"	6°48'3.78"
13	5° 2'15.80"	7° 0'30.30"	33	5°17'0.16"	6°47'13.74"
14	5° 2'52.55"	6°59'39.20"	34	5°17'55.31"	6°47'1.37"
15	5° 3'13.06"	6°58'37.66"	35	5°18'58.66"	6°47'16.14"
16	5° 3'33.50"	6°57'36.58"	36	5°20'1.43"	6°47'31.05"
17	5° 3'54.07"	6°56'35.17"	37	5°21'5.07"	6°47'45.92"
18	5° 4'14.51"	6°55'33.89"	38	5°22'14.06"	6°48'2.98"
19	5° 4'32.76"	6°54'29.37"	AQC1	4º48’ 57.37’’	7º 5’ 45.75’’
20	5° 4'42.00"	6°53'49.16"	AQC2	5º 26’ 40.0’’"	6º 54’ 30.0’’"

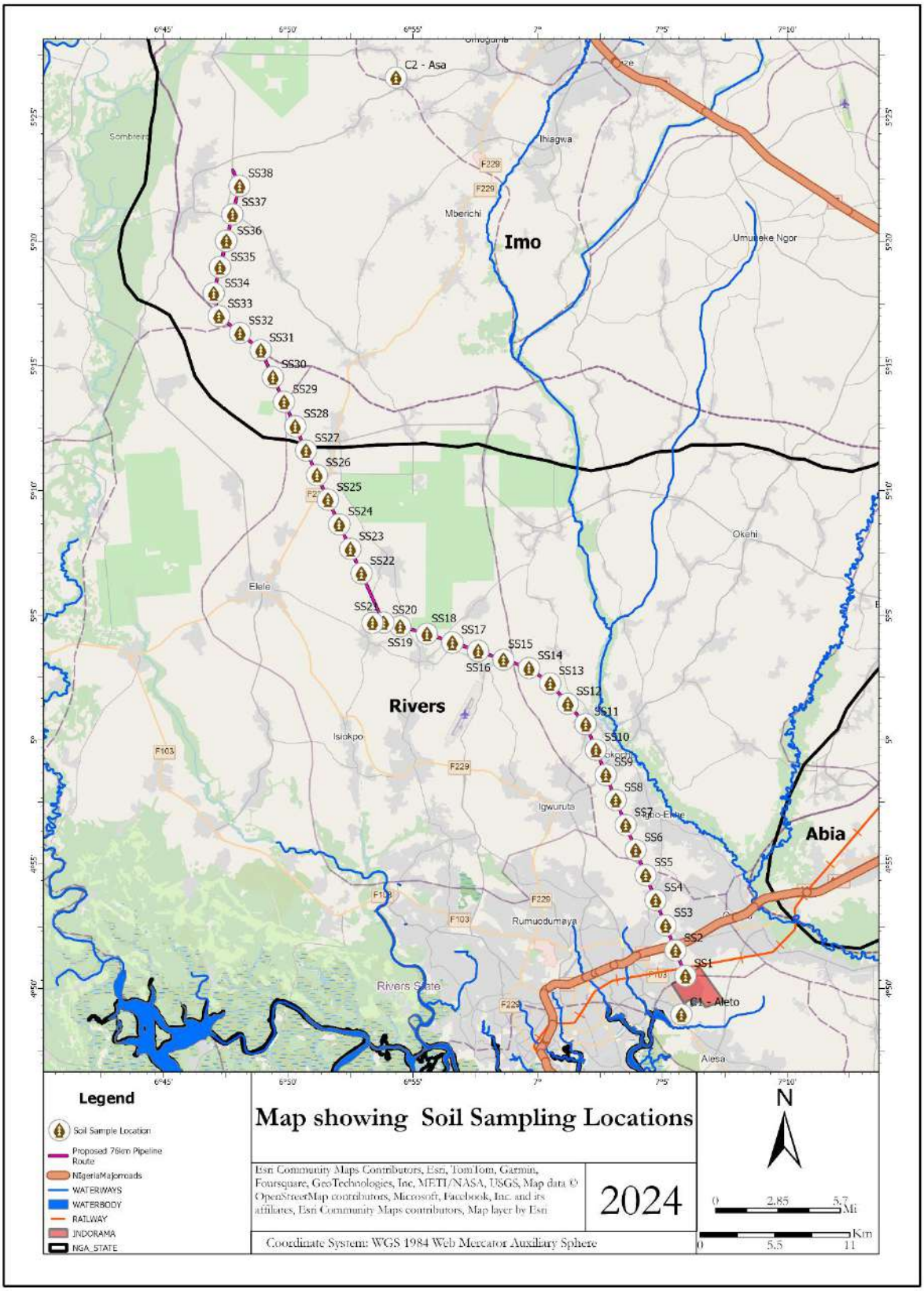


Figure 4.37: Map showing Soil quality monitoring stations

4.4.9.2Soil Sampling Methodology

International best practices for soil collection were adopted during the soil sampling campaign. A summary of the sampling methodology applied is discussed below.

A stainless-steel soil sampling augur was used to collect the samples. At each sampling position, a topsoil sample was collected at depths of between 0 – 15 cm while a second sample representing the subsoil was collected between 15 – 30 cm down the soil profile.

Each collected sample was placed into a plastic bag before being wrapped in aluminium foil and packed into a UV resistant container. Each sample bag was labelled at the point of collection with the correct station ID, depth and date of sampling.

The morphological and physical properties of the soils were noted based on visual observations and in-situ pH measurements were recorded for each soil sample.

4.4.9.3Physical Description of the Soils

SOIL MORPHOLOGY

The soils along the 76km Right of Way (RoW) are derived from geologic parent material of coastal plain sands friable when dry and slightly stick when wet. They are moderately deep, weakly structured with coarse texture to fine particle in the surface while the subsurface soils have clay accumulation. The soil is relatively characterized by high nutrients, water retention capacity and may be vulnerable to erosion hazards during the rainy season. They are strongly to moderately acidic in reaction due to the leaching of the basic cations from the soil *solum* (FPDD, 1990; Miller and Donahue, 1995). Most of the soils are classified as *Ultisols* and *Entisols* depending on the stage of *pedogenic* development (Soil Survey Staff, 1992, 1998; Fitzpatrick, 1980). Economic trees such as oil palm, Raphia palm, *inter alia* thrive well in the area. The topography of the area is relatively flat.

PHYSICAL PROPERTIES

The physical properties of the soils sampled from the prescribed study area are summarized in Table 4.16 while a detailed sol quality results is presented in Annexure 4.3. The sand, silt and clay fractions varied in texture along the sampling stations. The texture of the soils collected along the stations varied from sandy loam, and loamy sand texture depending on the *pedogenesis* and edaphic features of the study area. Sand fractions ranged from 80.15 to 87.33% with a mean value of 84.79 % (surface soils) and between 54.16 to 86.40% with a mean of 82.24% (subsurface soils); Silt from 2.23 to 6.09% and 1.99 to 8.12% with means of 4.51% and 4.63% respectively; clay contents from 7.55 to 16.21% and 8.35 to 15.38% with means of 10.62% and 12.31% respectively for surface and subsurface soil samples collected from the study area (Table 4.16a), during dry season

while during the wet season Sand fractions ranged from 77.62 to 85.82% with a mean value of 82.79 % (surface soils) and between 78.62 to 86.02% with a mean of 82.67% (subsurface soils); Silt from 3.02 to 17.28% and 2.26 to 8.35% with means of 7.70% and 4.94% respectively; clay contents from 4.25 to 15.59% and 8.57 to 15.70% with means of 9.51% and 12.39% respectively for surface and subsurface (Table 4.16b) . The soil is characterized as coarse textured with a high proportion of sand fraction exceeding 70%. Such soils may lack adsorptive capacity for basic plant nutrients. The soils have weak surface aggregation and are vulnerable to erosion hazards (FPDD, 1990).

4.4.9.4Soil Chemistry Results

Soil pH is fundamental to the understanding of soil systems, because it is an indicator of many reactions in the soils (Moore and Loeppert, 1987; SSSA, 2001). It shows whether the soil is acidic, neutral or basic and provides useful information on the availability of the exchangeable cations. Soil pH controls plant nutrient availability and microbial reactions in soils. The pH (H_20) of the air-dried for topsoil ranged from 4.1 to 6.7 and 3.59 to 5.70 for dry and wet season respectively, while subsoil pH ranged 4.3 to 6.3 and 3.48 to 5.78 for dry and wet seasons respectively (Table 4.16a and Table 4.6b) in the project environment, thus depicts strong acidity within the project environment due to leaching of basic cations from the soil *solum.* Such acidic soil condition can induce phosphate fixation and consequently reduce the ability of microbes to fix atmospheric nitrogen. The strong acid condition indicates that certain elements such as Zinc, Iron, Manganese and Aluminum are available in soils of the prescribed project environment.

ORGANIC CARBON AND TOTAL NITROGEN CONTENTS

Carbon is an essential plant nutrient and the foundation of all life (Magddoff, 1992). Carbon compounds are enzymatically oxidized to produce carbon dioxide, water, energy, and decomposer biomass. Soil organic matter contributes to soil aggregation and reduces susceptibility to erosion (Brady and Weil, 1996). The organic carbon present in topsoil of the study area ranged from 0.936 to 2.262% and 1.014 to 2.901% for dry and wet season respectively, while for subsurface soil organic carbon ranged between 0.758 to 2.108% and 0.819 to 2.212% for dry and wet seasons respectively. Such soils are rated medium in fertility status (Holland *et al.,* 1989). Thus, the soil can sustain crop production in the ecological zone.

Nitrogen in the form of protein is present in the protoplasm of every cell. The available form of nitrogen in the soil is ammonium or nitrate ion. Total nitrogen topsoil varied from 0.081 to 0.196% and 0.136 to 0.199% for dry and wet season, while the subsoil ranged between 0.066 to 0.182% and 0.073 to 0.329% for dry and wet season respectively. This range of values is rated low when compared with the medium range of 0.10 to 0.45% (Holland *et al.,* 1989) for soils of the area under study. This range of values are consistent

with the works of Ukaegbu and Akamigbo (2005) who reported average total percentage of 0.08 in soils of the Cross River Coastal plain sands and mean range of 0.10 to 0.14% reported by Aluko (2005) for surface and subsurface soils of Onne in Rivers State. Thus, there is variation in the contents of total nitrogen in the present ecological zone.

HYDROCARBON (THC, TPH, PAH, BETEX & PHENOL)

Hydrocarbon content of the soils of the area were assessed using the following (THC, TPH, PAH, BETEX & Phenol) hydrocarbon parameters. Laboratory analysis results reveal THC range between 0.73 – 2.28mg/kg, and 0.57 – 1.58mg/kg topsoil, 0.52 -2.27mg/kg and 0.62 – 2.53mg/kg subsoil; TPH 1.04 -2.52, and 1.01 – 2.38mg/kg topsoil, 0.69 – 2.65mg/kg and 0.86 -2.73mg/kg subsoil; PAH 0.002 – 0.005mg/kg, and <0.001mg/kg topsoil, 0.002 – 10.002mg/kg and <0.001mg/kg subsoil for dry and wet season respectively indicating that the hydrocarbon source is biogenic. While BETEX and Phenol were <0.0001mg/kg across depth,station and season.

HEAVY METAL

Heavy metal level depicts bedrock characteristics of the study area with iron showing the highest concentration with mean value of 279.49 and 296.9mg/kg topsoil; 319.49 and 325.6mg/kg subsoil, followed by copper 16.30 and 15.36mg/kg topsoil 16.06mg/kg and 16.86mg/kg subsoil, zinc 9.54 and 10.46mg/kg topsoil 8.64mg/kg and 8.77mk/kg, Nickel 8.36 and 7.59mg/kg topsoil, 62mg/kg and 6.86mg/kg subsoil, Lead 3.14 and 2.77mg/kg topsoil, 3.29 and 3.55mg/kg subsoil, chromium 2.29 and 2.21mg/kg topsoil,1.48 and 1.31mg/kg subsoil and Arsenic 0.15 and 0.12mg/kg topsoil, 0.15mg/kg and 0.19mg/kg subsoil all for dry and wet season respectively.

SOIL MICROBIOLOGY

The importance of soil microbiology in the soil cannot be overemphasized as they play a vital role in soil organic matter decomposition to release soil nutrient, moreso their presence in the soil revealed how healthy the soil is. Consequently, the analysis of HUB reveals average counts of 1.02 and 2.3cfu/g topsoil, 0.64 and 1.07cfu/g subsoil ; HUF 0.62 and 0.9 cfu/g topsoil, 0.32 and 0.23CFU/g; THB 2.97 and 3.6 cfu/g topsoil, 1.90 and 2.34CFU/g subsoil; THF 1.86 and 2.3cfu/g topsoil and 1.01 and 1.8 CFU/g subsoil all for dry and wet season.

Table 4.16a: Summary results of soil physiochemical properties along the Pipeline RoW – Dry season

S/N	Parameter(s)	Topsoil							Subsoil							NESREA limit[20]
		Min	Max	Ave	StDv	CV	SSC 1T	SSC 2T	Min	Max	Ave	StDv	CV	SSC 1B	SSC 2B	
1	pH	4.1	6.7	4.76	0.46	9.58	5.6	5.7	4.3	6.3	4.76	0.46	9.61	4.6	5.1	-
2	Moisture Content (%)	3.08	11.23	7.29	2.00	27.42	10.13	8.63	4.83	11.57	8.11	1.76	21.64	7.23	7.12	-
3	Sulphide, S2 (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	-
4	Sulphate, SO42- (mg/kg)	0	16	5.42	3.91	72.10	3	10	0	14	3.55	3.12	87.73	5	2	-
5	Nitrate, NO3- (mg/kg)	0.2	2.8	1.06	0.64	61.00	0.3	0.8	0.2	2.3	0.83	0.47	57.30	0.8	0.8	-
6	Total Nitrogen (%)	0.081	0.196	0.15	0.03	20.87	0.098	0.122	0.066	0.182	0.13	0.03	20.70	0.088	0.109	-
7	Phosphate, PO43- (mg/kg)	0.12	2.45	0.95	0.63	66.98	2.7	0.75	0.13	2.5	0.68	0.57	83.91	1.3	0.46	-
8	THC (mg/kg)	0.73	2.28	1.23	0.27	22.16	0.51	0.68	0.52	2.27	1.13	0.28	24.37	0.12	0.67	-
9	TPH (mg/kg)	1.04	2.52	1.60	0.45	28.31	1.00	1.69	0.69	2.65	1.39	0.47	34.08	<0.001	1.58	-
10	PAH (mg/kg)	0.002	0.005	0.00	0.00	30.62	0.002	0.003	0.002	10.002	0.30	1.71	577.86	0.003	0.002	-
11	BTEX (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	0.1
12	Phenol (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	10
13	Ammonia (mg/kg)	0.14	0.75	0.27	0.11	38.87	0.28	0.21	0.1	0.49	0.24	0.08	32.36	0.25	0.18	-
14	TOC (%)	0.936	2.262	1.70	0.36	20.93	1.131	1.416	0.758	2.108	1.51	0.31	20.72	1.016	1.256	-
15	TOM (%)	1.618	3.911	2.92	0.61	20.85	1.955	2.448	1.311	3.645	2.61	0.54	20.72	1.756	2.172	-
16	Electric Conductivity (µs/cm)	9	245	70.08	53.16	75.86	22	52	10	161	45.42	33.67	74.13	27	20	-
17	Sand (%)	80.15	87.33	84.79	1.96	2.31	89.25	86.16	54.16	86.4	82.24	5.03	6.11	86.13	84.31	-
18	Silt (%)	2.23	6.89	4.51	1.25	27.81	2.00	3.02	1.99	8.12	4.63	1.48	32.03	4.61	2.00	-
19	Clay (%)	7.55	16.21	10.62	2.20	20.70	8.75	10.82	8.35	15.38	12.31	1.90	15.47	9.26	13.69	-
20	Particle Size Distribution	~	~	~	~	~	SS	LS	~	~	~	~	~	SS	LS	-

[20] National Environmental (Chemical, Pharmaceutical, Soap and Detergent Manufacturing Industries) Regulations 2009

S/N	Parameter(s)	Topsoil							Subsoil							NESREA limit[20]
		Min	Max	Ave	StDv	CV	SSC 1T	SSC 2T	Min	Max	Ave	StDv	CV	SSC 1B	SSC 2B	
21	Porosity	0.369	0.463	0.40	0.02	5.45	0.43	0.42	0.363	0.47	0.39	0.02	5.52	0.42	0.42	-
22	Colour	~	~	~	~	~	Brown	Brown	~	~	~	~	~	Brown	Brown	-
23	Permeability (cm/sec) ×10	0.11	0.18	0.14	0.02	12.35	0.17	0.13	0.11	0.18	0.14	0.02	10.82	0.18	0.12	-
24	Bulk Density (g/cm3)	1.05	1.53	1.21	0.09	7.86	1.16	1.21	1.13	1.53	1.23	0.08	6.87	1.17	1.20	-
25	Sodium, Na (mg/kg)	17.3	71.01	31.13	9.39	30.17	21.73	22.17	20.85	57.55	32.56	8.62	26.49	21.45	21.71	-
26	Magnesium, Mg (mg/kg)	1.15	21.3	5.67	5.50	96.93	10.45	7.48	0.73	16.12	4.07	3.76	92.44	2.86	9.53	-
27	Calcium, Ca (mg/kg)	617	682.8	649.90	46.53	7.16	<0.001	<0.001	113.2	579.3	346.25	329.58	95.19	<0.001	<0.001	-
28	Potassium, K (mg/kg)	2.42	38.43	6.25	6.22	99.49	2.11	3.44	1.41	20.05	5.03	3.49	69.33	2.19	2.78	-
29	Manganese, Mn (mg/kg)	1.84	58.3	19.23	15.66	81.45	2.84	1.84	0.27	67.4	18.03	16.22	89.94	1.81	1.68	-
30	Vanadium, V (mg/kg)	0.01	1.18	0.39	0.28	72.68	0.23	0.14	0.08	0.71	0.33	0.20	59.93	0.24	0.08	-
31	Nickel, Ni (mg/kg)	0.19	24.78	8.36	5.67	67.80	4.84	3.01	1.73	14.96	6.62	4.07	61.57	4.99	1.61	70
32	Chromium, Cr (mg/kg)	0.03	6.04	2.29	2.41	105.19	<0.001	<0.001	0.85	2.06	1.48	0.64	43.30	<0.001	<0.001	100
33	Iron, Fe (mg/kg)	85.54	599.7	279.49	112.68	40.32	148.7	210.4	35.54	607.7	319.49	129.74	40.61	477.0	320.7	-
34	Lead, Pb (mg/kg)	0.92	4.51	3.14	0.86	27.42	3.65	3.08	0.82	5.54	3.29	1.11	33.82	3.45	3.46	164
35	Copper, Cu (mg/kg)	7.97	26.3	16.30	5.35	32.81	13.38	20.60	0.7	30.43	16.06	6.85	42.62	11.39	16.59	100
36	Zinc, Zn (mg/kg)	5.27	49.24	9.54	7.74	81.19	2.97	4.76	3.9	58.65	8.64	8.53	98.73	4.90	6.55	421
37	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	4
38	Arsenic, As (mg/kg)	0.07	0.24	0.15	0.05	32.75	0.12	0.19	0.01	0.28	0.15	0.06	42.49	0.1	0.15	20
39	HUB (CFU/g) x 103	0.2	1.9	1.02	0.37	35.94	1.2	1.8	0.2	1.2	0.64	0.27	42.48	0.8	1.0	-
40	HUF (CFU/g) x 103	0.2	1.2	0.62	0.26	42.08	0.7	0.5	0.1	0.7	0.32	0.18	56.96	0.4	0.2	-
41	THB (CFU/g) x 106	1.7	4.2	2.97	0.67	22.47	2.9	3.7	0.9	3	1.90	0.58	30.27	1.1	2.4	-
42	THF (CFU/g) x 106	0.7	2.8	1.86	0.59	31.50	1.3	2.5	0.3	1.9	1.01	0.47	46.46	0.6	1.8	-

Table 4.16b: Summary results of soil physiochemical properties along the Pipeline RoW – Wet season

S/N	Parameter(s)	Topsoil							Subsoil							NESREA limit[21]
		Min	Max	Ave	StDv	CV	SSC 1T	SSC 2T	Min	Max	Ave	StDv	CV	SSC 1B	SSC 2B	
1	pH	3.59	5.70	4.88	0.48	9.73	4.72	4.95	3.48	5.78	4.91	0.49	10.05	4.41	5.24	-
2	Moisture Content (%)	7.33	19.07	11.71	3.00	25.63	16.59	13.21	7.63	18.38	11.65	2.60	22.30	10.42	9.93	-
3	Sulphide, S2 (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	-
4	Sulphate, SO42- (mg/kg)	3.00	136.10	21.80	31.94	146.52	38.8	98.1	0.80	427.10	29.57	68.62	232.09	99.5	66.0	-
5	Nitrate, NO3- (mg/kg)	0.69	2.91	1.50	0.65	43.11	1.12	1.57	0.28	2.50	0.98	0.39	39.70	1.13	0.95	-
6	Total Nitrogen (%)	0.136	0.199	0.179	0.017	9.514	0.121	0.163	0.073	0.329	0.153	0.042	27.731	0.179	0.157	-
7	Phosphate, PO43- (mg/kg)	0.36	2.64	1.20	0.61	51.42	2.96	1.12	0.34	2.52	1.11	0.54	48.85	1.33	0.38	-
8	THC (mg/kg)	0.57	1.58	0.99	0.19	18.78	0.48	0.53	0.62	2.53	1.30	0.32	25.01	0.67	0.91	-
9	TPH (mg/kg)	1.01	2.38	1.37	0.35	25.68	1.01	1.37	0.86	2.73	1.59	0.49	30.48	0.23	1.84	-
10	PAH (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	10.00	0.27	1.62	609.62	0.004	0.003	-
11	BTEX (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	0.1
12	Phenol (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	10
13	Ammonia (mg/kg)	0.02	0.80	0.31	0.19	62.65	0.25	0.45	0.02	0.72	0.16	0.13	80.55	0.39	0.31	-
14	TOC (%)	1.014	2.901	1.899	0.372	19.571	1.475	1.829	0.819	2.212	1.637	0.314	19.199	2.214	1.869	-
15	TOM (%)	1.748	5.001	3.273	0.641	19.572	2.542	3.153	1.412	3.813	2.822	0.542	19.197	3.817	3.222	-
16	Electric Conductivity (µs/cm)	22	102	53	21	41	56	44	14	840	62	130	210	64	48	-
17	Sand (%)	77.62	85.82	82.79	2.08	2.51	87.46	83.71	78.62	86.02	82.67	1.89	2.29	85.72	83.94	-
18	Silt (%)	3.02	17.28	7.70	3.68	47.75	9.74	3.54	2.26	8.35	4.94	1.42	28.80	2.53	3.01	-
19	Clay (%)	4.25	15.59	9.51	3.35	35.23	2.80	12.75	8.57	15.70	12.39	1.92	15.49	11.75	13.05	-

[21] National Environmental (Chemical, Pharmaceutical, Soap and Detergent Manufacturing Industries) Regulations 2009

S/N	Parameter(s)	Topsoil							Subsoil							NESREA limit[21]
		Min	Max	Ave	StDv	CV	SSC 1T	SSC 2T	Min	Max	Ave	StDv	CV	SSC 1B	SSC 2B	
20	Particle Size Distribution	~	~	~	~	~	SS	LS	~	~	~	~	~	SS	LS	-
21	Porosity	0.35	0.47	0.39	0.02	5.91	0.38	0.40	0.32	0.43	0.39	0.02	5.89	0.348	0.405	-
22	Colour	~	~	~	~	~	Brown	Brown	~	~	~	~	~	Brown	Brown	-
23	Permeability (cm/sec) ×10	0.15	0.42	0.32	0.05	16.78	0.29	0.31	0.24	0.41	0.33	0.04	13.39	0.42	0.29	-
24	Bulk Density (g/cm3)	1.13	1.55	1.32	0.09	6.49	1.44	1.23	1.14	1.47	1.31	0.08	5.78	1.41	1.23	-
25	Sodium, Na (mg/kg)	17.01	69.58	29.89	9.08	30.38	21.41	21.55	20.88	57.81	32.89	8.67	26.35	21.93	21.65	-
26	Magnesium, Mg (mg/kg)	0.72	21.25	5.28	5.41	102.40	10.21	7.26	0.75	16.44	4.13	3.79	91.80	3.16	10.07	-
27	Calcium, Ca (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	121.60	561.10	341.35	310.77	91.04	<0.001	<0.001	-
28	Potassium, K (mg/kg)	2.98	38.74	6.66	6.25	93.84	2.35	3.92	1.96	20.83	5.45	3.52	64.53	2.52	2.90	-
29	Manganese, Mn (mg/kg)	2.31	59.55	20.04	15.84	79.06	3.31	2.16	0.47	67.82	18.48	16.28	88.10	2.27	2.03	-
30	Vanadium, V (mg/kg)	0.01	0.92	0.34	0.22	64.13	0.17	0.09	0.01	0.88	0.30	0.24	81.39	0.29	0.16	-
31	Nickel, Ni (mg/kg)	0.02	24.22	7.59	5.52	72.72	4.31	3.17	1.76	15.03	6.86	4.06	59.21	5.18	1.93	70
32	Chromium, Cr (mg/kg)	0.03	5.71	2.21	2.42	109.54	<0.001	<0.001	0.003	2.880	1.317	1.160	88.08	<0.001	<0.001	100
33	Iron, Fe (mg/kg)	118.5	622.5	296.9	112.6	37.9	163.0	227.5	35.50	631.40	325.66	128.74	39.53	491.6	321.2	-
34	Lead, Pb (mg/kg)	0.61	4.28	2.77	0.88	31.81	3.17	3.17	0.88	5.92	3.55	1.11	31.32	3.56	3.77	164
35	Copper, Cu (mg/kg)	7.36	25.27	15.36	5.34	34.76	13.04	19.65	2.15	40.08	16.86	7.55	44.80	11.71	16.82	100
36	Zinc, Zn (mg/kg)	3.98	65.68	10.46	12.18	116.36	2.34	4.29	4.06	58.05	8.77	8.40	95.76	5.02	6.79	421
37	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	4
38	Arsenic, As (mg/kg)	0.02	0.22	0.12	0.05	45.6	0.09	0.17	0.05	0.90	0.19	0.13	68.42	0.21	0.18	20
39	HUB (CFU/g) x 103	1.3	3.6	2.3	0.6	25.8	2.2	2.7	0.36	2.72	1.07	0.51	47.49	0.54	1.07	-
40	HUF (CFU/g) x 103	0.3	1.6	0.9	0.3	30.4	1.1	0.8	0.20	1.20	0.55	0.23	42.22	0.7	0.5	-
41	THB (CFU/g) x 106	2.1	4.7	3.6	0.7	19.1	3.1	4.3	1.15	3.48	2.34	0.60	25.50	1.93	2.68	-

S/N	Parameter(s)	Topsoil							Subsoil							NESREA limit[21]
		Min	Max	Ave	StDv	CV	SSC 1T	SSC 2T	Min	Max	Ave	StDv	CV	SSC 1B	SSC 2B	
42	THF (CFU/g) x 106	1.1	3.2	2.3	0.5	23.9	1.5	2.9	0.30	2.30	1.28	0.46	35.77	0.9	2.1	-

4.4.9.5Land Use

The proposed 76km Natural Gas Pipeline project is to be laid partly within an existing right of way (RoW) (approximately 65 km) and partly within a new RoW (approximately 11 km), and traverses 22 communities, five Local Government Areas (Eleme, Ikwerre, Etche, Obio/Akpor and Ohaji/Egbema) and two states (Rivers and Imo). The 65 km existing RoW has been established and in use for an extended period and already accommodates the 83 km IFF pipeline. Therefore, construction within this section is not expected to result in physical displacement, economic displacement, or additional resettlement of people or livelihoods, subject to confirmation through the land and social baseline survey. However, the remaining 11 km of new RoW will require land acquisition and may result in potential physical and/or economic displacement, including loss of land, crops, structures and other livelihood assets. These impacts will be assessed through the Resettlement Action Plan (RAP) and managed in accordance with applicable Nigerian requirements and AfDB OS5 – Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement. Observations made within the study environment during the field data gathering in December 2023 revealed that residential areas made up the largest percentage (40%) of the land use, followed by industry covering approximately 30% of the area.

Table 4.17: Observed land use pattern within the study area

Land use	Percentage
Residential	40%
Industry	30%
Agriculture	20%
Undistributed forest	10%
Habitat protected area	0%

4.4.10 Hydrogeology

4.4.10.1 Hydrogeological setting

The bulk of groundwater in the Niger Delta is contained in very thick and extensive sediments of the Benin Formation. In general, the hydrogeological data in the upland areas of the Niger Delta have very broad similarities not only on the sub surface lithology but also in the overall aquifer characteristics. The exploited aquifers in the Niger Delta including the Greater Port Harcourt are derived from the Benin Formation (The Coastal Plain Sands). Basically, the Benin Formation is unconsolidated and consists of very thick sediment over 2000meters thick. The sand sediments of Benin Formation are intercalated with layers of clay, and this has given rise to a multi layered aquifer system a common feature of the Niger Delta. The major recharge to the aquifers of the Niger Delta is from precipitation.

4.4.10.2 Static Water Level

Groundwater was not in any trial pits dug and any soil auger hole. The maximum depth to each trial hole is 1.5m and 3.0m for the soil auger holes. This suggest that groundwater occurs at depths beyond 3.0m across the site. Although groundwater was encountered in all surrounding residential boreholes where water samples were collected, depth to water levels were not determined within the boreholes. Abam (2016) collated depth to water levels for most boreholes in the Niger Delta (particularly Rivers State) which includes the study area and revealed depth to groundwater in the area ranges from 0.0m at the Mangrove Swamp Forest to 10.0m more inland.

4.4.10.3 Groundwater Flow Direction

Water tables in unconfined aquifers varies with season. The groundwater level, although not measured, it is a known fact that it mimics the surface topography to a large degree. Hence, groundwater flows from the northwest towards the southeastern part of the area. This trend is expected since surface topography is highest towards the northwest and lowest towards the southeastern part of the project site.

4.4.10.4 Groundwater Recharge and Discharge

The major source of aquifer recharge in the project area is surface precipitation (rainfall). With rainfall varying from 2000 mm inland of the Delta to 3600mm at the coastline, it is reasonable to attribute the source of recharge of the aquifers in the region to precipitation (Abam and Nwankwoala, 2020). Precipitation generates about 70×10^6 m^3 of fresh water per annum, 75% of which occurs between April and October of every year. Analysis of Rainfall and concurrent evaporation indicates that 80% of the precipitation is lost to evapo-transpiration, leaving 20% which contributes to surface runoff and infiltration into the sub-surface to eventually recharge the groundwater (Abam and Nwankwoala, 2020).

Groundwater recharge in the eastern part of the niger Delta region estimated using the methods of Krishna (1970) and Chaturvedi (1973) gave values of 405 mm and 304 mm respectively. An estimated groundwater recharge of 31.9 BCM/year was predicted by JICA (2014), for the Niger delta region of Nigeria. This value is just below that of the Southeast region which is the highest in Nigeria. The high perennial aquifer recharge in the area is supported by the abundant rainfall averaging 2532 mm/year, favorable geology, vast catchment area, North Southwards groundwater flow and presence of a rich network of freshwater rivers and streams in the area. Discharge sources in the area include groundwater abstraction from residential boreholes, tube wells and hand dug wells located within the project area and evapo-transpiration.

4.4.10.5 Aquifer Hydraulic Properties

Due to the persistence of the Benin Formation across the Niger Delta which includes the study area, the hydrogeological data in the up-land areas of the Niger Delta have very

broad similarities not only on the subsurface lithology but also in the overall aquifer hydraulic properties of permeability, storativity and specific capacity (Abam and Nwankwoala, 2020).

According to Offodile (2002), the hydraulic conductivities of the sandy units in Benin Formation vary from 3.82×10^{-3} to 9.0×10^{-2} cm/sec indicating a potentially productive aquifer. The transmissivity values for the aquifers across the Niger delta region range from 1.05×10^{-3} to 11.3×10^{-2} m^2 /sec, while the coefficient of storage varies between 1.07×10^{-4} and 3.53×10^{-4} and specific capacity values lie between 19.01 and 139.8 m^3 /h/m drawdown. These values suggest that the sandy aquifers in the Niger Delta have very good capacity to transmit groundwater (Offodile, 2002).

4.4.10.6 Groundwater Use/availability

Groundwater in the study area is primarily utilized for domestic purposes, including drinking, cooking, bathing, and washing. A few industries in the area also rely on groundwater for their industrial needs. However, the use of groundwater for irrigation is minimal due to fallow farming practices and the extended rainy season in the study area. Groundwater is available at the depth of 1.5m and 3.0m within the project environment tapped household borehole installations, hand dug well and monopumps.

4.4.10.7 Groundwater quality

Table 4.18 presents the summary results of groundwater quality along the RoW, the detailed results is presented in Annexure 4.4. The chemistry of groundwater varies from place to place depending on the nature of the subsoils and rocks through which it comes in contact with. Therefore, in considering the impact of anthropogenic activities on groundwater quality, it is necessary to first consider the natural (or baseline) water quality. This will help determine any potential impact that may affect groundwater quality from construction activities. Groundwater is usually considered pure and safe to drink as it undergoes a filtering and cleansing process through a subsoil cover and rock medium that surface waters do not have. However, this does not guarantee groundwater purity. Problems can arise either due to the natural conditions in the ground or pollution by human activities. The results of physicochemical parameters determined in groundwater within the vicinity of the pipeline ROW project is presented in Table 4.18. The data represent the prevailing water quality status of the groundwater system within the project site and would serve as a reference for future monitoring.

Groundwater pH ranged from 4.27 to 7.86 during the dry season, with a mean of 6.27 ± 1.25, and from 4.56 to 7.55 during the wet season, with a mean of 6.12 ± 1.01 (Table 4.18). The results indicate that groundwater within the vicinity of the pipeline RoW was generally slightly acidic in both seasons. The seasonal mean pH decreased slightly during the wet season. Several groundwater samples recorded pH values below the stated

NSDWQ and WHO potable-water range of 6.5–8.5. The control stations at Indorama complex (GWC1) and ANOH gas plant (GWC2) also recorded acidic conditions, with dry-season pH values of 5.16 and 4.68 and wet-season values of 5.12 and 5.31, respectively. The persistence of low pH in both project and control locations indicates that acidity is an important baseline characteristic of the groundwater system.

Total dissolved solids (TDS) ranged from 6.70 to 84.90 mg/L in the dry season, with a mean of 22.36 ± 21.30 mg/L, and from 5.90 to 76.20 mg/L in the wet season, with a mean of 21.03 ± 19.55 mg/L. Electrical conductivity (EC) ranged from 12.00 to 169.50 µS/cm in the dry season and from 10.30 to 142.60 µS/cm in the wet season, with corresponding means of 43.25 ± 42.20 and 38.84 ± 36.96 µS/cm. Both TDS and EC were well below the stated NSDWQ limits of 500 mg/L and 1,000 µS/cm, respectively. The slight reduction in mean EC and TDS during the wet season is consistent with dilution associated with increased recharge. Groundwater appearance was clear in the sampled and control boreholes. Turbidity ranged from <1.0–1.60 NTU in the dry season and 0.01–1.80 NTU in the wet season, with mean values of 1.15 ± 0.22 and 0.76 ± 0.66 NTU, respectively; these values remained below the NSDWQ limit of 5 NTU. TSS remained below the analytical detection limit of 1.0 mg/L in both seasons.

Total alkalinity ranged from 8–16 mg/L in the dry season, with a mean of 10.68 ± 2.17 mg/L, and from 6–16 mg/L in the wet season, with a mean of 9.73 ± 2.43 mg/L. Total hardness ranged from 2–42 mg/L in the dry season and 2–26 mg/L in the wet season, with corresponding mean values of 9.23 ± 10.17 and 6.82 ± 6.33 mg/L. These values are well below the stated NSDWQ limit of 150 mg/L and classify the groundwater as soft water, since the measured hardness values are below 75 mg/L. The lower wet-season mean hardness may reflect dilution and seasonal recharge.

The groundwater appearance is clear and turbidity values ranged from <1.0 to 1.60 with an average of 1.15 NTU which is within NSDWQ regulatory guidelines of 5 NTU. Total soluble solids is below detectable limit of 1.0 mg/L in all sampled boreholes which includes the control boreholes.

Anionic composition during the dry season followed the order $Cl > SO_4 > NO_3 > PO_4$. The same general pattern of low concentrations was maintained during the wet season. Chloride decreased from a dry-season mean of 10.09 ± 11.23 mg/L to 4.63 ± 4.47 mg/L in the wet season, remaining well below the NSDWQ limit of 250 mg/L. Sulphate decreased from a dry-season mean of 2.45 ± 1.71 to 1.66 ± 1.29 mg/L and remained below the stated NSDWQ and WHO limits. Nitrate increased slightly from a dry-season mean of 0.60 ± 0.49 mg/L to 0.87 ± 0.53 mg/L, but remained far below the NSDWQ/WHO limit of 50 mg/L. Phosphate was below 0.10 mg/L in the dry season and had a wet-season mean of

0.06 ± 0.04 mg/L, with a maximum of 0.11 mg/L. Generally, the nutrient and major-anion concentrations indicate low dissolved nutrient loading in the groundwater.

Cationic composition revealed the general order Na > Ca > K > Mg. Mean sodium value decreased from 4.56 ± 3.43 mg/L in the dry season to 3.57 ± 2.50 mg/L in the wet season, remaining below the stated NSDWQ limit of 200 mg/L. Also, mean calcium decreased from 2.78 ± 3.05 in the dry season to 2.09 ± 2.22 mg/L in the wet season. Potassium remained low, with mean concentrations of 0.77 ± 1.11 and 0.75 ± 0.80 mg/L in the dry and wet seasons, respectively. Mean magnesium decreased from 0.48 ± 0.62 in the dry season to 0.33 ± 0.48 mg/L in the dry season. The generally low concentrations of the major cations are consistent with the low EC and TDS values observed in the groundwater.

Dissolved oxygen (DO) ranged from 3.50–5.00 mg/L in the dry season, with a mean of 4.29 ± 0.41 mg/L, and from 4.40–6.50 mg/L in the wet season, with a mean of 5.84 ± 0.54 mg/L. The wet-season increase suggests improved oxygenation of the groundwater system during the sampling period. BOD ranged from 1.50–4.80 mg/L in the dry season and 1.00–6.00 mg/L in the wet season, with mean values of 3.09 ± 1.14 and 3.32 ± 1.61 mg/L, respectively. COD increased from a dry-season mean of 5.66 ± 3.23 mg/L to a wet-season mean of 6.27 ± 3.51 mg/L.

Table 4.18: Results of groundwater physicochemical, heavy metal and bacteriological parameters within the study area

Parameter(s)	Unit	DRY SEASON						WET SEASON						NSDWQ (2007)	WHO (2011)
		Min	Max	Mean	St. Dev	GW C1	GW C2	Min	Max	Mean	St. Dev	GW C1	GW C2		
pH		4.27	7.86	6.27	1.25	5.16	4.68	4.56	7.55	6.12	1.01	5.12	5.31	6.5-8.5	6.5-8.5
Temperature	°C	26.60	36.50	30.57	3.42	28.40	28.60	25.7	28.1	26.49	0.63	27.3	27.2	Ambient	NA
Appearance		-	-	-	-	-	*Clear*	-	-	-	-	Clear	Clear	NA	NA
EC	µs/cm	12.00	169.50	43.25	42.20	26.80	52.60	10.3	142.6	38.84	36.96	30.6	46.9	1000.00	1000.00
TDS	mg/L	6.70	84.90	22.36	21.30	25.80	26.40	5.9	76.2	21.03	19.55	16.8	26.2	500.00	500.00
Turbidity	NTU	<1.0	1.60	1.15	0.22	<1.0	<1.0	0.01	1.8	0.76	0.66	0.47	0.13	5.00	5.00
TSS	mg/L	<1.0	<1.0	<1.0	0.00	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NA	5.50
Total Hardness	mg/L	2.00	42.00	9.23	10.17	*5.00*	*15.00*	2	26	6.82	6.33	4.0	8	150.00	100.00
Total Alkalinity	mg/L	8.00	16.00	10.68	2.17	*10.00*	*8.00*	6	16	9.73	2.43	9	6	NA	50.00
Chloride	mg/L	2.00	45.00	10.09	11.23	*6.00*	*8.00*	1.42	20.56	4.63	4.47	1	1	250.00	250.00
Sulphate	mg/L	1.00	7.00	2.45	1.71	*2.00*	*4.00*	0.37	6.05	1.66	1.29	3	2	100.00	250.00
Nitrate	mg/L	0.10	1.80	0.60	0.49	*0.60*	*1.00*	0.2	2.2	0.87	0.53	0.9	1.4	50.00	50.00
Phosphate	mg/L	<0.10	<0.10	<0.10	0.00	<0.10	<0.10	0.01	0.11	0.06	0.04	0.01	0.01	NA	1.00
Cyanide	mg/L	<0.001	<0.001	<0.001	0.00	<0.001	<0.01	<0.001	<0.001	<0.001	0.00	<0.001	<0.01	0.01	NA
Ammonia	mg/L	<0.10	<0.10	<0.10	0.00	<0.10	<0.10	<0.10	<0.10	<0.10	0.00	<0.10	<0.10	NA	1.50
Silica	mg/L	2.00	8.30	5.57	1.62	*9.60*	*3.80*	1.85	517	28.01	109.23	8.89	4.04	NA	NA
Salinity	mg/L	0.01	0.08	0.02	0.02	0.01	0.01	0.01	0.05	0.02	0.01	0.01	0.01	NA	NA
Oil & Grease	mg/L	*<1.00*	*<1.00*	*<1.00*	0.00	*<1.00*	*<1.00*	0	0	0	0	0	0	NA	10.00
DO	mg/L	3.50	5.00	4.29	0.41	3.90	3.60	4.4	6.5	5.84	0.54	4.9	4.8	NA	6.00
BOD	mg/L	1.50	4.80	3.09	1.14	*<1.00*	*1.90*	1	6	3.32	1.61	2.0	1.9	NA	6.00
COD	mg/L	2.00	12.50	5.66	3.23	*2.60*	*4.50*	2	13.11	6.27	3.51	3.01	5.02	NA	10.00
Sodium	mg/L	1.41	12.47	4.56	3.43	*2.96*	*2.38*	1.14	9.83	3.57	2.50	2.15	2.01	200.00	50.00
Potassium	mg/L	0.06	3.96	0.77	1.11	*0.18*	*0.43*	0.05	2.85	0.75	0.80	0.13	0.36	NA	12.00
Calcium	mg/L	0.51	12.27	2.78	3.05	*1.53*	*4.61*	0.31	8.72	2.09	2.22	1.22	2.86	NA	100.00
Magnesium	mg/L	0.07	2.65	0.48	0.62	*0.29*	*0.68*	0.02	2.01	0.33	0.48	0.23	0.51	20.00	150.00
Manganese	mg/L	0.03	0.16	0.07	0.04	*0.07*	*0.13*	0.089	0.201	0.13	0.03	0.105	0.151	0.20	0.10

Parameter(s)		DRY SEASON						WET SEASON						NSDWQ (2007)	WHO (2011)
	Unit	Min	Max	Mean	St. Dev	GW C1	GW C2	Min	Max	Mean	St. Dev	GW C1	GW C2		
Iron	mg/L	0.05	0.25	0.16	0.06	*0.17*	*0.24*	0.107	0.306	0.21	0.06	0.267	0.325	0.30	0.30
Copper	mg/L	0.02	0.20	0.08	0.05	*0.07*	*0.12*	0.051	0.93	0.20	0.18	0.116	0.180	1.00	2.00
Zinc	mg/L	0.01	0.07	0.03	0.01	*0.01*	*0.08*	0.041	0.746	0.13	0.14	0.093	0.102	3.00	3.00
Arsenic	mg/L	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	0.01	0.01
Chromium	mg/L	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	0.05	0.05
Lead	mg/L	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	0.01	0.01
Mercury	mg/L	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	0.001	0.006
Nickel	mg/L	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	0.02	0.07
Cadmium	mg/L	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	<0.001	0.00	<0.001	<0.001	0.003	0.003
HUB	CFU/ml x 10^2	0.10	0.60	0.37	0.16	*0.40*	*0.40*	0.1	0.7	0.39	0.21	0.4	0.5	NA	NA
HUF	CFU/ml x 10^2	0.10	0.40	0.18	0.09	*0.30*	*0.10*	0	0.4	0.16	0.10	0.3	0.2	NA	NA
THB	CFU/ml x 10^2	1.40	2.70	1.91	0.39	*2.20*	*1.70*	1	5.1	2.87	1.16	2.8	2.4	NA	NA
THF	CFU/ml x 10^2	0.40	1.80	1.03	0.38	*1.20*	*0.80*	0.7	2	1.36	0.40	1.7	1.0	NA	NA
Total Coliform	MPN/100ml	0.00	4.00	0.73	1.28	2.00	3.00	0	3	1.32	1.17	2	2	10.00	0.00
Faecal Coliform	MPN/100ml	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00

Heavy-metal concentrations in groundwater were generally low. Arsenic, chromium, lead, mercury, nickel and cadmium were below detection limits in both seasons. Manganese ranged from 0.03 to 0.16 mg/L in the dry season, with a mean of 0.07 ± 0.04 mg/L, and from 0.089 to 0.201 mg/L in the wet season, with a mean of 0.13 ± 0.03 mg/L. Iron increased from a dry-season mean of 0.16 ± 0.06 mg/L to 0.21 ± 0.06 mg/L in the wet season and remained below the stated 0.30 mg/L guideline. Mean copper increased from 0.08 ± 0.05 to 0.20 ± 0.18 mg/L, while mean zinc increased from 0.03 ± 0.01 to 0.13 ± 0.14 mg/L; both remained below the stated NSDWQ/WHO limits.

Microbiological results showed no faecal coliforms in the groundwater samples or control boreholes during either season. Total coliforms, however, were detected. During the dry season, total coliform ranged from 0 to 4.0 MPN/100 ml, with a mean of 0.73 ± 1.28 MPN/100 ml; during the wet season, it ranged from 0 to 3.0 MPN/100 ml, with a mean of 1.32 ± 1.17 MPN/100 ml. Total coliform was also recorded at the control stations. The increase in mean total coliform during the wet season may be associated with seasonal recharge and mobilisation of microorganisms from the surrounding environment. THB increased from a dry-season mean of 1.91×10^2 CFU/ml to 2.87×10^2 CFU/ml in the wet season, while THF increased from a dry-season mean of 1.03×10^2 to 1.36×10^2 CFU/ml in the wet season. HUB remained relatively low, with mean values of 0.37×10^2 and 0.39×10^2 CFU/ml in the dry and wet seasons, respectively. HUF remained low, with corresponding means of 0.18×10^2 and 0.16×10^2 CFU/ml in the dry and wet seasons, respectively. In summary, the microbiological results indicate low microbial abundance and no detectable faecal contamination, although the occurrence of total coliform warrants continued sanitary protection of groundwater sources in the study area.

4.4.10.8 Hydrochemical evolution and composition of groundwater

Piper diagram was used for understanding and describing chemical evolution of groundwater which depends on pattern recognition techniques and permits the classification of water. It can also define the patterns of spatial change in the water chemistry among geological units, along a line of the section or along a path line. It is therefore useful in understanding the water flow and water quality (Sikdar and Bhattacharya 1999), and the changes in water types and mixing relationships based on the relative proportions of major ions rather than the bulk concentrations. Hence, the Piper diagram is the most widely used method for delineation of hydrochemical evolution and identification of dominant processes that control water chemistry. Piper diagram constructed for groundwater within the vicinity of the pipeline ROW is presented in Figure 4.38. Two groundwater classes were recognized across the site on Piper diagram (Calcium-Chloride water type and Sodium-Chloride water type).

Stiff diagram, a complementary tool to the Piper Diagram, shows how the ionic composition of a water body changes over space and time. It is a relatively distinctive method of showing differences or similarities in water and changes in the water composition with depth. It is useful especially for illustrating the chemical composition in hydrogeologic cross sections. It can also be used for classification purposes and is useful as a symbol on a map. The stiff diagrams which represent the chemical composition of water types in the study area are presented in Annexure 4.4. Stiff diagrams revealed a predominance of Sodium-Chloride water type and minor Calcium-Chloride water type. These results agrees with the interpreted Piper diagram.

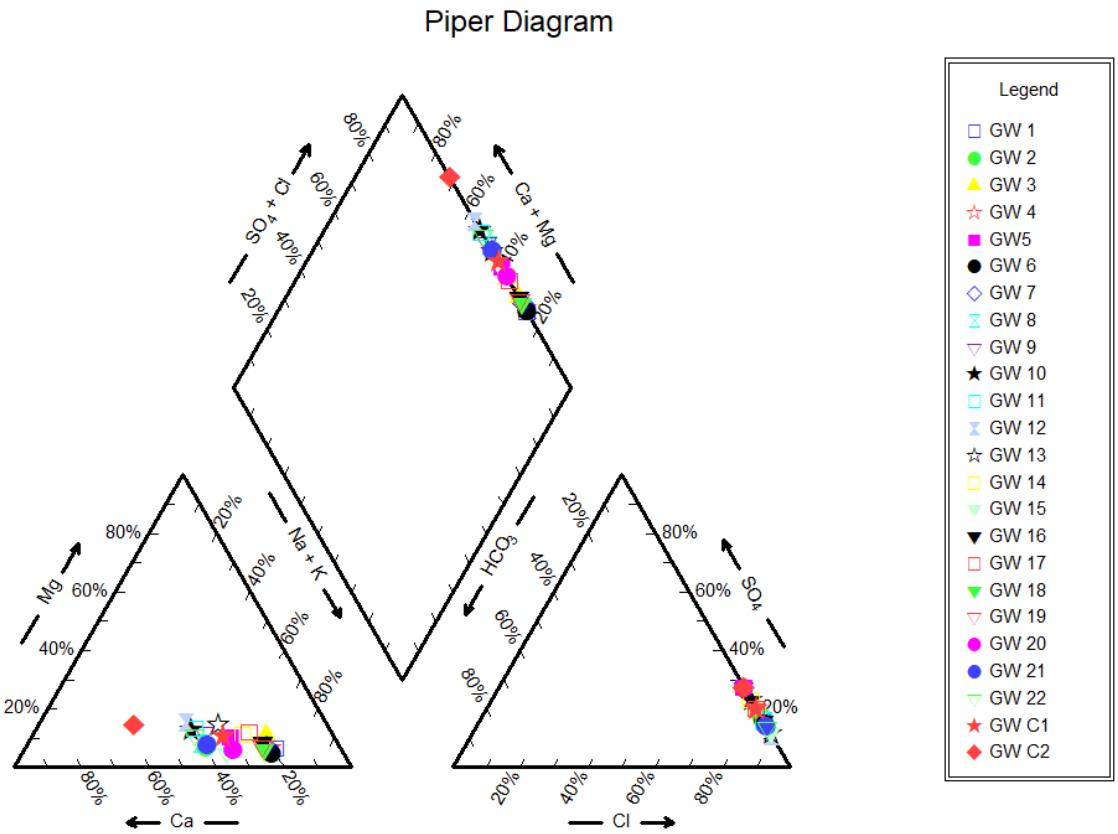


Figure 4.38: Piper diagram showing groundwater chemistry across the project site

4.4.11 Surface Water

4.4.11.1 Introduction

This Section presents the baseline for surface water and has assessed the surface water resources and associated riverine sediments in the region of the Project.

Surface water samples was conducted with the aid of a water sampler from the Egbeda stream, Otamiri stream and Okulu stream in the study area. Upon collection of surface water samples, in-situ measurement was carried out for conductivity, temperature, salinity, pH, dissolved oxygen and turbidity. Samples was afterwards sub sampled into recommended bottles and preserved in ice chest for transfer to the laboratory for further analysis. Sample analysis was carried out in FMEnv approved laboratory.

4.4.11.2 Regional Setting

The proposed natural gas pipeline Project run through a 76km distance from Indorama complex to AGPC facility in Asa North in Imo State which is within the coastal plains of the eastern Niger Delta basin and wetlands. The proposed Right of Way (ROW) environment was formed on the dry islands between the low-lying mangrove swamps that form part of the Bonny River delta, therein part of the broader Niger Delta basin (Lawal and Umeuduhi,

2017). The mainstem of the Niger River lies approximately 100 km west of the Project of the project environment. The region between Port Harcourt and the Gulf of Guinea (open ocean lies approximately 45 km to the south of the city and the site) is further made up of swampy low-lying islands between a dense network of creeks, streams and wider rivers that form the Bonny River estuary. The Bonny River estuary is an important waterway for shipping and transportation of goods. The project environment is majorly drain by Otamiri River which take its course from Imo running into River State through Etche with closest proximity to the Pipeline RoW around Chokocho. The waterbody is fresh.

4.4.11.3 Local (Site) Setting

Waterbody within the pipeline RoW are Egbede stream, Otamiri rivers and Okulu river. The closest waterbody to the pipeline RoW is the Otamiri river at about 7km, while Egbeda stream and Okulu River are way off the pipeline RoW refer to surface water sampling map. Both Otamiri and Okulu Rivers are under serious sand mining/dredging activities which has change the physiognomy of the watterbodies. Land use within and around the waterbodies are largely residential and agricultural with vegetable farming, cattle grazing and industrial activities. Few industrial activities within pipeline RoW include poultry farms, farmlands, markets, block industry and other Industrial/commercial activities. The river is used for cleaning, sand mining not used for particular purposes, but community domestic waste is routinely dumped on the riverbanks. In addition to this, the Okulu River has been subjected to intense sand mining/dredging over the years, which has significantly altered and widened the physiognomy of waterbody as such is currently tidal. The channel flowing south from the current Indorama Complex to the Okulu River has also widened significantly over time. The commercial sand mining (through mechanical and manual means) had also resulted in high turbidity and regular bank collapses and ongoing erosion (Onyeugbo et al, 2021).

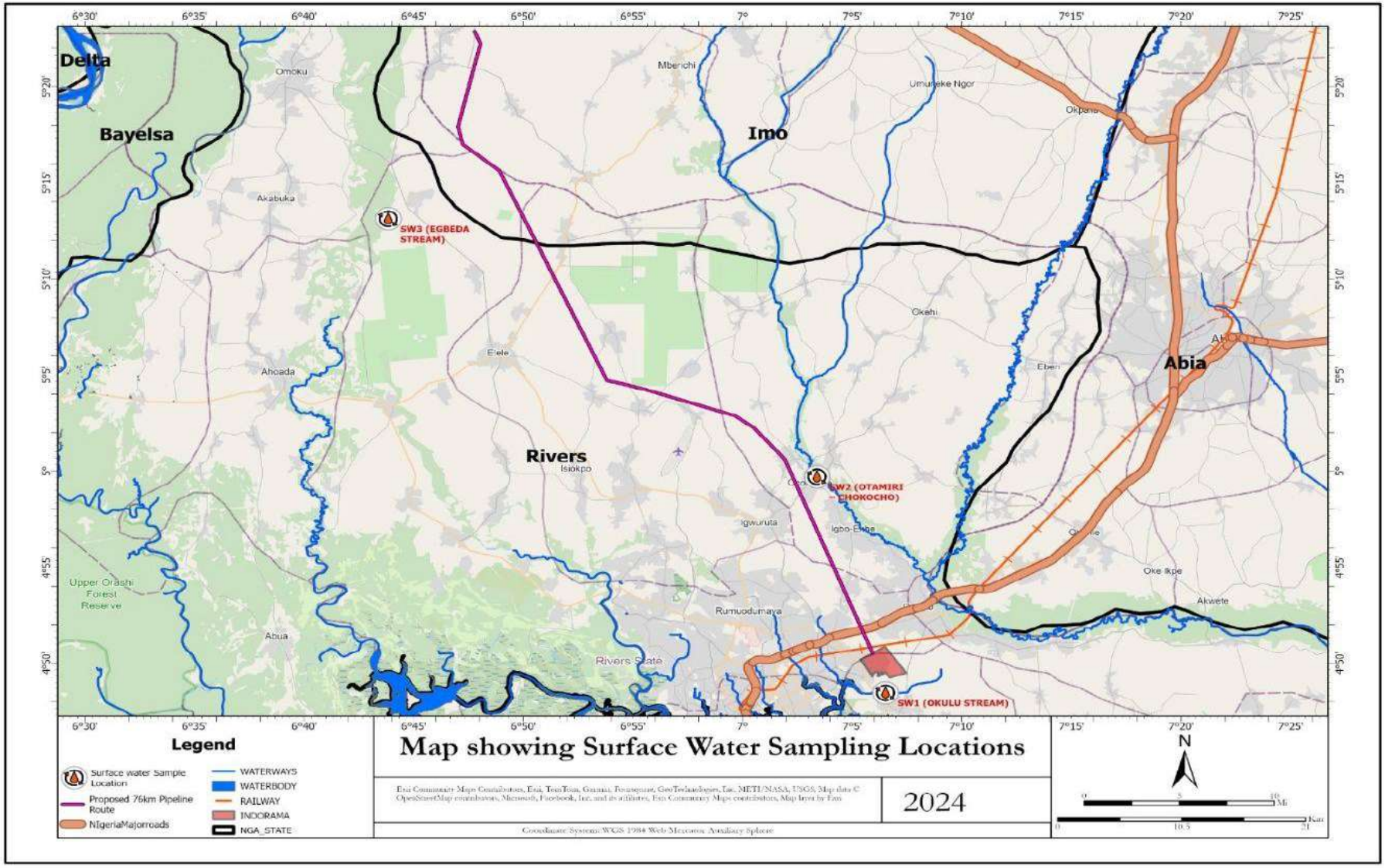


Figure 4.39: Map showing Surface Water Sampling Location

4.4.11.4 Surface Water Quality

Table 4.19 presents the summary of surface-water quality results obtained from the three sampling stations during the dry and wet seasons for the proposed 76 km natural gas pipeline, together with the applicable NESREA limits. Detailed analytical results are presented in Annexure 4.5. The comparison of the two seasons provides a representation of the baseline condition of the surface-water environment. Surface-water depth ranged from 3.8 to 5.7 m during the dry season and 4.7 to 6.8 m during the wet season, with corresponding mean values of 4.53 ± 1.02 m and 5.67 ± 0.87 m. The increase in mean depth during the wet season is consistent with increased water availability associated with rainfall. Water temperature ranged from 26.6 to 31.2°C in the dry season, with a mean of 28.63 ± 2.35°C, and from 25.8 to 27.3°C in the wet season, with a mean of 26.47 ± 0.62°C. The lower wet-season temperature reflects seasonal differences in atmospheric conditions and sampling conditions. Surface-water pH remained within the stated NESREA range of 6.5 to 8.5 in both seasons, with mean values of 7.56 ± 0.06 and 7.76 ± 0.06 for the dry and wet seasons, respectively. The waters were therefore generally neutral to slightly alkaline. Colour was reported as clear at the sampled stations. Turbidity increased during the wet season, from 4.97 ± 0.57 NTU in the dry season to 9.60 ± 2.69 NTU, while TSS increased from 3.77 ± 0.65 mg/l to 5.60 ± 1.07 mg/l. The wet-season increase in turbidity and suspended solids indicates increased suspended material in the water column during the rainy period. Electrical conductivity showed substantial variability among the sampling locations in both seasons. The dry-season values ranged from 18 to 7,720 µS/cm, with a mean of 2,591.67 ± 4,441.28 µS/cm, whereas wet-season values ranged from 16.2 to 5,264 µS/cm, with a mean of 1,769.33 ± 2,471.11 µS/cm. TDS similarly decreased from a dry-season mean of 1,306.67 ± 2,237.24 mg/l to 887.53 ± 1,239.89 mg/l during the wet season. Salinity remained relatively similar between seasons, with mean values of 1.48 ± 2.53 ppt in the dry season and 1.56 ± 2.19 ppt in the wet season. These results reflect the mixed freshwater and brackish-water character of the sampling locations and the influence of seasonal hydrological conditions. Dissolved oxygen ranged from 4.6–5.8 mg/l in the dry season and 5.2–5.6 mg/l in the wet season, with mean concentrations of 5.33 ± 0.64 mg/l and 5.40 ± 0.16 mg/l, respectively. Both seasonal mean values were above the stated NESREA minimum of 4.0 mg/l, indicating adequate dissolved oxygen conditions for aquatic organisms. BOD5 ranged from 10.0–16.2 mg/l in the dry season and 9.0–17.0 mg/l in the wet season, with mean values of 12.73 ± 3.16 mg/l and 12.33 ± 3.39 mg/l. COD ranged from 32.4–54.4 mg/l in the dry season and 30.5–48.3 mg/l in the wet season, with mean values of 41.87 ± 11.32 mg/l and 37.20 ± 7.91 mg/l.

Anions (***Nitrates, Sulphates and Phosphates)***

Nutrients (NO^{3-}, SO_4^{2-}, PO_4^{3-}) are present in a dissolved form in surface water. The concentrations of all the nutrients obtained were similar in Otamiri River (SW2) and Egbeda River (SW3). Sulphates were higher in the surface water than nitrate and phosphate. Also, low nitrate values were obtained in Okulu Stream (SW1).

Heavy Metals

The summary of heavy-metal concentrations recorded in the surface water is presented in Table 4.19. Most of the investigated metals were below the analytical detection limit in both the dry and wet seasons. Silver (Ag), cobalt (Co), vanadium (V), nickel (Ni), chromium (Cr), lead (Pb), mercury (Hg), cadmium (Cd) and arsenic (As) were all reported as <0.001 mg/l in both seasons. Manganese, iron, copper and zinc were detected at measurable concentrations. Mean manganese increased from 0.031 mg/l in the dry season to 0.060 mg/l in the wet season, while mean iron increased from 0.128 mg/l to 0.150 mg/l. Mean copper decreased from 0.052 mg/l to 0.040 mg/l, whereas mean zinc increased slightly from 0.047 mg/l to 0.050 mg/l. The mean iron and zinc concentrations were below their stated NESREA limits of 0.5 mg/l and 0.2 mg/l, respectively.

Microbiology

Microbiological results showed seasonal variation in the abundance of heterotrophic and indicator organisms. Total Heterotrophic Bacteria (THB) ranged from 2.0×10^2 to 2.4×10^2 CFU/ml during the dry season, with a mean of 2.17×10^2 CFU/ml, and from 2.0×10^2 to 9.6×10^2 CFU/ml during the wet season, with a mean of 5.03×10^2 CFU/ml. Total Heterotrophic Fungi (THF) increased from a dry-season range of 1.1×10^2 to1.6×10^2 CFU/ml and mean of 1.30×10^2 CFU/ml to a wet-season range of 1.4×10^2 to 2.7×10^2 CFU/ml and mean of 2.00×10^2 CFU/ml. Heterotrophic fungi capable of utilising petroleum hydrocarbons as a source of carbon and energy were detected in the surface-water samples. The higher wet-season heterotrophic counts may be associated with increased runoff and mobilisation of organic materials into the surface-water system during rainfall. Human-associated microbial indicators were also higher during the wet season. Total coliform counts increased from 8 to 60 MPN/100 ml, with a dry-season mean of 29.33 MPN/100 ml, to 20–90 MPN/100 ml, with a wet-season mean of 47.33 MPN/100 ml. Faecal coliform counts increased from 0 to 23 MPN/100 ml, with a mean of 12.67 MPN/100 ml, to 9–35 MPN/100 ml, with a mean of 21.33 MPN/100 ml. The occurrence of faecal coliforms in both seasons suggests probable faecal contamination associated with activities within or around the study area, with a greater indicator count recorded during the wet season. The microbiological results therefore reinforce the need for appropriate control of wastewater, sanitation and runoff sources around the surface-water bodies, particularly during the wet season.

Table 4.19: Summary of the physicochemical and microbiological characteristics of the surface water in the study area

Parameter(s)	DRY SEASON				WET SEASON				NESREA[22]
	Min	Max	Mean	STDEV	Min	Max	Mean	STDEV	
Depth (meters)	3.8	5.7	4.53	1.02	4.7	6.8	5.67	0.87	
pH	7.49	7.61	7.56	0.06	7.7	7.82	7.76	0.056	6.5-8.5
Temperature (oC)	26.6	31.2	28.63	2.35	25.8	27.3	26.47	0.62	-
Elec. Conductivity (µs/cm)	18	7720	2591.67	4441.28	16.2	5264	1769.33	2471.11	-
TDS (mg/l)	11	3890	1306.67	2237.24	8.1	2641	887.53	1239.89	-
Turbidity (NTU)	4.5	5.6	4.97	0.57	5.8	11.8	9.6	2.69	-
TSS (mg/l)	3.1	4.4	3.77	0.65	4.1	6.5	5.6	1.07	0.75
Salinity (ppt)	0.01	4.4	1.48	2.53	0.01	4.67	1.56	2.19	-
Total Hardness (mg/l)	10	940	321.33	535.79	9	780	267	362.75	-
Alkalinity (mg/l)	30	65	45	18.03	18	60	32.67	19.34	-
Chloride, Cl- (mg/l)	8	2280	766.67	1310.59	35	1864	644.67	862.19	350
Sulphate, SO42- (mg/l)	2	345	117	197.47	5.15	181.62	67.04	81.11	500
Phosphate, PO43- (mg/l)	0.62	1.36	0.91	0.39	1.43	3.82	2.41	1.02	3.5
Nitrate, NO3- (mg/l)	0.56	3.36	1.6	1.53	1.99	5.12	3.13	1.41	40
Cyanide (mg/l)	0	0	0	0	0	0	0	0	-
Ammonia (mg/l)	0.2	0.68	0.39	0.25	0.43	0.94	0.65	0.22	2
Total Nitrogen (mg/l)	5.35	9.54	6.92	2.28	4.94	6.96	5.72	0.89	-
Oil & Grease (mg/l)	0	0	0	0	0	0	0	0	0.1
DO (mg/l)	4.6	5.8	5.33	0.64	5.2	5.6	5.4	0.16	<4.0
BOD5 (mg/l)	10	16.2	12.73	3.16	9	17	12.33	3.39	6
COD (mg/l)	32.4	54.4	41.87	11.32	30.5	48.3	37.2	7.91	30
Sodium, Na (mg/l)	12.35	1219.72	416.92	695.26	10.27	896.14	306.12	417.21	120
Potassium, K (mg/l)	1.23	28.68	10.56	15.69	2.6	31.52	12.309	13.59	50

[22] National Environmental (Surface and Groundwater Quality Control) Regulation Schedule I, II, III

Parameter(s)	DRY SEASON				WET SEASON				NESREA[22]
	Min	Max	Mean	STDEV	Min	Max	Mean	STDEV	
Calcium, Ca (mg/l)	2.88	298.96	101.99	170.58	1.52	207.04	70.56	96.51	180
Magnesium, Mg (mg/l)	0.57	45.47	15.62	25.85	0.287	29.57	10.10	13.77	40
Silver, Ag (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Manganese, Mn (mg/l)	0.016	0.056	0.031	0.022	0.032	0.104	0.06	0.03	-
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Nickel, Ni (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.1
Chromium, Cr (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.5
Iron, Fe (mg/l)	0.032	0.271	0.128	0.126	0.053	0.288	0.15	0.10	0.5
Lead, Pb (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.1
Copper, Cu (mg/l)	0.026	0.089	0.052	0.032	0.018	0.065	0.04	0.02	0.01
Zinc, Zn (mg/l)	0.032	0.075	0.047	0.024	0.03	0.081	0.05	0.02	0.2
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0005
Cadmium, Cd (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
HUB (CFU/ml) x 10^2	0.3	0.6	0.43	0.15	0.2	0.7	0.47	0.21	-
HUF (CFU/ml) x 10^2	0.1	0.4	0.23	0.15	0.5	1	0.7	0.22	-
THB (CFU/ml) x 10^2	2	2.4	2.17	0.21	2	9.6	5.03	3.29	-
THF (CFU/ml) x 10^2	1.1	1.6	1.3	0.27	1.4	2.7	2	0.54	-
Fecal Coliform (MPN/100ml)	0	23	12.67	11.68	9	35	21.33	10.67	-
Total Coliform (MPN/100ml)	8	60	29.33	27.23	20	90	47.33	30.57	-

4.4.11.5 Sediment

The physical and chemical characteristics of sediments provide an insight into the existing health status of the aquatic environment. Suspended environmental contaminants accumulate in aquatic sediment via gravitational deposition on the river floor. Sediments retain the impact of pollution long after it has occurred and are thus used for environmental monitoring. Sediments are the largest sink of contaminants and sources of pollution to the aquatic biota and environment with which they are associated. This repository of contaminants constantly turns over the pollutants to bottom dwellers, and surface water during up-welling and by current action. Sediment samples were collected from three streams in the study area at locations from where surface water samples are collected. Detailed physicochemical and microbiological characteristics of sediment samples are presented in Annexure 4.6 and summary in Table 4.20.

Physical Properties

The sediments encountered in the study area were generally classified as sandy loam, with sand particles predominating, followed by clay and silt. The sediment colour was predominantly black, with no significant variation in colour or particle-size matrix among the sampling locations. These characteristics indicate a relatively similar sedimentary environment across the investigated sampling stations. Seasonal differences were observed in the physical properties presented in Table 4.20. Sediment moisture content increased considerably from a dry-season mean of 27.90% to a wet-season mean of 41.83%. This increase is expected under wetter environmental conditions and reflects increased water availability and retention within the sediment matrix. The higher wet-season moisture content may also influence microbial activity, nutrient transformation and the mobility or partitioning of some chemical constituents within the sediment. Sediment porosity increased slightly from a dry-season mean of 0.362 to 0.38 during the wet season, while permeability increased from approximately 0.23 × 10 cm/sec in the dry season to 0.38 × 10 cm/sec in the wet season, based on the units presented in Table 4.20. Bulk density, however, increased from 1.29 g/cm³ in the dry season to 1.63 g/cm³ in the wet season. These changes indicate seasonal modification of the sediment physical structure and water-retention characteristics. The observed variation in sediment physical properties may be associated with seasonal changes in precipitation, surface-water flow, sediment deposition and re-suspension. Increased runoff during the wet season can

introduce and redistribute fine particles and organic materials within the aquatic system, thereby influencing sediment moisture, porosity, permeability and bulk density.

Sediment pH and Electrical Conductivity

Sediment pH during the dry season ranged from 5.00 to 5.30, with a mean of 5.17 ± 0.15, indicating slightly acidic sediment conditions. During the wet season, pH ranged from 4.69 to 5.79, with a mean of 5.15 ± 0.57. Thus, the mean sediment pH remained relatively similar between seasons, although the wet-season results exhibited a wider range and greater variability. The slightly acidic sediment condition may be associated with anaerobic conditions and the production of carbon dioxide through the decomposition of oxidisable organic matter. The recorded values are within the range reported as expected in natural environmental settings. Electrical conductivity showed a notable seasonal reduction. The dry-season EC ranged from 141 to 858 µS/cm, with a mean of 424 µS/cm, whereas the wet-season values ranged from 108 to 525 µS/cm, with a mean of 293 µS/cm. The reduction in mean EC during the wet season may be associated with dilution arising from increased rainfall and freshwater inflow, which can reduce the concentration of dissolved ionic constituents in the sediment-water interface. The higher EC observed at some dry-season locations, particularly within the Okulu stream system, is consistent with the influence of the estuarine/brackish environment.

Sulphide, Sulphate and Nutrient Characteristics

Sulphide concentrations remained below the analytical detection limit of <0.001 mg/kg during both seasons. The absence of measurable sulphide indicates that there was no significant accumulation of sulphide in the sampled sediments during either sampling period. Sediment sulphate concentrations decreased from a dry-season mean of 16.00 mg/kg to a wet-season mean of 11.00 mg/kg, with corresponding ranges of 10–25 mg/kg and 6–18 mg/kg, respectively. The seasonal reduction may reflect dilution, hydrological flushing and differences in organic matter decomposition processes between the two seasons. Variation in sediment sulphate concentrations may also be associated with differences in the rate of organic matter biodegradation within sedimentary layers. In contrast, nitrate increased from a dry-season mean of 2.30 mg/kg to 3.77 mg/kg in the wet season. Total nitrogen also increased from 0.221% to 0.30%, while phosphate increased from 1.46 mg/kg to 2.39 mg/kg. The increases in nitrate, total nitrogen and phosphate may be associated with increased surface runoff and the transport of nutrients and particulate organic matter into the streams during the wet season. Phosphate in sediments is primarily associated with particulate organic matter entering river systems. The wet-season increase in nutrient concentrations is therefore consistent with enhanced

hydrological connectivity and increased mobilisation of nutrient-bearing materials within the catchment.

Organic Matter Characteristics

The organic matter indicators showed slight seasonal differences. Total Organic Carbon (TOC) increased from a dry-season mean of 2.55% to 4.14% during the wet season, while Total Organic Matter (TOM) increased from 4.41% to 7.14%. Ammonia also increased from a mean of 0.38 mg/kg in the dry season to 0.95 mg/kg during the wet season. The increased TOC and TOM during the wet season may be associated with enhanced input of plant debris, soil organic matter and other organic materials transported by surface runoff into the aquatic environment. Increased organic matter availability can subsequently influence microbial processes and nutrient cycling within the sediments. The seasonal increase in organic matter is also consistent with the observed increase in microbial abundance during the wet season, particularly the total heterotrophic and hydrocarbon-utilising microbial populations. This suggests increased availability of biodegradable substrates under the wetter environmental conditions.

Exchangeable Cations

The concentrations of exchangeable cations were generally comparable among the sampling locations, although some seasonal variations were observed. Sodium decreased from a dry-season mean of 54.48 mg/kg to 46.15 mg/kg during the wet season. This reduction may partly reflect increased freshwater input and dilution during the wet season. Magnesium remained relatively stable, decreasing only slightly from a dry-season mean 20.79 mg/kg to 20.53 mg/kg during the wet season. Calcium remained below the detection limit in both seasons. Potassium increased slightly from a dry-season mean of 18.97 mg/kg to 20.24 mg/kg during the wet season. The observed variation in exchangeable cations may be influenced by clay minerals, sediment characteristics and direct interaction between sediments and the overlying surface water. The original assessment similarly attributed station-to-station variation in exchangeable cations to the influence of kaolinite and overlying surface waters.

Trace Elements in Sediments

The concentrations of the analysed trace elements were generally low and below the applicable EGASPIN (2018) intervention values for micropollutants in sediments. Chromium and mercury remained below detection limits during both seasons. Iron decreased slightly in mean concentration from 49.16 mg/kg during the dry season to 39.67 mg/kg during the wet season, although the wet-season range was wider, extending from 5.83 to 74.05 mg/kg. Iron and manganese are natural constituents of sedimentary materials, and the concentrations recorded were within ranges for Niger Delta sediments.

Manganese decreased from a dry-season mean of 4.34 mg/kg to 3.15 mg/kg in the wet season. Vanadium also decreased slightly from a dry-season mean of 0.49 mg/kg to 0.41 mg/kg in the wet season, while nickel increased from a dry-season mean of 10.30 mg/kg to 11.78 mg/k in the wet season. The mean concentrations of lead, copper, zinc and arsenic increased during the wet season. Lead increased from 3.68 to 4.47 mg/kg, copper from 9.13 to 12.58 mg/kg, zinc from 12.98 to 15.96 mg/kg, and arsenic from 0.08 to 0.19 mg/kg. Although these increases indicate seasonal changes in the distribution of these elements, the concentrations remained relatively low based on EGASPIN intervention values for micropollutants in sediments. The observed seasonal variations in trace-element concentrations may be associated with changes in runoff, sediment transport, particle deposition, organic matter content and interaction between the sediment and overlying water. In particular, increased wet-season runoff can transport naturally occurring and anthropogenically derived materials into receiving water bodies.

*Note on the use of EGASPIN values for sediment: The target and intervention values given in EGASPIN (2018) are derived for remediation decision-making and, in accordance with EGASPIN 2018 Part VIII-G, Section 8, they are standard values that must first be corrected for the organic matter and clay content of the particular sediment before a measured concentration can properly be compared against them. The comparisons made in this section have not been corrected in that way and are therefore presented only as a screening indication of sediment condition against a nationally recognised benchmark; they are not, and should not be read as, an assessment of whether remediation is required. The concentrations recorded in both seasons are in any event low and consistent with reported background ranges for Niger Delta sediments.

Hydrocarbon Characteristics

Hydrocarbon concentrations in the sediments were generally low during both seasons. Dry-season Total Hydrocarbon Content (THC) ranged from 2.12 to 3.51 mg/kg, with a mean of 2.77 mg/kg, while the wet-season values ranged from 3.42 to 4.16 mg/kg, with a mean of 3.77 mg/kg. TPH decreased slightly in mean concentration from 33.04 mg/kg in the dry season to 32.63 mg/kg in the wet season. The dry-season range was 23.30 to 41.30 mg/kg, while the wet-season range was 28.80 to 36.90 mg/kg. The similarity of the seasonal means suggests that there was no substantial seasonal change in the overall TPH burden of the sediments. Also, the TPH concentrations were below the reported EGASPIN target value of 50 mg/kg and intervention value of 5,000 mg/kg for sediment micropollutants. PAH concentrations were higher during the wet season, increasing from a dry-season mean of approximately 0.0037 mg/kg to approximately 0.02 mg/kg. Despite this increase, the absolute concentrations remained low. BTEX and phenol concentrations were below detection limits during both seasons. The seasonal pattern may reflect

differences in runoff, sediment transport and deposition during the wet season. Increased rainfall can mobilize hydrocarbon-bearing materials from surrounding surfaces and transport them into receiving streams. However, the relatively low THC and TPH concentrations, together with the non-detection of BTEX and phenol, indicate that the sediments were not characterized by a significant petroleum hydrocarbon burden at the time of sampling.

Sediment Microbiology

Microbiological characteristics showed pronounced seasonal differences. During the dry season, hydrocarbon-utilising bacteria (HUB) ranged from 0.8×10^3 to 1.3×10^3 CFU/g, with a mean of 0.97×10^3 CFU/g, while hydrocarbon-utilising fungi (HUF) ranged from 0.3×10^3 to 0.9×10^3 CFU/g, with a mean of 0.60×10^3 CFU/g. During the wet season, HUB increased substantially to $14–27 \times 10^3$ CFU/g, with a mean of 21×10^3 CFU/g, while HUF increased to $3–4 \times 10^3$ CFU/g, with a mean of 3.33×10^3 CFU/g. This marked increase indicates enhanced microbial activity associated with hydrocarbon-utilising organisms during the wet season. Total heterotrophic bacteria (THB) also increased considerably from a dry-season mean of 2.73×10^5 CFU/g to 23.23×10^5 CFU/g in the wet season. Similarly, total heterotrophic fungi (THF) increased from 1.70×10^5 CFU/g to 11.33×10^5 CFU/g. The increase in both total heterotrophic and hydrocarbon-utilising microorganisms during the wet season may be associated with increased organic matter and greater availability of nutrients observed in the wet-season sediments.

Table 4.20: Summary of the physicochemical and microbiological characteristics of the sediment in the study area

Parameter(s)	DRY SEASON				WET SEASON			
	MIN	MAX	MEAN	STDEV	MIN	MAX	MEAN	STDEV
pH	5.00	5.30	5.17	0.15	4.69	5.79	5.15	0.57
Moisture Content (%)	27.2	28.3	27.9	0.59	40.15	42.72	41.83	1.46
Sulphide, S_2 (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sulphate, SO_4^{2-} (mg/kg)	10	25	16	7.944	6.00	18.00	11.00	6.24
Nitrate, NO_{3-} (mg/kg)	2.0	2.5	2.3	0.27	3.50	4.10	3.77	0.31
Total Nitrogen (%)	0.209	0.231	0.221	0.01106	0.29	0.32	0.30	0.02
Phosphate, PO_4^{3-} (mg/kg)	1.21	1.75	1.46333	0.272	2.05	3.02	2.39	0.54
THC (mg/kg)	2.12	3.51	2.77	0.69	3.42	4.16	3.77	0.37
TPH (mg/kg)	23.3	41.3	33.04	9.09	28.80	36.90	32.63	4.07
PAH (mg/kg)	0.002	0.006	0.00367	0.002082	0.01	0.02	0.02	0.01
BTEX (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenol (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ammonia (mg/kg)	0.32	0.45	0.38	0.07	0.72	1.25	0.95	0.27
TOC (%)	2.415	2.675	2.552	0.13	4.00	4.43	4.14	0.25
TOM (%)	4.172	4.625	4.411	0.22	6.89	7.64	7.14	0.43
Electric Conductivity (µs/cm)	141	858	424	381.61	108.00	525.00	293.00	212.44
Porosity	0.36	0.365	0.362	0.003	0.37	0.40	0.38	0.01
Permeability (cm/sec) ×10	0.2	0.25	0.23	0.03	0.38	0.38	0.38	0.00
Bulk Density (g/cm^3)	1.26	1.31	1.29	0.03	1.61	1.64	1.63	0.02
Sodium, Na (mg/kg)	33.62	83.93	54.48	26.23	31.53	69.77	46.15	20.65
Magnesium, Mg (mg/kg)	20.31	21.07	20.79	0.42	20.01	20.94	20.53	0.47
Calcium, Ca (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameter(s)	DRY SEASON				WET SEASON			
	MIN	MAX	MEAN	STDEV	MIN	MAX	MEAN	STDEV
Potassium, K (mg/kg)	5.02	29.68	18.97	12.65	6.27	31.03	20.24	12.68
Manganese, Mn (mg/kg)	4.03	4.65	4.34	2.52	0.01	4.98	3.15	2.73
Vanadium, V (mg/kg)	0.49	0.49	0.49	0.28	0.41	0.41	0.41	0.24
Nickel, Ni (mg/kg)	10.3	10.3	10.3	5.95	11.78	11.78	11.78	6.80
Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron, Fe (mg/kg)	34.59	63.72	49.16	31.89	5.83	74.05	39.67	34.11
Lead, Pb (mg/kg)	3.44	3.86	3.68	0.22	4.18	4.72	4.47	0.27
Copper, Cu (mg/kg)	4.65	15.6	9.13	5.74	8.18	18.30	12.58	5.19
Zinc, Zn (mg/kg)	11.32	15.27	12.98	2.049	12.93	19.45	15.96	3.28
Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	0.04	0.14	0.08	0.05	0.13	0.27	0.19	0.07
HUB (CFU/g) x 10^3	0.8	1.3	0.97	0.29	14.00	27.00	21.00	6.56
HUF (CFU/g) x 10^3	0.3	0.9	0.6	0.3	3.00	4.00	3.33	0.58
THB (CFU/g)	2.3	3.2	2.73	0.45	19.40	26.50	23.23	3.58
THF (CFU/g)	1.2	2.4	1.7	0.62	10.00	13.00	11.33	1.53

4.5 Biological Environment

4.5.1 Introduction

This Section of the Report presents the ecological baseline for the Project and was prepared using the international guidance on Impact Assessments for biodiversity (mainly IFC PS6). The proposed Indorama Gas Pipeline will extend from Akpajo in Rivers State to Asa in Imo State, Nigeria. The study area is shown in Figure 4.40.

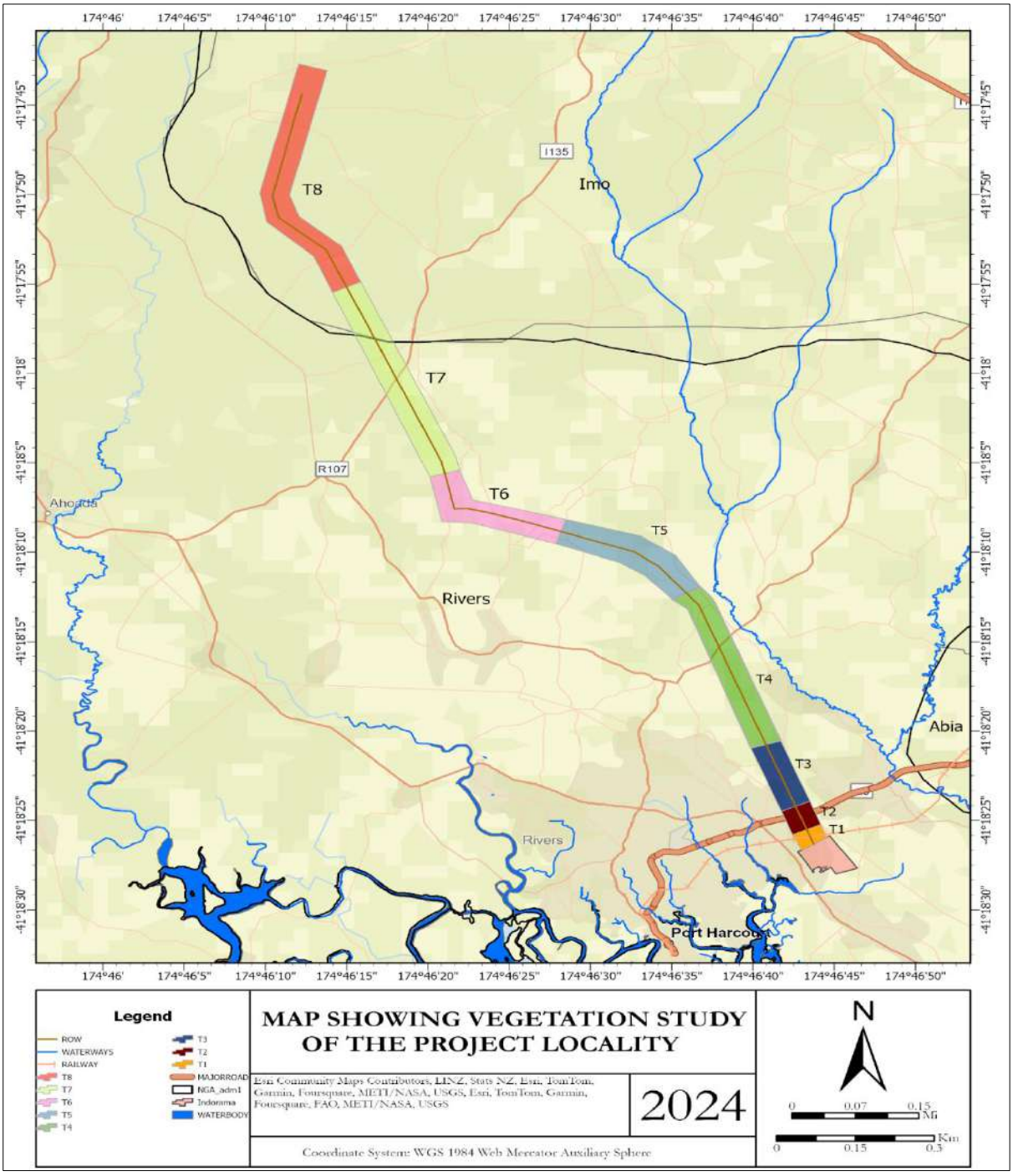


Figure 4.40: Vegetation Study map

Table 4.21: Summary of Method used in Vegetation and Wildlife Survey

Field Activity	Method used
Plants	Transects and quadrats
Reptiles	Field observations and interviews with the hunters
Birds	Field observations and interviews with the hunters
Mammals	Field observations and interviews with the hunters

A variety of sampling techniques were used to sample the terrestrial biodiversity of the site. The Study Area was set using the pipeline RoW as the core and adding a 2 km buffer from both sides of the pipeline RoW to this to allow for a complete assessment of the biodiversity along right out of way. The nearby communities are clustered and covered in eight (08) trasnsect for the vegetation study. All plant species were identified as far as possible, with unknown species collected, labelled, pressed, and taken to the University of Port Harcourt Herbarium for identification. The identification and ethno-botanical uses of the plants were derived from the local interviews.

Faunal data were obtained through active searching for animal paths, burrows, nesting sites, calls, scales, food cuttings, footprints, droppings, fur, and sighting. However, 60% of the checklists on mammalian, avian, rodent, and reptilian species were obtained from hunters, farmers and gatherers of non-timber forest products in the community.

The avifaunal assemblage was sampled during the morning hours from 6:30 am to 9:30 am, and again from 4:00 pm to 6:30 pm. All birds encountered were recorded, and nest searches were also undertaken along the vegetation transects.

Amphibians were sampled using their calls, the presence of eggs, and tadpole stages. Again, this sampling was undertaken along the transects and quadrants used for the vegetation assessment.

Insects were sampled using active (tree beating, sweep netting, active searching) and passive (pitfall traps and bait traps) techniques. As with the other groups sampled above, the majority of the insect sampling was undertaken along the transects, and within the quadrats previously described for the vegetation assessment.

Indices Calculation

The Shannon evenness index, abbreviated as SEI, of the plant species were calculated as

$SEI = 1/ \Sigma pi2.$

Where Pi = The proportional representation of each habitat (pi). ...

Also, the diversity of the plant species was calculated using Shannon index as follows:

$H = \Sigma - (Pi * \ln Pi)$

i=1

The Shannon evenness index, abbreviated as SEI, of the plant species were calculated as

SEI = 1/ ∑ pi2.

Where Pi = The proportional representation of each habitat (pi). ...

Also, the diversity of the plant species was calculated using Shannon index as follows:

H = ∑ - (Pi * ln Pi)

i=1

where p = the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, Σ is the sum of the calculations, and s is the number of species.

The percentage species change between wet and dry seasons were calculated as follows:

Seasonal species turnover (%) = $((S_W + S_D - 2S_D)/ (S_W + S_D – S_C)) \times 100$

where:

S_W = number of species in the wet season

S_D = number of species in the dry season

S_C = number of species common to both seasons.

And interpretated as shown below

Seasonal variation	Percentage species turnover/change	Interpretation
Very low	0–20%	Wet and dry seasons have largely similar species composition
Low	>20–30%	Small seasonal change
Moderate	>30–50%	Noticeable seasonal turnover
Moderate to high	>50–70%	Substantial seasonal turnover
High	>70–100%	Very pronounced seasonal turnover

4.5.2 Terrestrial Environment

4.5.2.1 Vegetation Characteristics

The study area is divided in eight transects. The detailed study outcome is presented in Annexure 4.7 and transect wise vegetation characteristics is discussed below.

T-1: AKPAJO: The area is predominantly built-up with patches or fringe of farms (cassava and vegetable), forest regrowth, bush fallow, and seasonal swamps (**Plate 4.1**). The predominant species found within this area include *Elusine indica, Sida acuta, Amaranthus sp., Asystasia gangetica, Cintrocima puerens, Elieas guineensis, Euphorbia heterophylla, Carica papaya, Psidium guajava, Mangifera indica, Portulaca sp., Panicum maximum, Cloeme retrosperma, Mallotus oppositifolius, Synedrella sp., Luffa cylindrica, Senna sp, Ludwigia sp., Urena lobata, Vernonia amygdalina, Newbuldia leavis, Euphorbia hirta,*

Custus afer, Phyllathus amarus, Penissetum spp., Cyperus spp., Albemuscus esculenta, Ficus sur, Anthonatha macrophylla, Ficus exerparata, Ficus muscosa, Manihot esculenta, Triumffeta cordifolia, Senna semea, Rhynchospora corymbosa, Fuirena umbellata, Fimbristylis littoralis, Diptazium samnatii, Scleria naumanniana, Hydrolea palustris, Aeschynomene indica, Clerodendrum thomsoniae, Psychotria polanthera, Icacina trichanta, Hibiscus haspan, Harungana madagascarensis, Smilax anceps, Lantana camara, Alstonia bonnie, Combretum racemosum, Meosobotrya sp., *Solanuim torvum, Mormodica charantia, Baphia nitida, Landolphia* sp., *Adenia lobata, Anthocliesta vogelli, Adenia cissampliodes, Clerodendrum splendes, Mallotus* sp., *Cissus* sp., *Milecia excelsa, Solanium nigrum, Perperomia* sp., *Sida cordifolia, Phyllanthus amarus, Triumffeta rhombodea, Luffa cylindrica, Passiflora feotida, Tomatoccocus danieli, Dracinia* sp., etc.

T-1 showed moderate seasonal variation in species composition between the wet and dry seasons. The wet season was characterized by a diverse mixture of cultivated plants, secondary-forest species, ornamentals, herbs and grasses, with species such as *Costus lucanusianus*, *Senna hirsuta*, *Bidens pilosa*, *Commelina benghalensis*, *Ageratum conyzoides* and *Ludwigia* spp. prominent. In the dry season, the community shifted towards disturbance-tolerant herbs, grasses and swamp-associated species, including *Eleusine indica*, *Panicum maximum*, *Cyperus* spp., *Rhynchospora corymbosa*, *Fuirena umbellata* and *Fimbristylis littoralis*. Several woody and cultivated species, including *Elaeis guineensis*, *Carica papaya*, *Manihot esculenta*, *Harungana madagascariensis*, *Combretum racemosum* and *Maesobotrya* sp., occurred in both seasons, indicating a relatively stable woody component.



Plate 4.1: Overview of vegetation in the Akpajo close to Indorama Complex

T2: Elelenwo: This axis is predominated by bush fallow, farms (casava, okro and maize), and bush fallow (**Plate 4.2**). The dominant plant species here include*, Elieas guineensis, Milletia sp., Aspilia africana, Chromolenea ordoratum, Achornea cordifolia, Ficus sp, Amaramthus sp., Penthacletra macrophylla, Fumtumia sp., Anthocliesta sp., Combretum spp., Justicia carnea, Penissitum sp., Newbuldia leavis, Aspilia africana, Bambosa vulgaris, Amarathus hybridus, Combretum indicum, Echhornea natans, Urena lobata, Panicum laxum, Ipomeoa triloba, Physalis angulata, Bidens pinnata, Ludwigia* spp., *Vernonia cinerae, Musa* spp., *Acmelia uglinosa, Cyperus haspan, Saciolepsis africana, Polygonum lanigerum, Heteranthera callifolia, Pentodon pantandrus, Salvinia nymphellula, Sphenoclea zyylanica, Melochia corchorifolia, Acmella uglinosa, Acanthus montanus, Hypoestes forskalei, Monechma ciliatum, Nelsonia canescens, Ageratum houtonianum, Bidens pinnata, Xanthosoma sagitifolia, Desmodium scorpirus, Mimosa pidica, Carica papaya, Croton hirsuta, Canna indica, Gomphrena* sp., *Panicum* spp., *Cynodium* sp., *Napoleona* sp., etc.

This transect showed very low seasonal variation in species composition, with the wet- and dry-season species lists being largely identical. The transect was consistently dominated by bush fallow, agricultural fields and secondary vegetation, supporting a mixture of cultivated, woody, herbaceous and aquatic species. Common species occurring in both seasons included *Elaeis guineensis*, *Aspilia africana*, *Chromolaena odorata*,

Alchornea cordifolia, *Anthocleista* sp., *Combretum* spp., *Panicum laxum*, *Urena lobata*, *Ludwigia* spp., *Cyperus haspan*, *Sacciolepis africana*, *Mimosa pudica* and *Carica papaya*. The persistence of these species indicates a relatively stable plant community despite seasonal changes. However, the presence of moisture-associated species such as *Eichhornia natans*, *Salvinia nymphellula*, *Heteranthera callifolia* and *Ludwigia* spp. reflects the influence of wet conditions and seasonal water availability.



Plate 4.2: Overview of vegetation in the Elelenwo

T3: Rumukwurusi/Atali: The vegetation tpye within this area compriesd of biult up areas (homestead vegetation), seasonal swamps and patches of farms/bush fallow (**Plate 4.3**). The plant species here include *Ficus sp., Calamus sp., Alchornea cordifolia, Raphia spp., Musanga sp., Alstonia boniea, Syngonium pobophyllum, Elieas guineensis, Harumgana sp., Combretum racemosum, Calapogonium sp., Cyperus spp. Acanthus montanus., Cliestopholis pantens, Albizia* sp., *Dycrodes edulis, Citrus cinensis, Spondias mombin, Melletia arboensis, Cynthula prostrata, Ipomea sp., Dioscorea sp., Vitex sp., Ludwigia sp., Bambosa vulgaris, Acasia sp., Senna sp., Chromolenea ordorata, Adenia lobata, Smilax anceps, Cissus sp., Napoleona sp., Clerodendrum splendes, Senna alata, Macaranga* sp., *Alchornea oppositifolius,* etc.

Rumukwurusi/Atali arae exhibited moderate to high seasonal variation in species composition. The wet season supported a mixture of forest, secondary-growth, cultivated

and wetland species, including *Eclipta alba*, *Myrianthus arboreus*, *Centrosema pubescens*, *Amorphophallus* sp., *Milicia excelsa*, *Anthocleista vogelii*, *Dioscorea bulbifera*, *Xanthosoma mafaffa* and *Ammannia baccifera*. In contrast, dry season, we identified several woody and swamp-associated species not recorded in the wet-season list, including *Ficus* sp., *Calamus* sp., *Raphia* spp., *Musanga* sp., *Alstonia boonei*, *Cleisthopholis patens*, *Albizia* sp., *Spondias mombin* and *Vitex* sp. Nevertheless, some species such as *Alchornea cordifolia*, *Elaeis guineensis*, *Bambusa vulgaris*, *Smilax anceps*, *Combretum* spp. and *Ludwigia* sp. occurred across seasons, indicating a persistent vegetation component.



Plate 4.3: Overview of vegetation in the Rumukwurusi/Atali



Plate 4.4: Overview of seasonal swamp forest at Rumukwurusi/Abara/Ipo

T4: Umuogodo, Edegelem, Ime, Umuakuru, Chokocho and Umuechem: The vegetation in this areas comprised different vegetation types namely; secondary forest,

farm lands, bush fallow/forest regrowth, builtup areas (homestead) vegetation. Within this area there Oil plam plantation and casava/maize/melon farms. The dominant plant species include; *Elieas guineensis, Bambosa vulgaris, Alchornea cordifolia, Anthocliesta* sp., *Custus afer, Lantana camara, Maniphytom fulvum, Urena lobata, Cissus* sp., *Dioscorea* sp., *Funtumia* sp., *Brillantasia lamum, Anthonotha macrophylla, Alchornea laxiflora, Aspillia africana, Adenia lobata, Milletia* sp., *Landophia* sp., *Andropogon* sp., *Croton* sp.,

This axis exhibited high seasonal variation in species composition. The wet season supported a particularly diverse mixture of secondary-forest, farmland, bush-fallow and built-up vegetation, with numerous cultivated and herbaceous species such as *Musa* spp., *Manihot esculenta*, *Dioscorea* spp., *Senna* spp., *Phyllanthus* spp., *Emilia* spp., *Cucurbita* spp. and several grasses. The dry-season assemblage was comparatively fewer and was dominated by persistent woody and perennial species, including *Elaeis guineensis*, *Alchornea cordifolia*, *Anthocleista* sp., *Costus afer*, *Urena lobata*, *Alchornea laxiflora*, *Anthonotha macrophylla* and *Andropogon* sp. Species such as *Elaeis guineensis*, *Alchornea cordifolia*, *Urena lobata*, *Costus afer*, *Alchornea laxiflora* and *Andropogon* spp. provided continuity between seasons. The observed variation reflects seasonal changes in agricultural crops, annual herbs and grasses, while the established tree and shrub component remained relatively persistent.



Plate 4.4: Umuogodo, Edegelem, Ime, Umuakuru, Chokocho and Umuechem vegetation type

T5: Abara and Ipo: The vegetation in this area comprised built-up areas, bush fallow, and farms compring shrubs, grasses, herbs and small trees. The indentified in this area are *Milletia sp., Acanthus sp., Cynodon sp., Mimisa spp., Asystasia gangetica, Colocasis esculenta, Dracinia* sp., *Creponia* sp., *Allophalus* sp., *Annona* sp., *Anthonatha macrophylla, Stachythapheta cyanensis, Vitex* sp., *Bambosa vulgaris, Mallotus* sp., *Urena lobata, Asplilia africana, Alchornea cordifolia, Luffa cylindica, Cintrocima sp., Croton sp., Ipomea involucrata, Calapagonium sp., Melastrutum sp., Smilax sp., Anthonatha macrophylla, Gmelina aborea, Combretum spp., Sida acuta, Combertum platypterum, Baphia nitida, Mimosa invosa, Elieas guineensis, Treculia sp., Harungana sp., Anthociesta sp., Adenia sp., Funtumia sp., Panicum maximum, Abrus sp., Maniphytom fulvum, Pterocarpus sp., Cissus gracilis, Cyperus spp., Ficus spp., Penthacletra macrophylla, Andropogon sp., Amarathus sp., Dialium guineensis, Lageneria breviflora, Myristica sp., Gracinia sp,. Lugwigia sp., Hevea sp., Custus afer, Kola sp., Chromolenea sp., Bambosa vulgaris,* etc. while in farms were found *Manihot sp., Dioscorea spp. Zea mays, Xanthosoma sp, Colocasia sp. Pterocarpus santaloides, Raphia* sp., *Clapertonia fibliformis, Hiptis swavelencse, Paulinia* sp., *Ipomoea invulucrata, Funtumia* sp., ,

Abara-Ipo transect exhibited moderate to high seasonal variation in species composition. The wet-season community was characterized by bush fallows and farmlands with a diverse community of trees, shrubs, herbs and grasses, including *Milicia excelsa*, *Alstonia boonei*, *Myrianthus arboreus*, *Rauvolfia vomitoria*, *Ludwigia* spp., *Baphia nitida*, *Centrosema pubescens*, *Calopogonium mucunoides* and *Anchomanes difformis*. In the dry season, we identified species such as *Asystasia gangetica*, *Bambusa vulgaris*, *Gmelina arborea*, *Treculia* sp., *Ficus* spp., *Dialium guineense*, *Myristica* sp. and *Hevea* sp., together with cultivated crops including *Zea mays*, *Manihot* sp., *Dioscorea* spp., *Xanthosoma* sp. and *Colocasia* sp. Several species, including *Alchornea cordifolia*, *Aspilia africana*, *Baphia nitida*, *Mimosa* spp., *Elaeis guineensis*, *Urena lobata*, *Costus afer* and *Chromolaena* sp., occurred in both seasons, indicating a stable core community. The seasonal variation reflects changes in herbaceous, wetland and cultivated species, while many perennial trees and shrubs persisted across seasons.



Plate 4.5: Overview of seasonal swamp forest at Rumukwurusi/Abara/Ipo

T6: Ozuaha, Omademe and Omanwa: This area is comprise of bush fallow, farmlands (Casava, yam and oil palm), and secondary forest (in Omawa area). The dominant species include; *Allanmanda* sp., *Aspilia* sp., *Luffa cylindrica, Calapogonium* sp., *Manihot* sp., *Elieas guineensis, Musa* sp., *Panicum maximum, Bambosa vulgaris, Streculia* sp., *Croton* sp., *Alchornea cordifolia, Custus afer, Ipomea* sp. *Kola* sp. *Gracinia* sp., *Hevea brasilensis, Combretum bracteatum, Euphorbia hirta, Urena lobata, Phyllanthus amarus, Sida acuta, Spondias* sp., *Ficus* sp., *Musanga* sp., *Anthocliesta* spp., *Andropogon* sp., *Cynodon* sp., *Cleome* sp., *Pterocarpus* sp., *Cissus* spp.,, *Napoleona* sp., *Dialium giuneensis, Harungana* sp. etc.

T-6 exhibited moderate to high seasonal variation in species composition. The wet season supported a highly diverse assemblage of native forest, secondary-growth, cultivated and invasive species, including *Albizia zygia*, *Albizia adianthifolia*, *Cola gigantea*, *Uvariodendron* spp., *Milicia excelsa*, *Pycnanthus angolensis*, *Triclisia subcordata*, *Chrysophyllum albidum* and *Dacryodes edulis*. The dry-season community was comparatively dominated by bush-fallow, farmland and secondary-forest species, with additional records of *Musa* sp., *Hevea brasiliensis*, *Combretum bracteatum*, *Spondias* sp., *Musanga* sp., *Andropogon* sp., *Cynodon* sp. and *Dialium guineensis*. Several species, notably *Elaeis guineensis*, *Alchornea cordifolia*, *Costus afer*, *Urena lobata*, *Sida acuta*,

Panicum maximum, *Pterocarpus* spp. and *Harungana* spp., persisted across seasons, forming the core vegetation community.



Plate 4.6: Overview of vegetation within Ozuha, Omademe and Omanwa areas

T7: Ubima and Omerelu: This area consists of bush fallow, farm lands, and secondary forest vegetation types. The predonant plant species are grasses and small trees/shrubs. There patches of farmlands (casava and cocoa) within this area. Some of the plants indentifed here are; *Andropogon gayanus, Andropogon tectorum, Brachiaria deflexa, Brachiaria spp, Cenchrus biflorus, Chrysopogon aciculatus, Cymbopogon giganteus, Dactyloctenium aegyptium, Digitaria gayana, Eragrostis atrovirens, Hackelochloa granularis, Heteropogon connortus, Hyparrhenia involucrate, Hyperthelia dissolute, Imperata cylindrical, Leptochloa filiformis, Loudetia annua, Loudetia arundinacea, Pennisetum pedicellatum, Rottboellia cochinchinensis*, *Sorghum arundinaceum, Sporobolus pyramidalis, Panicum maximuim*.

T-7 showed high seasonal variation in species composition. The wet season supported a highly diverse community of secondary-forest trees, shrubs, herbs, climbers, cultivated species and invasive plants, including *Albizia* spp., *Alchornea cordifolia*, *Cola* spp., *Uvariodendron* spp., *Milicia excelsa*, *Pterocarpus* spp., *Nauclea diderrichii*, *Myrianthus arboreus* and *Garcinia mannii*. In contrast, the dry-season vegetation was dominated by grasses and small shrubs, with numerous Poaceae species such as *Andropogon gayanus*,

A. tectorum, *Brachiaria deflexa*, *Cenchrus biflorus*, *Chrysopogon aciculatus*, *Cymbopogon giganteus*, *Digitaria gayana*, *Imperata cylindrica*, *Pennisetum pedicellatum*, *Rottboellia cochinchinensis*, *Sporobolus pyramidalis* and *Panicum maximum*. Thus, unlike the wet season, the dry-season list showed a marked shift towards grass-dominated vegetation. This demonstrates substantial seasonal turnover, particularly in the herbaceous layer, while the more established woody vegetation provides continuity between seasons.



Plate 4.7: Overview of vegetation within Ubima and Omerelu

T8: Akanu, Awarra, Ochia and Asa: Other plant species identified in this area are *Chromolaena odorata, Chrysanthellum indicum, Laggera aurita, Sclerocarpus Africanus, Polycarpaea Corymbosa, Croton hirtus, Hyptis spicigera, Leonotis nepetifolia, Isoberlina doka, Piliostigma thonningii, Eriosema psoraleoides, Sida rhombifolia, Spermacoce octodon, Tephrosia pedicellata, Hibiscus asper, Malvastrum coromandelianum, Sida lini folia. Sesanum alatum, Oldenlandia herbacea, Triumfetta rhomboidea*., *Blepharis maderaspatensis, Hypoestes cancellata, Monechma ciliatum, Aerva Javanica, Celosia leptostachya Aspilia bussei, Conyza Sumatrensis, Vernonia ambigua, Vernonia galamensis, Vernonia perrottetii, Cochlospermum planchoni, Combretum hispidum, Evolvulus alsinoides, Euphorbia heterophylla, Chamaecrista mimosoides, Daniellia oliveri, Crotalaria macrocalyx, Desmodium salicifolium,*

The transect along Akanu, Awarra, Ochia and Asa showed high seasonal variation in species composition. The wet season had a diverse community of secondary-forest trees, shrubs, climbers, cultivated plants and herbs, including *Baphia nitida*, *Spondias mombin*, *Allophylus* spp., *Albizia* spp., *Ficus sur*, *Milicia excelsa*, *Alstonia boonei*, *Rauvolfia vomitoria* and *Uvariodendron occidentale*, together with numerous agricultural and herbaceous species. In contrast, the dry-season community was characterized largely by herbs, shrubs and grasses, including *Chromolaena odorata*, *Laggera aurita*, *Sida* spp., *Vernonia* spp., *Brachiaria deflexa*, *Cenchrus biflorus*, *Chrysopogon aciculatus*, *Cymbopogon giganteus*, *Imperata cylindrica*, *Pennisetum pedicellatum*, *Rottboellia cochinchinensis* and *Sporobolus pyramidalis*. The marked difference between the two seasonal lists suggests substantial turnover in the herbaceous layer, likely associated with changes in moisture, agricultural activity and vegetation senescence. This transect showed pronounced seasonal variation, with a structurally more diverse woody community in the wet season and a more herbaceous/grass-dominated assemblage in the dry season.



Plate 4.8: Overview of vegetation within Akanu, Awarra, Ochia and Asa

SPECIES DENSITY AND PERCENTAGE DISTRIBUTION

In the freshwater swamp, seasonal swamp, bush fallow and secondary forests the percentage composition of the species based on their habit is presented in Figure 4.41. The dominant plant species in the study area is trees and covered about 54.76% of the

plants identified. This is followed by herbs with 19.84%, small trees/shrubs 15.87% and climbers with 7.14%. Grasses were the least with 2.38%.

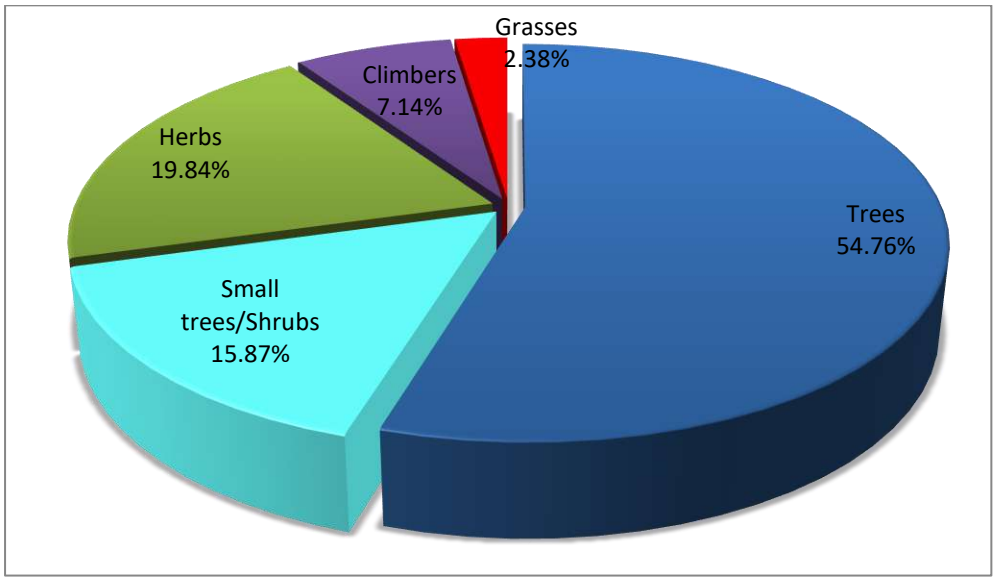


Figure 4.41: Percentage composition of the plant in the study area

SEASONAL SPECIES TURNOVER

Seasonal species turnover varied considerably among the eight transects. T2 exhibited very low seasonal change (<20%), indicating substantial similarity between wet- and dry-season species composition. T1 showed moderate turnover (approximately 40–50%), while T3, T5 and T6 exhibited moderate-to-high turnover (approximately 60–70%). The highest seasonal turnover occurred in T4, T7 and T8, where approximately 70–90% of the species composition differed between seasons. The pronounced turnover in these transects was largely associated with changes in herbaceous plants, grasses, agricultural species and moisture-dependent vegetation, whereas perennial woody species showed greater seasonal persistence.

Seasonal species turnover

Transect	Seasonal variation	Approximate species turnover
T1	Moderate	**~40–50%**
T2	Very low	**~0–10%**
T3	Moderate to high	**~60–70%**
T4	High	**~70–80%**
T5	Moderate to high	**~60–70%**
T6	Moderate to high	**~60–70%**
T7	High	**~80–90%**
T8	High	**~80–90%**

SPECIES COMPOSITION, RICHNESS, RELATIVE ABUNDANCE, EVENNESS AND DIVERSITY

A total of 254 plant species belonging to 179 genera, and 56 families were identified in wet and dry seasons. The results indicate that herbs were the dominant growth form in both seasons, accounting for approximately 31.3% of the wet-season flora and 32.4% of the dry-season flora. Trees were the second most represented group in the wet season (31.9%) but declined to 29.1% in the dry season. Small trees and shrubs increased slightly from 24.5% to 26.4% (Figs. 4.41a and 4.41b).

Grasses increased from 6.1% in the wet season to 8.8% in the dry season, consistent with the strong grass dominance observed particularly in T7 and other bush-fallow areas during the dry season. Conversely, climbers declined from 6.1% to 3.4%, probably reflecting seasonal changes in their detectability and vegetation support.

The pooled data indicate that wet-season vegetation had a slightly greater unique species richness (163 species) than the dry season (148 species), with the principal seasonal change occurring in the relative representation of grasses, climbers and woody plants.

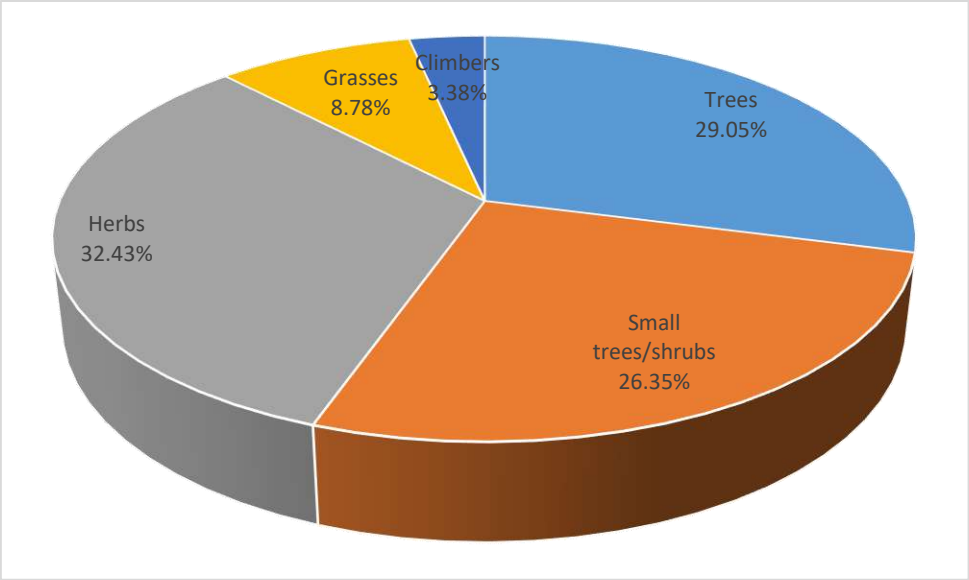


Figure 4.41a: Relative abundance of plant species in dry season

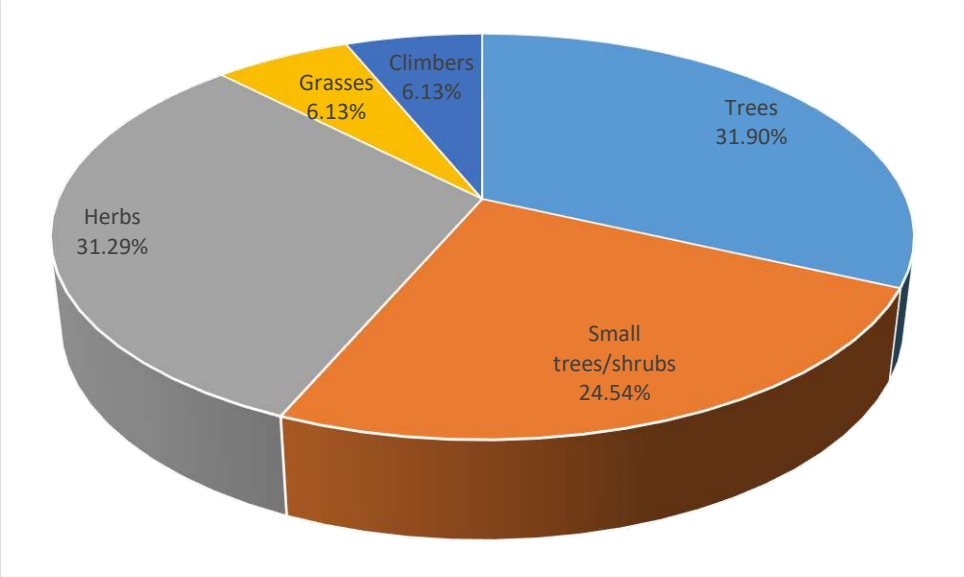


Figure 4.41b: Relative abundance of plant species in wet season

Plant Pathology: During the field work, there were few visible plant disease observed. Plant diseases encountered during the field survey showed that all the pathogens encountered are well-known causal agents of their respective hosts, which are mainly foliar diseases, and of insect-pest origin. No plant diseases arising from environmental stress were found in the study area and the forest species appeared very healthy. There were some leaf spots, but their incidence was negligible. Also, no environmental stress factor was found in the study area. There was also no indication of predisposition of plants to either a new disease or to higher disease incidence of unknown ones.

4.5.2.2 Faunal Assemblage

INTRODUCTION

The faunal assemblage of the Study Area includes a number of mammals, reptiles, birds, amphibians and insects; however, the number of species is relatively low due to increased human induced pressure. This anthropogenic pressure is exerted through hunting, farming, and loss of natural habitat for sand mining and timber cropping.

The wildlife study was based on interviews with the local hunters, opportunistic observation, and visits to the bush meat markets within the study area. Also, the presence of traps/iron cages used by the local hunters was observed.

MAMMALIAN: Significant among the mammals are the monkeys viz Mona monkey (*Cercopithecus mona*), and Tantalus monkey (*Chlorocebus tantalus*) (Plate 4.9), including Maxwell's Duiker (*Philantomba maxwelli* – Plate 10B), Sitatunga (*Tragelaphus spekii* – Plate 4.10C), Antelopes, Spotted grass mouse *Lemniscomys striatus*, Geoffroy's ground squirrel (*Xerus erythropus* – Plate 4.11B), The fire-footed rope squirrel (*Funisciurus pyrrhopus*), Giant rat (*Cricetomys gambianus* –Plate 4.11D), Stripped mouse (*Hvbomvs*

triviraatus), Brush-tailed porcupine (*Atherurus africanus*), Bat (*Taphozous* sp.), Squirrels *(Anomalrus* spp., *Epixerus* sp.), House rat *(Rattus rattus), Arvicanthis sp., Cricetomys gambianus, Thrynomys sp., Protoxerus stangeri, Crocidura* sp. (Musk shrews) etc. Among these mammals,

No observable seasonal difference was observed in the mammalian species composition reported between the wet and dry seasons. However, Bates's pygmy antelope (*Neotragus batesi*) was reported only during the wet season, suggesting a possible seasonal difference in its occurrence or detectability



Plate 4.9: Monkey found within the study area (A) Chlorocebus aethiops, (B) Mona monkey (Cercopithecus mona), and (D) Tantalus monkey (Chlorocebus tantalus) Source: Picture Taken by Hunters.

Table 4.22: Mammals observed in the Study Area

S/N	Species name	Common name	Family	Means of identification	IUCN status
1	*Anomalurus beecrofti*	Beecroft's flying squirrel	Anomaluridae	HR	LC
2	*Philantomba maxwelli*	Maxwell's Duiker	Bovidae	PTH	LC
3	*Cephalophus ogilbyi*	Ogilby's duiker	Bovidae	PTH	LC
4	*Tragelaphus spekii*	Sitatunga	Bovidae	PTH	LC
5	Unidentified monkey	Monkey	Cercopithecidae	PTH	EN
6	*Cercopithecus mona*	Mona monkey	Cercopithecidae	PTH	NT
7	*Chlorocebus tantalus*	Tantalus monkey	Cercopithecidae	PTH	LC
8	*Taphozous* sp	Bat	Emballonuridae	HR	

S/N	Species name	Common name	Family	Means of identification	IUCN status
9	*Herpestes ichneumon*	Egyptian mongoose	Herpestidae	PTH	LC
10	*Atherurus africanus*	Brush-tailed porcupine	Hystricidae	PTH	LC
11	*Lemniscomys striatus*	Grass mouse	Muridae	HR	LC
12	*Nandinia binotata*	African palm civet	Nandiniidae	HR	LC
13	*Epomophorus spp.,*	Fruit bats	Pteropodidae	HR	
14	*Eidolon helvum*	Straw-coloured fruit bat	Pteropodidae	HR	NT
15	*Euxerus erythropus*	African striped ground squirrel	Sciuridae	PTH	LC
16	*Funisciurus pyrrhopus*	Fire-footed rope squirrel	Sciuridae	HT	LC
17	*Funisciurus leucogenys*	Orange Headed Tree Squirrel	Sciuridae	DO	LC
18	*Heliosciurus rufobrachium*	Red-legged sun squirrel	Sciuridae	DO	LC
19	*Protoxerus stangeri*	Forest giant tree squirrel	Sciuridae	DO	LC
20	*Crocidura* sp	African pygmy shrew	Soricidae	HT	
21	*Hyemoschus aquaticus*	Water chevrotain	Tragulidae	HR	LC
22	*Civettictis civetta*	African Civet	Viverridae	HR	LC
23	*Genetta cristata*	Crested genet	Viverridae	HR	VU
24	*Philantomba maxwellii*	Maxwell's Duiker	Cervidae	HR	**LC**

Note: HT = Hunters trap, HR = Hunters report, DO = direct observation, PTH = Pictures taken by hunters, NT – Near threatened, CR- Critically Endangered, VU = Vulnerable, EN = Endangered **(Source: Fieldwork 2023)**

The relative abundance of the different mammalian families identified in the study area showed that the Pteropodidae and Viverridae are represented by 2 species (8.33%), Bovidae and Cercopithecidae are represented by 3 species (12.50%), and Sciuridae 5 species (20.83%). Other families are represented by 1 species each (4.17%) Fig. 4.42.

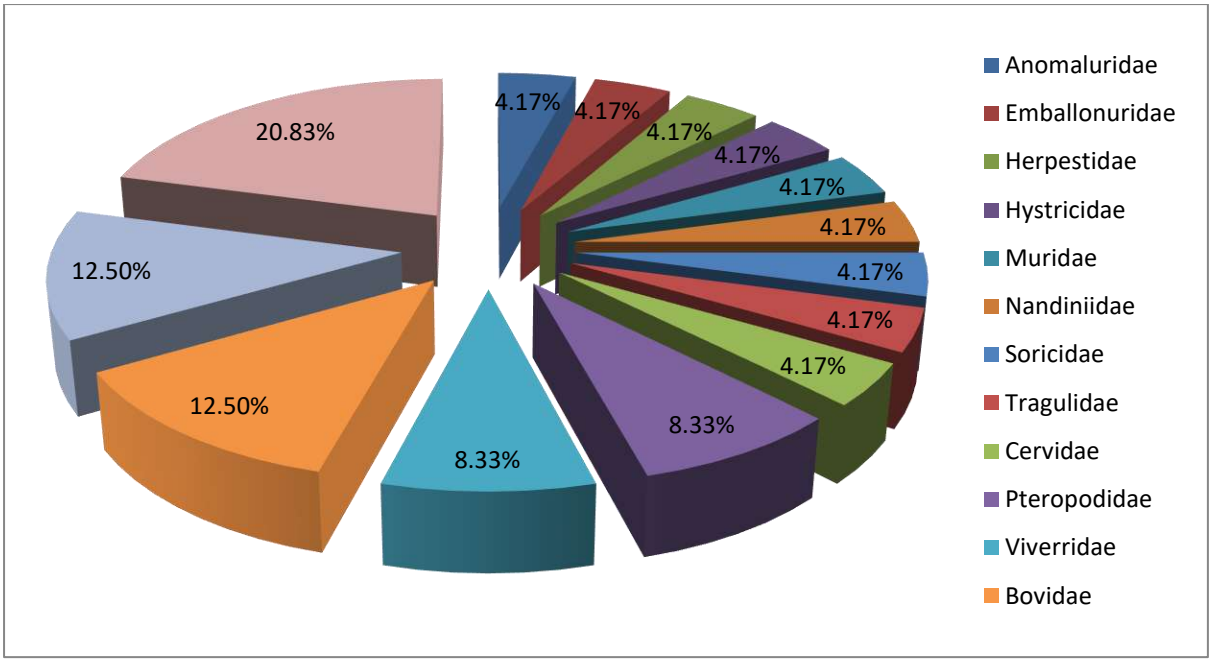


Figure 4.42: Relative abundance of diifferent mammal families identified in the study area



Plate 4.10: Antelopes found within the study area (A) unknown small duiker cut in the hunters trap, (B) Maxwell's Duiker (Philantomba maxwelli), (C) Sitatunga (Tragelaphus spekii) Source: Picture Taken by Hunters,



Plate 4.11: Other smaller mammals found in the study area (A) Egyptian mongoose (Herpestes ichneumon), (B) Arrow shows Geoffroy's ground squirrel (Xerus erythropus), (C) Brush-tailed porcupine (Atherurus africanus), and (D) Source: Picture Taken by Hunters

AMPHIBIANS: The amphibian community recorded in the study area comprised several common frog and toad species. These included the Common African toad (*Bufo regularis*), toad (*Bufo latifrons*), true green frog (*Rana temporaria*), Goliath frog (*Conraua goliath*), clawed frog (*Xenopus tropicalis*), and tree frog (*Hyperolius* sp.). *Afrixalus fulvovittatus* was recorded exclusively during the wet season. The occurrence of this species only during the

wet season may reflect the increased availability of temporary water bodies, higher humidity and suitable breeding conditions during periods of increased rainfall.

Table 4.23: The common amphibians identified in the study area

S/N	Species name	Common name	Family	Means of identification	IUCN status
1	*Bufo regularis* (*Sclerophrys regularis*)	Common African Toad	Bufonidae	DO	**LC**
2	*Bufo latifrons* (*Sclerophrys latifrons*)	Toad	Bufonidae	HR	**LC**
3	*Rana temporaria*	True green Frog	Ranidae	HR	**LC**
5	*Xenopus tropicalis*	Clawed toe frog	Pipidae	DO	**LC**
6	*Hyperclius sp*	Tree frog	Hyperoliidae	HR	

Note: HT = Hunters trap, HR = Hunters report, DO = direct observation, PTH = Pictures taken by hunters, NT – Near threatened, CR- Critically Endangered, VU = Vulnerable, EN = Endangered **(Source: Fieldwork 2023)**

AVES: The avian fauna recorded within the proposed project area comprised 31 species belonging to 29 genera and 21 families (Table 4.24). Accipitridae was the most represented family, with nine species, followed by Nectariniidae, with two species, while the remaining families were represented by one species each. Most of the bird species were recorded directly during the field surveys. However, *Bubo africanus* (Spotted Eagle-Owl), *Gyps africanus* (African White-backed Vulture), *Necrosyrtes monachus* (Hooded Vulture), *Ortygornis sephaena* (Crested Francolin), *Psittacus* sp. (African parrot), and *Tyto alba* (Barn Owl) were reported by local hunters and were not directly observed during the survey. *Poicephalus senegalus* (Senegal Parrot) was reported only during the wet season, suggesting a possible seasonal difference in its occurrence or detectability. The avian community reflects a mixture of forest, farmland, bush-fallow and human-modified habitats within the study area.

Table 4.24: The common birds identified in the study area

S/N	Species name	Common name	Family	Means of identification	IUCN status
1	*Milvus migrans*	Black kite	Accipitridae	DO	LC
2	*Polyboroides typus*	African harrier-hawk	Accipitridae	DO	LC
3	*Necrosyrtes monachus*	Hooded vulture	Accipitridae	HR	CR
4	*Elanus caeruleus*	Black-winged kite	Accipitridae	DO	LC
5	*Polyboroides typus*	African harrier-hawk	Accipitridae	DO	LC
7	*Micronisus gabar*	Gabar goshawk	Accipitridae	DO	LC
8	*Accipiter badius*	Shikra	Accipitridae	DO	LC
9	*Gyps africanus*	Vulture	Accipitridae	HR	CR
10	*Ispidina picta* (*Ceyx picta*)	African pygmy kingfisher	Alcedinidae	DO	LC
11	*Dendrocygna viduata*	White-faced whistling duck	Anatidae	DO	LC
12	*Apus barbatus*	African black swift	Apodidae	DO	LC
13	*Ardeola ibis*	Cattle egret	Ardeidae	DO	LC
14	*Anthracoceros albirostris*	Oriental pied hornbill	Bucerotidae	DO	LC
15	*Caprimulgus europaeus*	European nightjar	Caprimulgidae	DO	LC
16	*Streptoprelia semitorquata*	Red eye dove	Columbidae	DO	LC
17	*Corvus albus*	Pied crow	Corvidae	DO	LC
18	*Spermestes cucullata* (*Lonchura cucullata*)	Bronze mannikin	Estrildidae	DO	LC
19	*Falcon rupilocoides*	Greater Kestrel	Falconidae	DO	LC
20	*Halcyon senegalensis*	Woodland kingfisher	Halcyoninae	DO	LC

S/N	Species name	Common name	Family	Means of identification	IUCN status
21	*Lanius cabanisi*	Long-tailed fiscal	Laniidae	DO	LC
22	*Merops nubicus*	Carmine bee-eater	Meropidae	DO	LC
23	*Anthus* sp	Pipit bird	Motacillidae	DO	
24	*Cinnyris chloropygius*	Olive-bellied sunbird	Nectariniidae	DO	LC
25	*Cinnyris minullus*	Tiny sunbird	Nectariniidae	DO	LC
26	*Numida meleagris*	Helmeted guineafowl	Numididae	DO	LC
27	*Passer griseus*	Northern grey-headed sparrow	Passeridae	DO	LC
28	*Ortygornis sephaena* (*Francolinus sephaena*)	Crested francolin	Phasianidae	HR	LC
29	*Ploceus* sp.	Weaver bird	Ploceinae	DO	LC
30	*Psittacus* sp	African parrot	Psittacidae	HR	
31	*Bubo africanus*	Spotted eagle owl	Strigidae	HR	LC
32	*Tyto alba*	Barn owl	Tytonidae	HR	LC
33	*Poicephalus senegalus*	The Senegal parrot	Psittacidae	DO	LC

Note: HT = Hunters trap, HR = Hunters report, DO = direct observation, PTH = Pictures taken by hunters, NT – Near threatened, CR-Critically Endangered, VU = Vulnerable, EN = Endangered

(Source: Fieldwork 2023/2026)



Plate 4.12: Hunter displayed his kills Source: Picture Taken by Hunters



Plate 4.14: Congregation of Crows and Cattle egrets at a dumpsite in Rumukwurushi

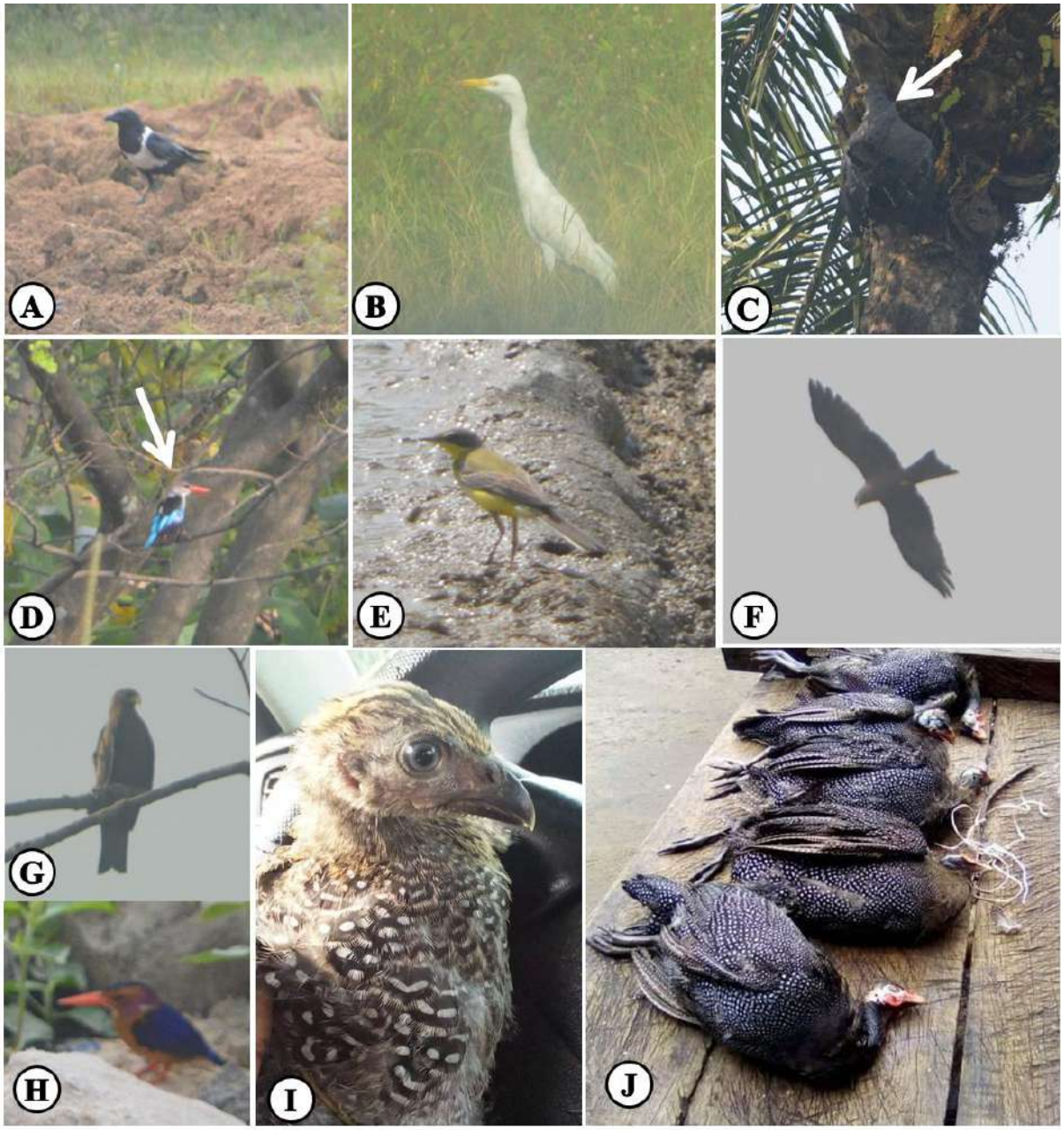


Plate 4.13: Bird species observed during the field survey (A) Crow, (B) Cattle egret (Ardeola ibis), (D) (C) Hawk (Polyboroides typus) (D) Woodland kingfisher (Halcyon senegalensis), (F and G) Black kite (Milvus migrans), (H) Ispidina picta (Ceyx picta) African pygmy kingfisher, (I) Greater Kestrel (Falcon rupilocoides), and (J) Helmeted guineafowl (Numida meleagris) (Source: Fieldwork 2023).



Plate 4.15: Congregation of Red-eyed doves at Igbo-Etche (Source: Fieldwork 2023)



Plate 4.16: Breeding site for weaver birds observed Omarelu

(Source: Fieldwork 2023)

Mollusks: African giant snail *Archachatina marginata*, was the prominent mollusk found in the proposed project area. Others may include: *Achatina spp.* and *Limicolaria aurora.*

Reptile: Nine reptile species were identified or reported from the study area (Table 4.25). The recorded reptiles included tortoises (*Kinixys* spp.), small lizards such as the common agama (*Agama agama*) and skinks (*Mabuya affinis* and *Mabuya maculilabris*), as well as forest geckos and chameleons. Hunters also reported encountering several snake species within the study area. These included the Black-necked spitting cobra (*Naja nigricollis*), emerald tree snake (*Gastrópyxis smaragdina*), Jameson's mamba (*Dendroaspis jamesoni*), Gabon viper (*Bitis gabonica*), and pythons, including the royal python (*Python regius*) and African rock python (*Python sebae*). The reported occurrence of these snakes, particularly in humid forest habitats, reflects the availability of suitable cover and prey resources within the study landscape. No significant difference was observed in the reptile species composition between the wet and dry seasons, indicating relatively consistent reptile occurrence across the two survey periods.

Table 4.25: The common reptile identified in the study area

S/N	Species name	Common name	Family	Means of identification	IUCN status
1	*Tarentola gomerensis*	Wall gecko	Gekkonidae	DO	LC
2	*Lampropholis guichenoti*	Skink	Scincidae	DO	LC
3	*Bitis gabonica*	Gabon Viper	Viperidae	HR	VU
4	*Naja nigricollis*	Black Cobra	Elapidae	DO	LC
5	*Python regius*	Royal Python	Pythonidae	HR	NT
6	*Python sebae*	Rock Python	Pythonidae	HR	NT
7	*Kinixys erosa*	Serrate hinge-back tortoise	Testudinidae	HR	NT
8	*Kinixys homeana*	Home's hinge-back tortiose	Testudinidae	HR	CR
9	*Dendroaspis* spp	Green Mamba	Elapidae	DO	LC

Note: HT = Hunters trap, HR = Hunters report, DO = direct observation, PTH = Pictures taken by hunters, NT – Near threatened, CR- Critically Endengered, VU = Vunerable, EN = Endangered **(Source: Fieldwork 2023/2026)**



Plate 4.17: Dead snake observed during the field survey (Rumukwurusi)

Insects: The major groups of insects were identified during the fieldwork is presented in **Table 4.26** and **Plates 4.18 & 4.19** present the insect fauna recorded in the study area. The survey documented a diverse assemblage comprising dragonflies, butterflies, grasshoppers, termites, beetles, bees, wasps, flies, ants, spiders and other arthropods. Most of the recorded groups were widely distributed across the study area, reflecting the heterogeneous habitats comprising agricultural fields, secondary forests, bush fallows and disturbed areas.

The insect assemblage included butterflies such as *Colias* spp., *Pontia daplidice*, *Pyrgus* spp. and *Hipparchia* spp.; beetles including *Cicindela* sp., *Pterostichus adstrictus*, *Aphodius* spp. and *Coccinella* spp.; and spiders such as *Episinus truncatus* and *Textrix denticulata*. Other notable groups included moths, crickets, grasshoppers, stink bugs, leaf beetles and palm-associated weevils. These organisms perform important ecological functions: bees and other pollinators contribute to plant reproduction, predatory insects and spiders help regulate arthropod populations, while termites and beetles contribute to decomposition and nutrient cycling.

Seasonal variation was evident in the insect community. Additional taxa (S/N 27–39) were recorded during the wet season, including moths, crickets, grasshoppers, crab spiders, stink bugs, leaf beetles and palm-associated weevils. Their occurrence may be associated with increased rainfall, humidity, vegetation growth and availability of food and breeding resources during the wet season. However, several major insect groups, particularly butterflies, flies, ants, beetles and spiders, were widely distributed within the study area, suggesting that portions of the insect community persist across seasons. Thus, the available records indicate seasonal differences in species occurrence and detectability, although the magnitude of seasonal variation cannot be quantitatively determined from

the available data. Overall, the insect assemblage reflects a biologically active and ecologically heterogeneous terrestrial environment.

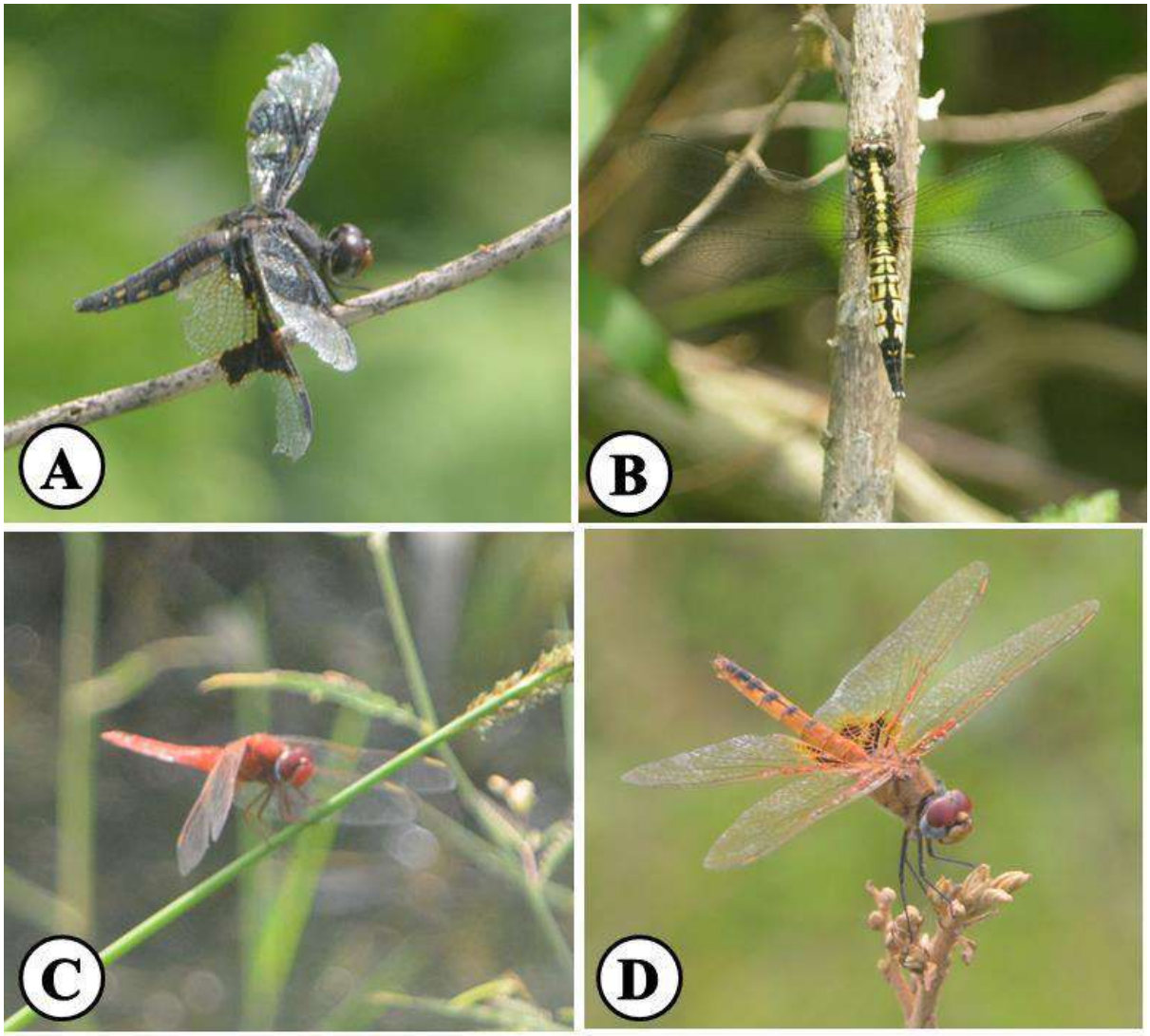


Plate 4.18: Dragon flies recorded during the field survey

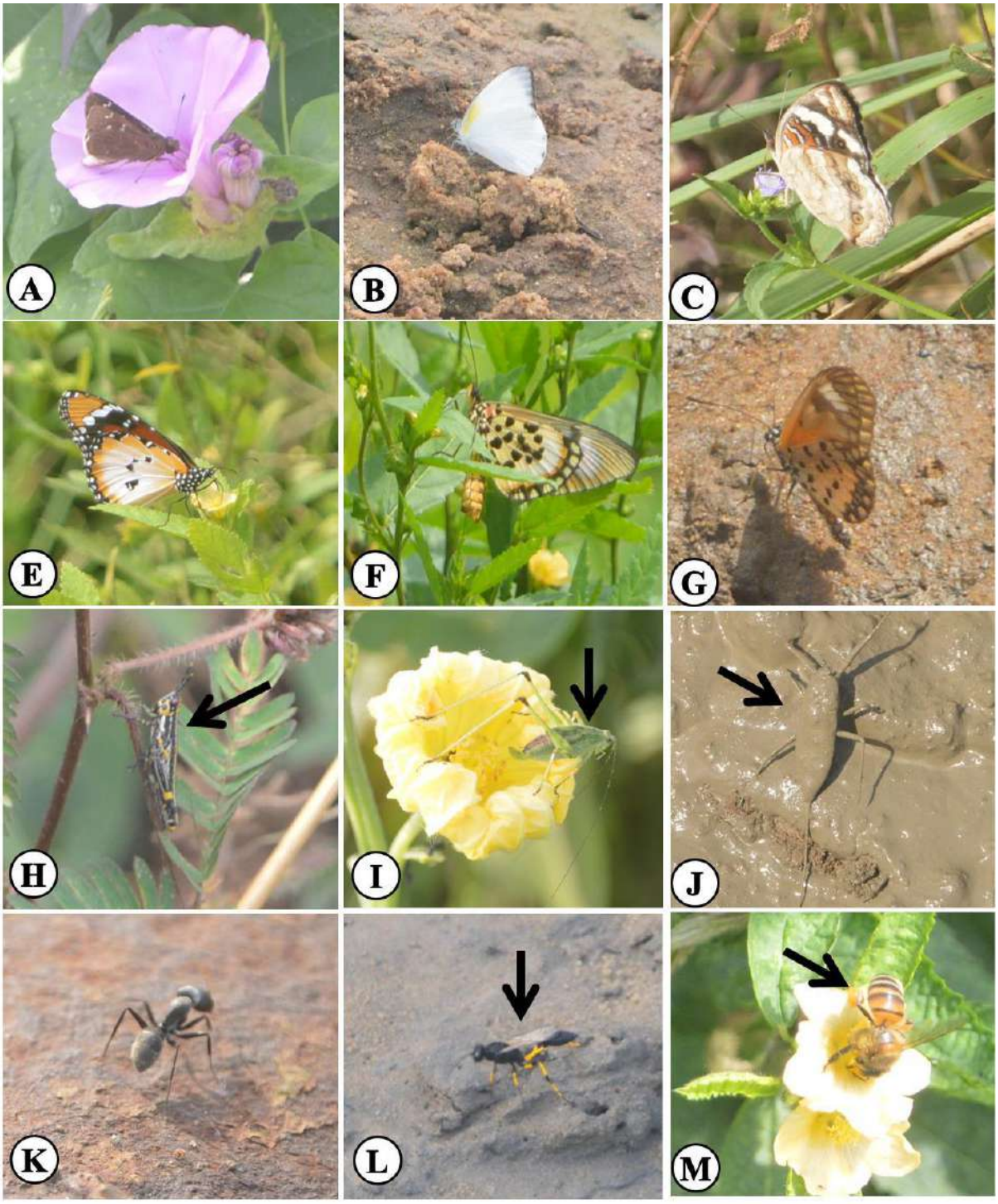


Plate 4.19: Some insect groups observed during the field survey 2023

Table 4.26: Checklist of insect identified in the Study Area

S/N	Scientific name	Common name	Family	IUCN status
1	*Gasteracantha cancriformis*	Spiny orb-weaver spider	Araneidae	NE

S/N	Scientific name	Common name	Family	IUCN status
2	*Orthetrum brachiale*	Strong skimmer/dragonfly	Libellulidae	**LC**
3	*Mantis religiosa*	Praying mantis	Mantidae	**LC**
4	*Zonocerus variegatus*	Variegated grasshopper	Pyrgomorphidae	NE
5	*Macrotermes bellicosus*	Termite	Termitidae	NE
6	*Acraea terpsicore*	Tawny coster butterfly	Nymphalidae	NE
7	*Apis mellifera*	Honeybee	Apidae	**DD***
8	*Anopheles* sp.	Mosquito	Culicidae	NE
9	*Glossina* sp.	Tsetse fly	Glossinidae	NE
10	*Limicolaria* sp.	Garden snail	Achatinidae	NE
11	*Eudrilus eugeniae*	African nightcrawler/earthworm	Eudrilidae	NE
12	*Hyperidrilus* sp.	Earthworm	Eudrilidae	NE
13	*Oryctes* sp.	Rhinoceros beetle/dung-associated beetle	Scarabaeidae	NE
14	*Trinervitermes* sp.	Termite	Termitidae	NE
15	*Amitermes* sp.	Termite	Termitidae	NE
16	*Odontotermes* sp.	Termite	Termitidae	NE
17	*Cubitermes* sp.	Termite	Termitidae	NE
18	*Lithobius forficatus*	Brown centipede	Lithobiidae	NE
19	*Archispirostreptus gigas*	Giant African millipede	Spirostreptidae	NE
20	*Gasteruption assectator*	Carrot wasp	Gasteruptiidae	NE
21	*Bicyrtes* sp.	Sand wasp/stinkbug hunter	Crabronidae	NE
22	*Bembix* sp.	Sand wasp	Crabronidae	NE
23	*Sceliphron* sp.	Mud dauber wasp	Sphecidae	NE
24	*Chlorion* sp.	Cricket-hunter wasp	Sphecidae	NE
25	*Eumenes fraternus*	Potter wasp	Vespidae	NE
26	*Bombus* sp.	Bumblebee	Apidae	NE
27	*Glymmatophora* sp.	Moth	**Not resolved**	NE
28	*Euscyrtus* sp.	Cricket	Gryllidae	NE
29	*Oedaleus infernalis*	Grasshopper	Acrididae	NE
30	*Thomisus labefactus*	Crab spider	Thomisidae	NE
31	*Euthystira brachyptera*	Short-winged grasshopper	Acrididae	NE
32	*Enoplotettix* sp.	Grasshopper	Acrididae	NE
33	*Xenocatantops humilis*	Grasshopper	Acrididae	NE
34	*Haliastuss* sp.†	—	**Not resolved**	NE
35	*Atractomorpha crenulata*	Slant-faced grasshopper	Pyrgomorphidae	NE

S/N	Scientific name	Common name	Family	IUCN status
36	*Edessa helix*	Stink bug	Pentatomidae	NE
37	*Trachymela* sp.	Leaf beetle	Chrysomelidae	NE
38	*Metamasius hemipterus*	West Indian sugarcane weevil	Curculionidae	NE
39	*Rhynchophorus phoenicis*	African palm weevil	Curculionidae	NE

Note: HT = Hunters trap, HR = Hunters report, DO = direct observation, PTH = Pictures taken by hunters, NT – Near threatened, CR- Critically Endengered, VU = Vunerable, EN = Endangered **(Source: Fieldwork 2023)**

Occurrence, Distribution, and IUCN status

Findings revealed that based on the wildlife species identified, Insects (40 species, 35.40%) predominated the species. This is followed by Aves **(**31 species, 27.43%), Mammals (24 species, 21.24%), Reptiles (9 species, 7.96%), amphibians (6 species, 5.31%), and Mollusks (3 species, 2.65%) **Fig. 4.43**.

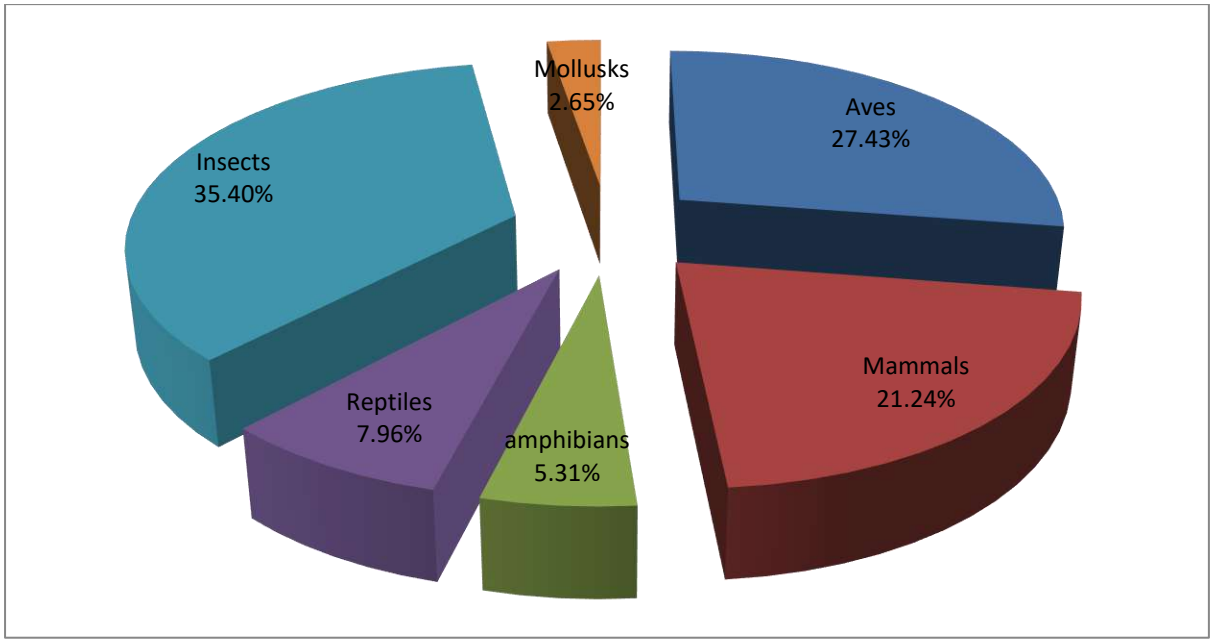


Figure 4.43: Wildlife occurrence and percentage distribution

The mammalian group have *Cercopithecus mona* (Mona monkey –Cercopithecidae), near threatened, *Eidolon helvum* (Straw-coloured fruit bat), Pteropodidae, NT; and *Genetta cristata* (Crested genet) Viverridae, Vunerable, VU. and *Cercopithecus mona* wasidentified based on the pictures taken by the Hunters while *Eidolon helvum* and *Genetta cristata* were recorded based on the interview with the hunters. These species were reported to have been killed within the last three months of this field survey suggesting their presence in the study area.

Among the reptile, *Bitis gabonica* (Gabon Viper) VU, *Python regius* (Royal Python) NT, *Python sebae* (Rock Python) NT; *Kinixys erosa* (Serrate hinge-back tortoise) NT; and *Kinixys homeana* (Home's hinge-back tortoise) CR. *Bitis gabonica* and *Python sebae* were reported to have been killed by the locals two months before this field survey while *Kinixys erosa* and *Kinixys homeana* was last observed or killed in the area in last one and half years. This, however, infer that *Kinixys erosa* and *Kinixys homeana* is rare in the study area while *Bitis gabonica* and *Python sebae* still inhabit the study area.

Among the bird species, *Gyps africanus* (Vulture) and *Necrosyrtes monachus* (Hooded vulture) in Accipitridae are Critically Endengered (CR). These species of birds were not directly observed during the field work but were reported to exit in the adjoining forest within the Igbo-Etche, Umuechem, Umuaturu, Edegelem, and Umuogodo forests.

4.5.3 Aquatic Biology

4.5.3.1 Introduction

The field survey and sample collection for aquatic biodiversity was done 12th and 13th December 2023 for Dry Season and 6th to 7th August 2026 for Wet Season. The sampling stations considered for this study are the same as for surface water and sediment studies, shown in Table 4.27 and presented in Figure 4.44.

Table 4.27: Sampling Stations for Surface water / Sediment / Aquatic Biodiversity

Station	Location	GPS Coordinates	
		North (N)	East (E)
SW1	Okulu Stream at Aleto	4°48'26.82"N	7°07'27.75"E
SW2	Otamimiri River (Chokocho)	4°48'27.33"N	7°06'39.19"E
SW3	Egbeda Stream	4°48'26.05"N	7°06'08.12"E

Plankton samples were collected by filtering 50L of water through a plankton net (65µ for mesh size 30 cm diameter). The content of the collection bottle was rinsed into sample containers and fixed immediately with a 5% formaldehyde-water mixture. Complimentary phytoplankton samples were obtained by the screen method. The Okulu stream is under tidal influence and the samples were collected during low tide conditions. The control stations are not under tidal influence.

Benthos samples were collected with a grab sampler, sieved through a 0.5 mm mesh size net and the debris emptied into a plastic container. The samples were immediately preserved with 5% formaldehyde-water mixture and stained with eosin to aid sorting. The Okulu stream is under tidal influence and the samples were collected during low tide conditions. The control stations are not under tidal influence.

Physical observation of fishing activities was undertaken to capture types of fishing gear and catch assessment. The use of Cast and Seine nets is common and suitable fishing gear used within the region. However, the depth of water and physical conditions at the sampling stations precluded the use of seine nets. Therefore, only cast nets were used for fish sampling during the study in Okulu Stream. Samples from each throw were counted to determine catch per unit effort (CPUE). All samples collected were placed in labelled polythene bags and placed in ice-cooled boxes for transportation to the laboratory where they were immediately frozen until analyzed. Fish were individually identified and counted.

Floating aquatic macrophytes were studied by visual assessment in the field. The Okulu stream banks are collapsing due to sand mining and hence samples cannot be collected for study of fauna associated with emergent vegetation.

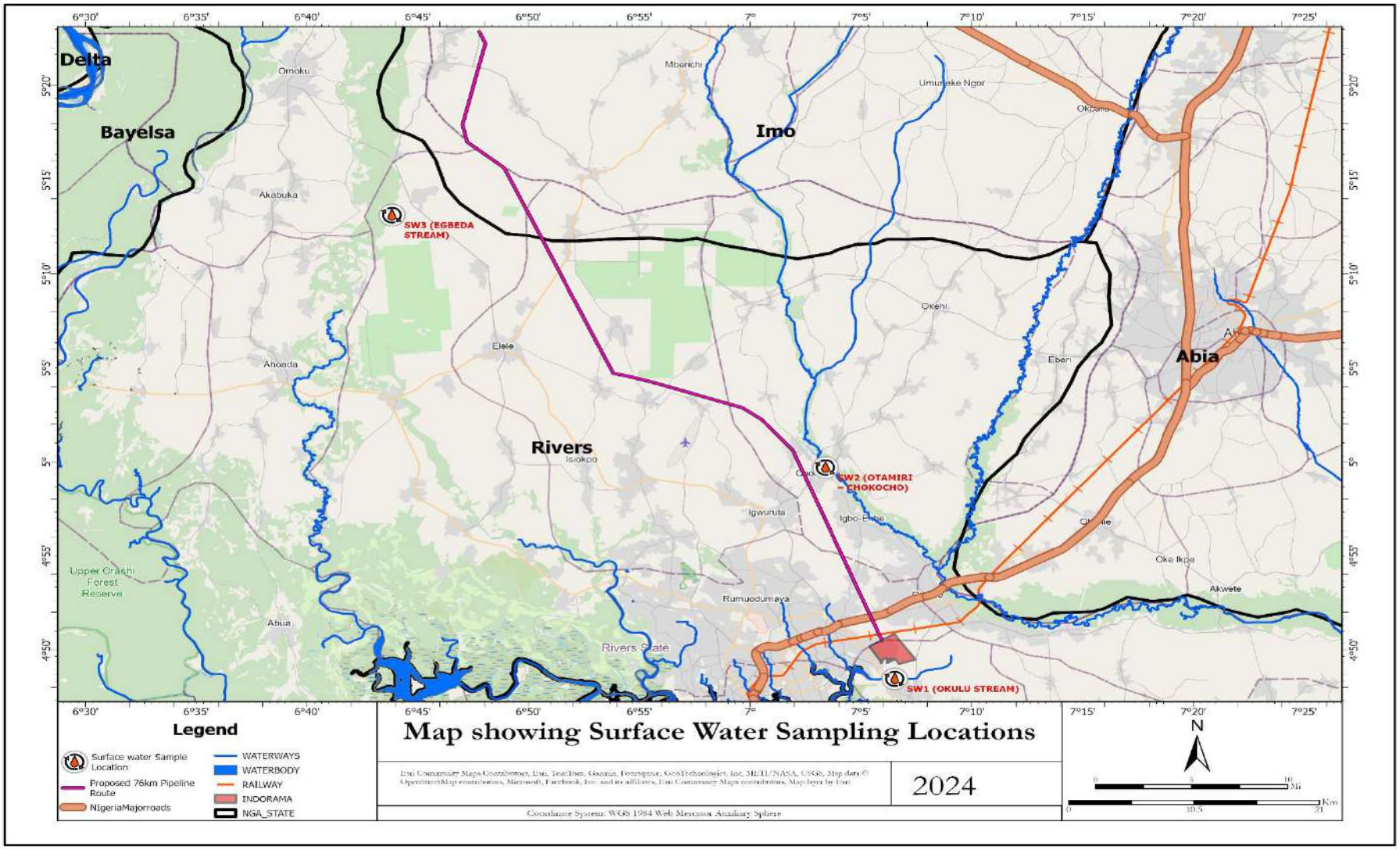


Figure 4.44: Map showing Surface Water Sampling Locations

4.5.3.2Phytoplankton

The phytoplankton composition from the study area is presented in Table 4.28A for Dry Season and4.28B for Wet Season, while the relative abundance of major taxa is presented in and Figure 4.45A and 4.45B for Dry and Wet Seasons respectively. Bacillariophyceae (diatoms) were the most dominant and abundant in both seasons. The phytoplankton consisted of five genera of bacillariophyeae (diatoms) in the dry season and six genera in the wet season, as well as two genera of chlorophyceae (green algae) in both seasons. Diatoms accounted for 62 % (SW2) to 87 % (SW1) in the dry season, and 71% (SW2) to 84% (SW1). However, the green algae were marginally higher at SW 3 with 51 % during the dry season. *Cyclotella, Nitzschia* and *Synedra* were the most widely distributed diatoms in both seasons. Amongst the green algae, *Spyrogyra* was found in all the stations *while Rivularia* and *Closterium* were found in one station each during the dry and wet seasons respectively.

The ranges of phytoplankton community indices for both seasons were: Margalef (0.46 to 0.73 dry, 0.50-0.94 Wet); Shannon-Weiner (1.30 to 1.59 dry, 0.05-1.77 wet); Pielou (0.81 to 0.85 dry; 0.76-0.99 wet) and Simpson (0.23 to 0.34 dry; 0.20-0.43wet).

The dominance of diatoms (which are an important component of the diet of several fish resources) is consistent with some other studies in Otamiri River (Ihejirika et al. 2023) and the Niger Delta (Davies & Nwosu, 2019, George et al., 2021).

Table 4.28: Composition and Distribution of Phytoplankton in the Study Area

Table 4.28A: Dry Season

TAXA	SW1	SW2	SW3
BACILLARIOPHYCEAE			
Synedra spp	200	800	1083
Nitzschia sp	183	200	450
Coscinodiscus spp	67	0	0
Navicula sp	33	0	200
Cyclotella sp	333	450	517
CHLOROPHYCEAE			
Spirogyra sp	117	850	2333
Rivularia sp	0	33	0
No of Genera	6	5	5
Abundance (N): Cells/L	933	2333	4583
Margalef Richness (d)	0.73	0.52	0.46
Pielou Evenness (J')	0.85	0.82	0.81
Shannon-Weiner Diversity (H')	1.59	1.32	1.30

TAXA	SW1	SW2	SW3
Simpson Dominance (λ)	0.23	0.30	0.34

Table 4.28B: Wet Season

TAXA	SW1	SW2	SW3
BACILLARIOPHYCEAE			
Asterionella sp	0	0	33
Navicula sp	133	17	117
Synedra spp	233	67	500
Nitzschia spp	233	83	400
Cyclotella spp	167	250	233
Gyrosigma sp	0	0	67
CHLOROPHYCEAE			
Closterium sp	0	0	50
Spirogyra sp	150	167	350
No of Genera	5	4	8
Abundance (N): Cells/L	966	417	1750
Margalef Richness (d)	0.58	0.50	0.94
Pielou Evenness (J')	0.99	0.76	0.85
Shannon-Weiner Diversity (H')	1.59	1.05	1.77
Simpson Dominance (λ)	0.21	0.43	0.20

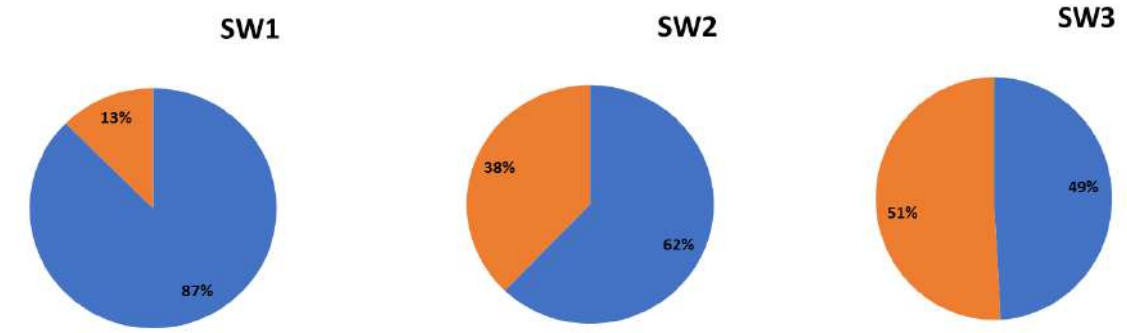


Figure 4.45A: Dry Season

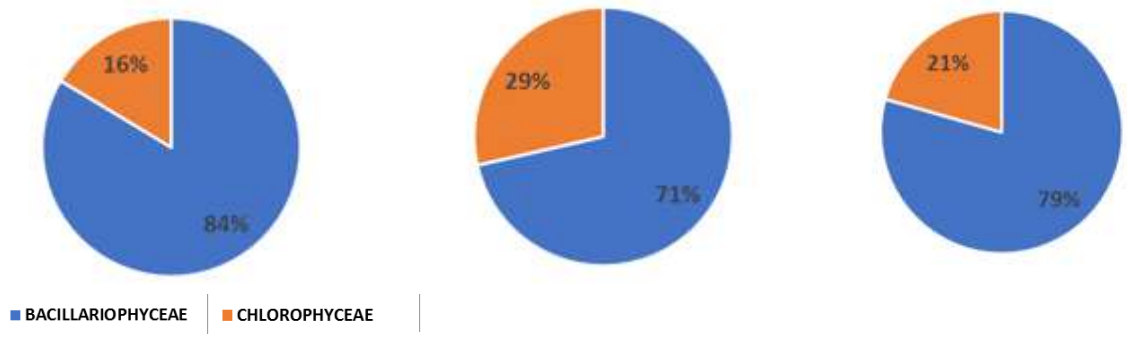


Figure 4.45B: Wet Season

Figure 4.45: Relative Abundance of Phytoplankton

4.5.3.3 Zooplankton

The list of zooplankton identified in the surface water bodies of the study area is presented in Tables 4.29A for Dry Season and 4.29B for Wet Season. The relative abundance of major taxa in the zooplankton is presented in Figure 4.46 (And B for Dry and Wet Seasons. During the dry season, copepods were the most dominant with 100% in SW1 and SW2 but were not observed in SW3 having Cladocera (75%) and Rotifera (25). Only copepod naupli were found in SW1 and SW2. Abundance of cladocera in SW3 was in the order *Bosmina longirostris, Daphnia rosea, Diaphanosoma* sp, *Moina wierzejskii*, while rotifer was *Kellikottia* sp *Keratella cochlearis Filinia* sp. Margalef index and Simpson dominance were 0 and 1 respectively in SW1 and SW2 as only one taxon was recorded. The ranges of zooplankton community indices in SW3 with more diverse composition were: Margalef-0.46; Shannon-Weiner- 1.64; Pielou- 0.84 and Simpson- 0.24. In the wet season, copepoda accounted for 72% at SW3 to 100% at SW2, while Cladocera was 25% and 28 % at SW1 and SW2 respectively. Copepod nauplii was the most widely distributed followed by *Senecella calanoides*. *Daphnia* sp was observed at SW1 and SW3. Community indices during the wet season (apart from SW2 which had only 1 genus were: Marglef 0.20-0.54; Shannon Weiner 1.21-1.30; Pielou 0.87-0.94 and Simpson 0.29-0.34.

Table 4.29: Composition and Distribution of Zooplankton in the Study Area

Table 4.29A: Dry Season

TAXA	SW1	SW2	SW3
COPEPODA			
Nauplius	83	67	0
CLADOCERA			
Moina wierzejskii	0	0	117
Diaphanosoma sp	0	0	217
Bosmina longirostris	0	0	1200
Daphnia rosea	0	0	900
ROTIFERA			
Kellikottia sp	0	0	317
Keratella cochlearis	0	0	267
Filinia sp	0	0	217
No of Genera	1	1	7
Abundance (N): Num/L	83	67	3233
Margalef Richness (d)	0	0	0.74
Pielou Evenness (J')			0.84
Shannon-Weiner Diversity (H')			1.64
Simpson Dominance (λ)	1	1	0.24

Table 4.29B: Wet Season

TAXA	SW1	SW2	SW3
COPEPODA			
Nauplius	133	117	83
Senecella calanoides	33	0	167
Limnocalanus macrurus	0	0	50
Eucyclops serrulatus	33	0	0
	200	117	300
CLADOCERA			
Daphnia spp	67	0	117
No of Genera	4	1	4
Abundance (N): Cells/L	266	117	417
Margalef Richness (d)	0.54	0	0.50
Pielou Evenness (J')	0.87		0.94
Shannon-Weiner Diversity (H')	1.21	0	1.30
Simpson Dominance (λ)	0.34	1	0.29

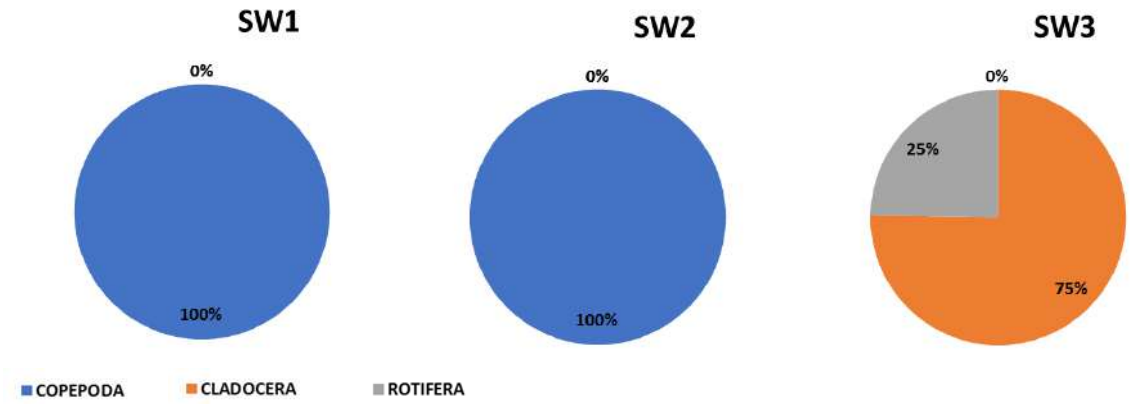


Figure 4.46A: Dry Season

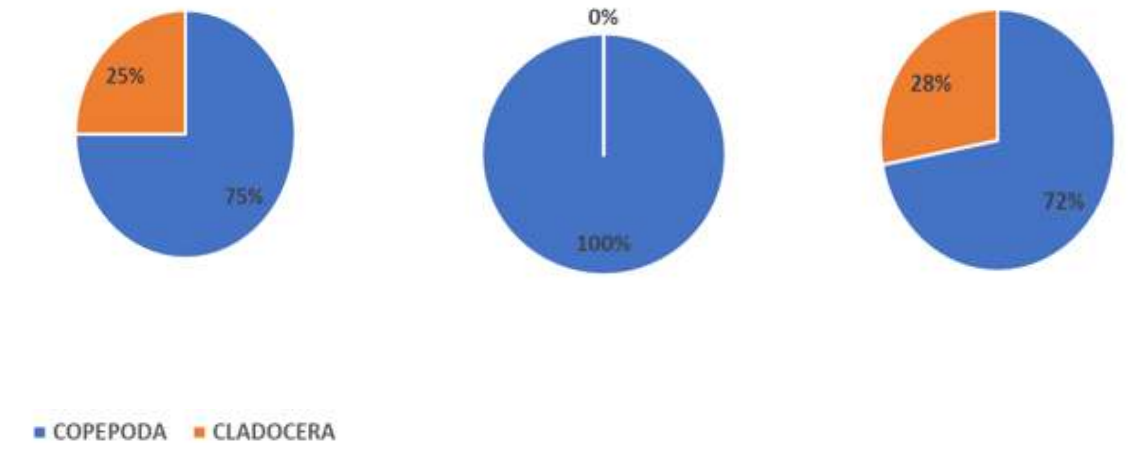


Figure 4.46B: Wet Season

Figure 4.46: Relative Abundance of Zooplankton

4.5.3.4 Benthos

The composition and abundance of benthic organisms in the study area was very low. No organism was recovered as SW2 in both seasons and SW3 in the wet season. While one genus of polychaeta (*Streblospio*) and one unidentified genus of Oligochaeta were recorded at SW1 and SW3 respectively in the dry season (Table 4.30A), one genus each of polychaeta (Nereis), oligochaeta (*Ophidonais)* and Mollusca (*Loripinus*) were recorded at SW1 during the wet season (Table 4.30B). The continuous sand mining at SW2 might be responsible for the zero-benthos count in both seasons. Also, a crude oil spill incident a few months before the dry season sampling may have led to benthic faunal obliteration, while subsequent low abundance values were due to sand mining.

Table 4.30: Composition and Abundance (num/m^2) of Benthos in the Study Area

Table 4.30A: Dry Season

TAXA	SW1	SW2	SW3
POLYCHAETA			
Streblospio sp	20	0	0
OLIGOCHAETA			
Unidentified	0	0	32

Table 4.30B: Wet Season

TAXA	SW1	SW2	SW3
POLYCHAETA			
Nereis sp	150	0	0
OLIGOCHAETA			
Ophidonais serpentina	67	0	0
MOLLUSCA			
Loripinus subfragilis	133	0	0

4.5.3.5 Fish and Fisheries

There is minimal fishing activity in the Aleto (Okulu) stream and is not a commercial venture. This is similar to the report by IFF (2017) that fishing activities in the surface water bodies around the project area are generally subsistent. During the fieldwork in December 2023 and August 2026, a couple of fishers were observed in dug-out canoes using cast nets. A checklist of fishes in Okulu stream was compiled from the biodiversity studies in Okulu steam from September 2021 to April 2026 is presented in Table 4.31 and Plate 4.20. Eleven (11) families (Cichlidae. Mugilidae, Lutjanidae, Clupeidae, Alestidae, Megalopidae, Clariidae, Gerreidae, Monodactylidae, Haemulidae, Carangidae) and 17

species of fish are reported with the cichlidae as the most abundant. The abundance score (based on the DAFOR Scale using aggregate data over the survey period), showed that black-chin tilapia *Sarotherodon melanotheron* is the dominant species in the Okulu Stream. The flathead grey mullet *Mugil cephalus, Neochelon facipinnis and Coptodon guineensis* were common*, Sardinella maderensis, Monodactylus sebae* and *Eucinostomus melanopterus were* occasional and all other species observed are rare. The bagrid catfish *Chrysichthys nigrodigitatus* and *Clarias gariepinus* caught *from* Chokocho River was observed during the fieldwork in December 2023 and August 2026 respectively (Plate 4.21). Dumka and Kingdom (2018) also reported *Clarias gariepinus* from Chokocho but Ohaturuonye *et al.* (2018) presents a comprehensive checklist of ichthyofaunal of the Otamiri river in Imo State with 18 families (Mochokidae, Schileidae, Bagridae, Claridae, Claroteidae, Channidae, Cichlidae, Anabantidae, Mormyridae, Notopteridae, Arapaimidae, Pantodontidae, Gymnarchidae, Hepsetidae, Alestidae. Distichodontidae, Cyprinidae) and 46 genera of fish. However, Temitope and Bobo (2020) reported 11 families (Cichlidae Notopteridae Clarotida Alestidae Hepsetidae Mormyridae Gymnarchidae) and 16 genera with dominance of Cichlidae and *Sarotherodon melanotheron* from the upper course of Otamiri River in Imo State.

The three water bodies within the spatial boundaries of the study (Okulu stream at Aleto, Chokocho River and Egbeda Stream) do not fall within any national legally protected area or an internationally recognized area. It is not an aquatic critical or sensitive fish habitat. There are no endemic species, and the IUCN status of the fish were mostly Least Concern or Data Deficient (except *Megalops atlanticus and Sardinella maderensis* listed as vulnerable globally).

Table 4.31: Composition of Fish in Okuly Strean

Family	Scientific name	Common Name	Abundance Score	IUCN Red List Status (IUCN 2022)
Cichlidae	*Sarotherodon melanotheron*	Blackchin tilapia	Dominant	LC
	Coptodon guineensis	Guinean tilapia	Common	LC
Mugilidae	*Mugil cephalus*	Flathead grey mullet	Common	LC
	Neochelon falcipinnis	Sicklefin mullet	Common	DD
	Liza grandisquanmis	Large-scaled mullet	Rare	DD
Lutjanidae	*Lutjanus agennes*	African red snapper	Rare	DD
	Lutjanus dentatus	African brown snapper	Rare	LC
Clupeidae	*Sardinella maderensis*	Madeiran sardinella	Occasional	VU
	Sardinella aurita	Round sardinella	Rare	LC
Alestidae	*Brycinus nurse*	Nurse tetra	Rare	LC
	Elops lacerta	West African ladyfish	Rare	DD
Megalopidae	*Megalops atlanticus*	Atlantic tarpon	Rare	VU

Family	Scientific name	Common Name	Abundance Score	IUCN Red List Status (IUCN 2022)
Clariidae	*Clarias garieinus*	African sharptooth catfish	Rare	LC
Gerreidae	*Eucinostomus melanopterus*	Flagfin mojarra	Occasional	LC
Monodactylidae	*Monodactylus sebae*	African moony	Occasional	LC
Haemulidae	*Plectorhinchus macrolepis*	Biglip grunt	Rare	LC
Carangidae	*Caranx hippos*	crevalle jack	Rare	LC



A: *Chrisichthys nigrodigitatus*



B: *Clarias garieinus*

Plate 4.20: Chrisichthys nigrodigitatus and Clarias garieinus on display for sale at Chokocho bridge

Source: Fieldwork (A: 2023 and B: 2026)



Sarotherodon melanotheron



Coptodon guineensis



Mugil caphalus



Neochelon falcipinnis



Liza grandisquanmis



Lutjanus agennes



Lutjanus dentatus



Sardinella marderensis



Brycinus nurse



Elops lacerta



Megalops atlanticus



Sardinella aurita



Clarias garieinus



Eucinostomus melanopterus



Caranx hippos



Plectorhinchus macrolepis



Monodactylus sebae

Plate 4.21: Photos of fishes from Okulu Steam

Source: Okulu Stream Biodiversity Studies (2021-2026)

4.5.3.6Floating Aquatic Macrophytes

No floating aquatic macrophytes were observed in any of the sampling stations of the water bodies surveyed during the dry season. However, a floating mat of aquatic vegetation was found at Otamiri River (SW3) during the wet season sampling (Plate 4.22).



Plate 4.21a: Floating map of aquatic vegetation at Otamiri River

4.5.3.7Key Stressors/Threats to Aquatic Biodiversity

The mining/dredging of sand in Okulu Stream (Tamunobereton-ari & Omubo-Pepple (2011) and the Otaminri River at Chokochi (Victor *et al*., 2018) constitute major threats to aquatic biodiversity. Dredging intensity appears to have increased over the years, further widened the Okulu Stream and turned the stream to a tidal water body with a progressive increase in the salinity occasioned by saltwater intrusion from the upper Bonny Estuary, treated effluent from the manufacturing complex is released into the stream. Pollution events from pipelines carrying petroleum products occur. Runoffs from

agriculture and other land-based activities such as abattoir; and wastes from domestic and commercial activities also enter the water bodies.

4.5.4 Ecosystem Services

4.5.4.1Introduction

The field work for both the terrestrial and aquatic biodiversity of the Study Area included interviewing local hunters, fisherman, gatherers, farmers, and communities with regards to their uses of the natural environment, and the resources that it contains. The ecosystem services that the communities gain from the local environment are varied, and includes direct services, such as food, medicine, timber for furniture and construction, leafy vegetables, fuelwood, fruits, seeds, nuts, spices, raw materials for pharmaceuticals, organic fertilizers, ornamentals, gums, resins, palm oil, and indirect services, such as sacred groves which serve spiritual and worship purposes.

Beyond the socio-economic and cultural gains of biodiversity, the ecosystem services extend to regulating the hydrological cycles regime, local and ambient air quality, carbon sequestration, recreation, and environmental aesthetics.

4.5.4.2Survey Findings

The ecosystems surrounding the Project Area such as secondary forest, riparian forest, marshy terrain, and freshwater swamp forest ecosystems have several habitats for different species of animals and plants. However, some of the ecosystems like the riparian and freshwater swamp forests have started losing their natural attributes due to human alterations in its structure, size, and extent. The secondary forests, Guinea savanna etc. provide shade, cover, nesting and breeding grounds, seeds and nuts, food and nectar for birds and other wildlife in the area.

Ongoing anthropogenic activities in the Study Area, in terms of logging, regular hunting/trapping of animals, indiscriminate extraction of sand and gathering of non-timber forest products (NTFPs), and infrastructural developments are drivers of degradation to ecological systems in the Study Area.

Fisheries provisioning services is one of the most important ecosystem services provided by rivers and streams. Fishing in Okulu stream and the Otamiri river at Chokocho is minimal and of low-level subsistence value. There are no species that support recreational fisheries, or culturally important fisheries. The ecosystem services of plankton are supporting services premised on their ecological role in the ecosystem.

The variety of ecosystem services that were identified by the local communities as important natural resources are listed in Table 4.32 below and uses of some of plants present in the study area is presented in Annexure 4.8.

Table 4.32: Ecosystem Services and Provisioning in the Study Area

S/N	Species Name	Economic importance
1	*Aframomum* spp.	Medicinal
2	*Alchornea cordifolia*	Medicinal/fuel-wood
3	*Alstonia boonei*	Medicinal/fuel-wood
4	*Anthocliesta vogelii,*	Fuel-wood
5	*Calamus* sp.	Fish trap/basket making
6	*Ceiba pentandra,*	Timber/fuel-wood
7	*Chromolenea ordorata.*	Medicinal
8	*Cliestopholis pentans*	Timber/fuel-wood
9	*Elaeis guineensis*	Food/fuel-wood
10	*Funtumia* sp	Medicinal/fuel-wood
11	*Gracinia* sp.	Medicinal/fuel-wood
12	*Harungana* sp	Fuel-wood
13	*Ipomea* spp.	Food
14	*Macaranga* sp	Timber/fuel-wood
15	*Mangifera indica*	Food/fuel-wood
16	*Millettia thonningii*	Medicinal/Fuel-wood
17	*Musanga sp*	Timber
18	*Napoleana sp*	Medicinal/ fuel wood
19	*Nauclea pobeguinii*	Timber
20	*Newbuldia levis*	Medicinal/food
21	*Phylanthus amarus*	Medicinal
22	*Raphia* spp.	Wine
23	*Senna spp*	medicinal
24	*Streculia tragacantha*	Fuel-wood
25	*Symphonia globulifera*	Timber/fuel-wood
26	*Tectonia grandis*	Timber/fuel-wood
27	*Terminalia* sp.	Timber/fuel-wood
28	*Euphorbia* spp.	Medicinal
29	*Combertum racemosum*	Medicinal
30	*Gmelina aborea*	Timber/fuel-wood
31	*Amaranthus* spp.	Vegetable
32	*Bambosa vulgaris*	Construction/fuel-wood
33	*Spondias* sp.	Medicinal/fuel-wood
34	*Anthonotha macrophylla*	Fuel-wood
35	*Pentacletra macrophylla*	Timber/food/fuel-wood

Source: Field work 2023

4.6 Socio-economic Environment

4.6.1 Introduction

This section provides the baseline socio-economic environment of communities hosting the Proposed 76 Km Gas Pipeline Project in Eleme, Obio/Akpor, Etche, Ikwerre and Ohaji/Egbema Local Government Areas (LGAs) in Rivers and Imo States. The origin of the pipeline being Asa community in Ohaji/Egbema LGA, Imo State and terminating at the Indorama Complex at Akpajo community in Eleme LGA, Rivers State.

Primary data was collected through sampling of the Project-affected communities in Decemer 2023. Prior to the commencement of fieldwork, community gatekeepers were informed of the proposed study to obtain their consent and to facilitate access for fieldworkers. The Community Relations & Development Team from the existing Indorama Site further assisted with access to community members and facilitation of data collection.

The questionnaire administrated is presented as Annexure 4.9. A non-proportional sample of 440 respondents were surveyed from the selected communities. The decision a priori was to study 20 households (selected randomly) per community was considered statistically large enough, in the circumstances, to provide stable estimates of population parameters., To provide the sampling frame, a rapid house-to-house listing of households was undertaken by trained personal. For further gathering of qualitative data, Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and Participatory Appraisal techniques were used. Collected data was analysed using relevant statistical software such as SPSS. In the case of data estimations, applicable statistical formulae were used. The studied communities and sampling details are provided in Table 4.33.

Table 4.33: Target Community and Sampling Details

S/No	Communities	1991 National Census Population	Projected 2024 Population*	Number of Households	No. of Households Surveyed	Sampling Percentage
1	Akpajo	5,196	35,124	5,854	20	0.3
2	Elelenwo	8,645	58,440	9,740	20	0.2
3	Rumukrushi	11,476	77,577	12,929	20	0.2
4	Atali	2,428	16,413	2,735	20	0.7
5	Chokocho	3,463	23,409	3,901	20	0.5
6	Abara	1,866	12,614	2,102	20	1.0
7	Omuodogo	-	9,877	1,646	20	1.2
8	Umuakuru	1,736	11,735	1,955	20	1.0
9	Ime	2,781	18,799	3,133	20	0.6
10	Edegelem	2,378	16,075	2,679	20	0.7
11	Umuechem	4,593	31,048	5,174	20	0.4
12	Ipo	2,125	14,365	2,394	20	0.8

S/No	Communities	1991 National Census Population	Projected 2024 Population*	Number of Households	No. of Households Surveyed	Sampling Percentage
13	Omademe	4,267	28,844	4,807	20	0.4
14	Ozuoha	4,742	32,055	5,342	20	0.4
15	Omanwa	5,019	33,928	5,654	20	0.4
16	Ubima	13,491	91,199	15,199	20	0.1
17	Omereolu	7,530	50,902	8,483	20	0.2
18	Omuapu (Akanu)	-	15,433**	2,572	20	0.8
19	Awara I	-	7,423**	1,237	20	1.6
20	Awara II	-	6,344**	1,057	20	1.9
21	Ochia	-	6,056**	1,009	20	2.0
22	Asa	-	7,635**	1,272	20	1.6
Total			**605,295**	**100,874**	**440**	**0.4**

* Using the Linear Extrapolation Model and applying the National Population Commission -established average Annual growth rate of 2.4%.
**Estimated population (Source: Field Survey, December 2023)

To further understand socio-economic factors in the macro-environment, desktop research was conducted to corroborate and complement outcomes of primary data collection. Secondary data was collected through the following methods:

- Review of official publications such as the National Population Commission and the National Bureau of Statistics; and
- Additional desktop-based research, using reliable sources, where necessary.

4.6.2 Study Area

Twenty-two communities (to be traversed by the pipeline) were studied in five Local Government Areas across two states (Table 4.34). For administrative convenience, Indorama organised the host communities into clusters with cluster chairmen heading a committee of four members from each of the communities in that cluster.

Table 4.34: Details of Study Communities

S/N	Community	Local Government Area (LGA)	Cluster	State
1.	Akpajo	Eleme	1	Rivers
2.	Elenwo	Obio/Akpor		
3.	Rumuokwurusi			
4.	Atali			
5.	Chokocho	Etche	2	
6.	Abara			
7.	Omuogodo			
8.	Umuakuru			
9.	Ime			
10.	Edegelem			
11.	Omuechem			
12.	Ipo			

S/N	Community	Local Government Area (LGA)	Cluster	State
13.	Omademe	Ikwerre	3	
14.	Ozuaha			
15.	Omuanwa			
16.	Ubima			
17.	Omerelu			
18.	Omuapu (Akanu)	Ohaji/Egbema	5	Imo
19.	Awara 1			
20.	Awara 2			
21.	Ochia			
22.	Asa			

4.6.3 Overview of the study area

4.6.3.1 Eleme LGA, Rivers State

Eleme is a local government area in Rivers State, Nigeria's South-South geopolitical zone, having its headquarters in the town of Ogale. Agbonchia, Alesa, Akpajo, Alode, Ebubu, Onne, Eteo, and Aleto are among the towns and communities that make up Eleme LGA. It covers an area of 150.1 km^2 and an estimated population of 273,500 as at 2022.

Eleme is traditionally agrarian, with farmers travelling out to farms due to emergence of white-collar jobs and the ongoing industrial activities within LGA.

Eleme plays host to industries like as two refineries, a fertiliser plant, Indorama Eleme Petrochemicals limited (IEPCL), the newly built Indorama Eleme Fertilizer & Chemicals Limited (IFF) with so many other companies located within Onne Port.

4.6.3.2 Obio/Akpor LGA, Rivers State

Obio/Akpor is a local government area[23] in the metropolis of Port Harcourt, one of the major hubs of economic activities in Nigeria, and one of the major cities of the Niger Delta, located in Rivers State. Obio-Akpor has its secretariat at Rumuodomaya. The LGA is constituted mainly by the people of the Ikwerre ethnic nationality. Obio-Akpor is also known for fisheries and aquaculture [24]

Obio-Akpor, is popularly known as the gateway city, because of its location. It is located between latitudes 4°45'N and 4°60'N and longitudes 6°50'E and 8°00'E[25] and a land area of approximately 263.1 km^2 with estimated population of 665,000 as at 2022 and shares boundaries with Emohua, Ikwerre, Etche, Oyigbo, Eleme, Okirika, Port Harcourt Local Government Area of Rivers State and accessible by road, sea, and air transportation.

[23] "Organisations located in Obio/Akpor Local Authority - Nigeria". www.afdevinfo.com. Archived from the original on 3 March 2024.

[24] " Journal of the Korean Society of International Agriculture ". www.intagrijournal.org. doi:10.12719/KSIA.2020.32.2.120. S2CID 225796832. Retrieved 6 March 2024.

[25] "Map - Obio-Akpor (Obio/Akpor) - MAP[N]ALL.COM". mapnall.com. Retrieved 5 May 2023.

4.6.3.3Ikwerre LGA, Rivers State

Ikwerre Local Government Area is one of the LGAs in Rivers State, Nigeria. Its headquarters is in the town of Isiokpo 'known as the ancient Kingdom of Ikwerre land'. It is the first *Iwhuruonha* local government and later Emohua, Obio/Akpor and Port Harcourt were created. The Ikwerre ethnic nationality occupy the upland region of Rivers State. It shares boundaries with Imo State to the North, Emohua to the West, Etche to the East and Obio/Akpor to the South. Ikwerre LGA sits on a total area of 667.5 square kilometres and the estimated population is approximately 271,700 as at 2022.

Ikwerre LGA has a strong agrarian population with a variety of crops such as yam, cassava, plantain, and banana grown in the area. Also, the area has a booming trade sector with several markets. The LGA is also rich in mineral deposits which include crude oil and natural gas.

4.6.3.4Etche LGA, Rivers State

Etche is a Local Government Area in Rivers State, Nigeria. It is located in the southeastern part of the state, and it is bordered by Imo State to the North, Obio-Akpor LGA to the South, and Omuma LGA to the East. The headquarters of Etche LGA is in Okehi. LGA covers 774.7km2 area with estimated population of 539,500 as at 2022. Etche is a predominantly agrarian area, and the major crops grown includes yams, cassava, maize, and plantains. The people of Etche are also known for their fishing and pottery industries.

Etche has over 250 producing oil wells and a host 3 of flow stations[26]. It is also said to have the largest deposit of natural gas, in south of the Niger river. The people of Etche are mostly engaged in agriculture, earning the nickname 'the food basket of the state[27]. In recent times, real estate development has grown in the area with rapid expansion going on in Igboh-Agwuruasa, Ulakwo-Umuselem, and Okehi Clans[28].

4.6.3.5Ohaji/Egbema LGA, Imo State

Ohaji-Egbema is an oil-rich Local Government Area of Imo State, Nigeria and headquartered in Mmahu-Egbema. LGA comprises three political districts: Ohaji East, Egbema North, and Ohaji West. LGA lies in the south-western part of Imo State and shares common boundaries with Owerri in East, Oguta LGA in North and Ogba/Egbema/Ndoni in Rivers State in the South-west [29].

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[26] "Niger Delta: Osinbajo and the Unresolved Etche Question". *THISDAYLIVE*. Retrieved 2024-03-08.

[27] *"A brief walk into the history and economy of Etche culture". Pulse Nigeria. Retrieved 2024-03-08.*

[28] Patrick Naagbanton (April 2, 1999). "Shell's toxic war against umuakuru-igbo people". Environmental rights action (ERA). Retrieved 2024-03-05.

[29] "Egbema Generation Company Limited". nipptransactions.com. National Integrated Power Project (NIPP Transactions), Nigeria. Archived from the original on 2013-08-18. Retrieved 2015-11-29.

The LGA covers 940.1 km2 area with estimated population of 254,200 as at 2022. The Igbo ethnic group dominats and Igbo language is commonly spoken in the area while Christianity is widely practiced. The traditional administrator of the Ohaji-Egbema LGA is referred to as the Nze Obi.

There are vast deposits of crude oil and natural gas in Ohaji-Egbema LGA and hosting several local and international oil companies. The LGA is also a hub for agricultural practices with crops such as oil palm, yam, maize and cassava. Other important economic activities undertaken by dwellers of LGA include lumbering, fishing, hunting, and trade.

4.6.4 Governance, Social Organization and Culture

4.6.4.1 Oral Tradition and Traditional Governance

In cluster 4 (Umuapu, Awara I, Awara II, Ochia and Asa), the origin of the communities varied especially in their migration patterns. While communities like Akanu-Umuapu claimed to be one of the four (4) villages that make up the present day Umuapu town, Awara I& II claimed to have migrated from Omoku in Rivers State, though others claimed to have been in their present locations from time immemorial, their system of governance remained identical, with the paramount ruler and his council of chiefs being at the helm of governance. Members of the council of chiefs were heads of extended families who constituted the paramount rulers' cabinet. They were assisted by the community development committee, youths and women in the governance of the community to ensure peace and harmony in the community.

Communities in cluster 3 (Ipo, Ozuaha, Omademe, Ubima, Omuanwa and Omerelu) were predominantly Ikwerre speaking, reportedly founded centuries ago by a Nigerian from the ancient Benin Kingdom (in the present-day Edo State, Nigeria) with Prince Akalaku, who fled Benue to escape assassination attempt by his brother Oba Ewuane. His descendants later became founders of various communities that are known today as the Ikwerre Ethnic.

Nationality in today's Rivers State, Nigeria. The communities are ruled by paramount rulers called *Nnyewe eli*, some were first class, second class or third-class chiefs, based on government recognition. In most cases, the paramount ruler is selected among the council of chiefs, who are male heads of extended family groups, and rotated among clans that make up the communities or by hereditary.

Most communities in Etche cluster like Ime, Umuakuru, Abara and Edegelem claimed to belong to Igbo kingdom in Etche, while Umuogodo and Umuechem claimed to be descendants of Odu-uka and Echeru respectively. Despite these claims, linguistic affinity still binds them together. Each of these communities were governed by the paramount ruler and his ruling council comprising the council of chiefs (male heads of extended

families of the community) community development committee (CDC) youth forum, women forum and other opinion leaders in the community.

Cluster one is a heterogenous cluster, having Akpajo and three Ikwerre speaking communities (i.e. Akpajo, Elelenwo, Rumuokwurusi and Atali).

Akpajo is among the clans that make up Eleme Kingdom in Eleme Local Government Area of Rivers State, Nigeria. The Paramount Ruler is the head of the clan and a third-class chief as classified by the Rivers State Government and gives directives for all activities in the community, seconded by the spokesman, palace secretary and community development committee chairman in hierarchy.

4.6.4.2Social Organisation

Males in the study area were stratified into age groups, each with its own leader. These groups played important economic, cultural, security and environmental roles, since they:

- Helped to organise community development projects
- Active during cultural events, such as wrestling, dancing and masquerading
- Acted as vigilante groups for community protection; and
- Led community sanitation exercises.

Women were organised into associations with elected officials. There were also clubs exclusive to females. They assisted in traditional governance and sometimes also engaged in the initiation and execution of self-help community development projects.

4.6.4.3Social Controls

Social controls in the study area took the form of rewards and punishments. The former comprised award of traditional titles to community members who had distinguished themselves in their fields of endeavour and/or brought honour to the community. Evil doers, on the other hand, were punished with cash fines, handed over to appropriate government authorities in the case of criminal offences or sometimes, ostracism.

4.6.4.4Land Practices

Community land was found to be owned and managed by extended families. Farming, though still present, was found to be steadily losing ground due to dwindling stocks of land because of urbanisation and the desire for other off-farm economic pursuits. Residential land was found to be by inheritance.

In the Ohaji/Egbema Cluster, land was owned by individuals, families and communities. Farmland could be sold or leased by individuals. The fallow farming period was between 2 to 10 years based on the community and availability of land. Indigenes willing to undertake residential development could build on individual land or family land after satisfying some conditions. Indigenes or non-indigenes could buy land from individuals who have land to sell. The cost of one (1) plot of land (i.e. 100ft x 50ft or 30m x 15m) today was between

N500,000.00 (five hundred thousand) to N2,000,000(Two million naira) depending on community and location.

In the Ikwerre cluster, land was found to be owned by extended families, communities and individuals by inheritance. Farmland could be mortgaged, sold or leased by individuals and groups, but must be indigenes. The fallow period was between 3 – 7 years based on the community and availability of land. Generally, the fallow period had decreased to 2 years in some communities and others 3 years, due to increase in population and development. For residential purposes, individuals could build on inherited land, family land or approach the community for land. In some cases, individuals could purchase from another individual. Non-indigenes who wish to embark on residential development could buy from indigenes of the community. Cost of one plot of land (i.e. 100ft x 50ft or 30m x 15m) as of the time of this study was between N400,000.00 (Four hundred Thousand Naira) to N1,500,000.00 (One million, five hundred thousand naira) as against N200,000.00 (Two Hundred Thousand Naira) and N500,000.00 (Five hundred thousand Naira) 5 years ago, depending on the location despite the existence of the Land Use Act of 1978.

Similarly, in the Etche cluster, land was found to be owned by families and communities. Individuals could sell, lease or mortgage farmlands. Non-indigenes willing to acquire farmland whenever the land was ripe for farming, could buy from individual families or approach the communities. The rotational bush fallow system was 7 years but now reduced to 3 – 5 years due to increase in population, cow grazing, kidnapping, and developmental projects. Indigenes willing to embark on projects could build on personal land, family land, or communal land after satisfying certain conditions. Non-indigenes who intended to embark on residential projects could buy from individuals or approach any of the families or community for assistance. The cost of a plot land (i.e. 100ft x 50ft or 30m x 15m) was between N1,000,000.00 (One million naira) to N4,000,000.00 (Four million naira) as against N200,000.00 (two hundred thousand naira) to N700,000.00 (seven hundred thousand naira) 5 years ago.

At Rumuokwurusi and Elelenwo, Land was found to be owned by individuals and the community. Individuals could sell or lease farmland allocated to them by their families. For residential land, individuals approached the family for allocation of land. Non-indigenes willing to embark on the same could buy from individuals with land for sale or the community. The cost of one plot of land (100ft x 50ft or 30m x 15) was N6,000,000.00 (six million naira) as against N1,500,000.00 (one million, five hundred thousand naira) five years ago.

At Akpajo, the community has lost almost all their land to industries and non-indigenes. Individuals or groups were permitted to sell or lease farmlands. Non-indigenes could

acquire farmland from individuals. The common farming method practiced was the rotational bush fallow system with fellow period of 7 years. This has decreased over the past 10 years due to industrial and business activities. Indigenes and non-indigenes could buy land. Cost of a plot of residential land (i.e. 100ft x 50ft or 30m x 15m) at the time of this study was between N6,000.000,00 (six million naira) to N15,000,000 (fifteen million naira) as against N3,500,000.00 (three million, five hundred thousand naira) five years ago.

4.6.4.5Human Rights

The 2022 Freedom in the World Index ranks Nigeria as 'Partly Free'. While Nigeria has made significant improvements to the quality of its elections since the 1999 transition to democratic rule, the 2023 presidential and National Assembly elections, which saw President Ahmed Bola Tinubu and the All-Progressives Congress (APC) regain its legislative majority. The petroleum industry remains vulnerable to global volatilities on the one hand and security challenges and corruption at the National level.

4.6.4.6Crime and Vices

Crimes and vices within the study covers conflect and fight for land ownership, kidnapping and some anti-social activities. The numbers are comperatevily low than the national crime rate.

4.6.5 Demography

There are two states playing host to the proposed natural gas pipeline project namely Rivers and Imo State, Five LGAs and 22 communities. Out of the LGAs four (4) belongs to Rivers State while one (1) Ohaji/Egbema belong to Imo State, while out the 22 communities only 5 communities belong to Imo State. The most recent available population data is from the 1991 census. Table 4.35 presents this data, as well as the projected potential population size of the Project-affected communities in 2024 assuming a 2.4% annual growth rate.

Table 4.35: Population data of the study area

S/No	Communities	1991 National Census Population	Projected 2024 Population*
1	Akpajo	5,196	35,124
2	Elelenwo	8,645	58,440
3	Rumuokwurusi	11,476	77,577
4	Atali	2,428	16,413
5	Chokocho	3,463	23,409
6	Abara	1,866	12,614
7	Omuodogo	-	9,877**
8	Umuakuru	1,736	11,735

S/No	Communities	1991 National Census Population	Projected 2024 Population*
9	Ime	2,781	18,799
10	Edegelem	2,378	16,075
11	Umuechem	4,593	31,048
12	Ipo	2,125	14,365
13	Omademe	4,267	28,844
14	Ozuaha	4,742	32,055
15	Omuanwa	5,019	33,928
16	Ubima	13,491	91,199
17	Omerelu	7,530	50,902
18	Omuapu	-	15,433**
19	Awara I	-	7,423**
20	Awara II	-	6,344**
21	Ochia	-	6,056**
22	Asa	-	7,635**
Total			**605,295**

* Estimated population using the Linear Extrapolation Model and applying the National Population Commission -established average Annual growth rate of 2.4%.

**Estimated Population (Source: Field Survey, December 2023), in the absence of 1991 census figures

4.6.6 Age-Sex Distribution

Figure 4.47 and Table 4.36, show the age-sex distribution for study area. It can be observed in Figure 4.47 that the population exhibited a near true pyramidal (bottom-heavy) structure, characteristic of developing areas. The population structure of the study area is slightly similar to the national figures. Persons aged less than 15 years accounted for 41.7% of the national age distribution, while the corresponding figure for the study

area was lower at 27.8%. The age range, 15-64 years accounted for 55% of the national distribution as against 63.2% in the study area.

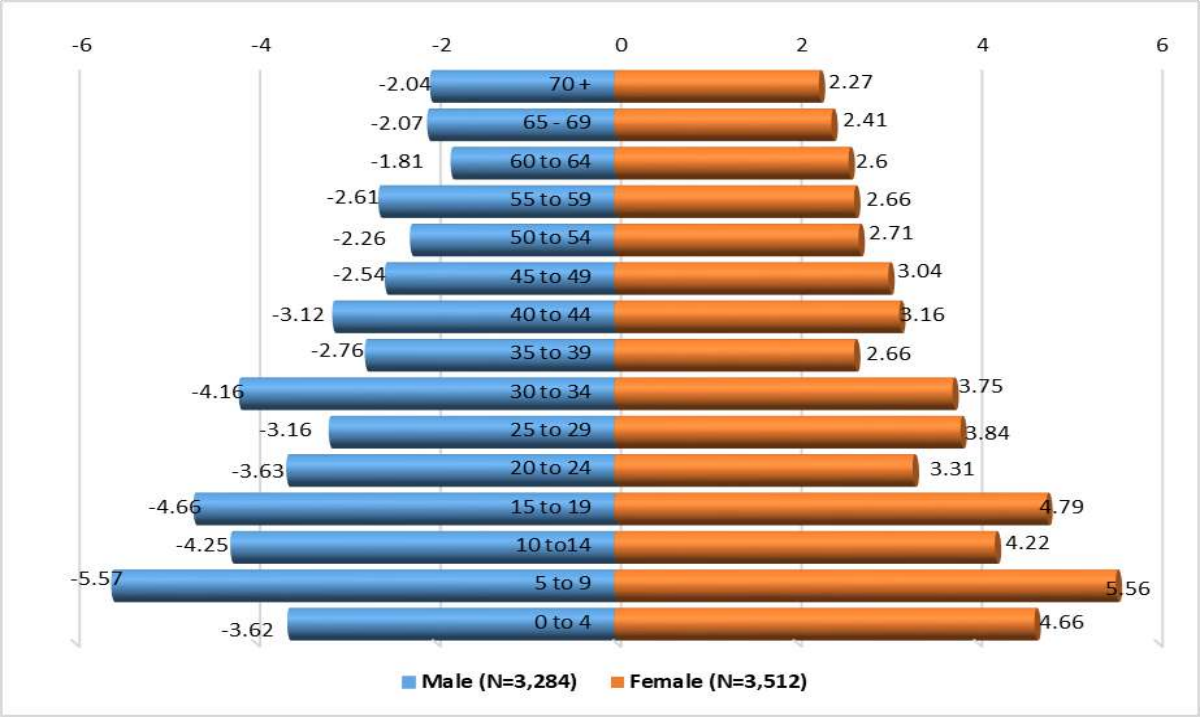


Figure 4.47: Age-Sex Pyramid of the Study Area

(Source: Field Survey, December 2023)

Table 4.36: Percentage Age-Sex Distribution of the Study Area

Age Cohorts (Years)	Male		Female		Total	
	No	%	No	%	No	%
0 to 4	246	3.62	317	4.66	563	8.28
5 to 9	379	5.57	378	5.56	757	11.13
10 to14	289	4.25	287	4.22	576	8.47
15 to 19	317	4.66	326	4.79	643	9.45
20 to 24	247	3.63	225	3.31	472	6.94
25 to 29	215	3.16	261	3.84	476	7.0
30 to 34	283	4.16	255	3.75	538	7.91
35 to 39	188	2.76	181	2.66	369	5.42
40 to 44	212	3.12	215	3.16	427	6.28
45 to 49	173	2.54	207	3.04	380	5.58
50 to 54	154	2.26	184	2.71	338	4.97
55 to 59	178	2.61	181	2.66	359	5.27
60 to 64	123	1.81	177	2.6	300	4.41
65 - 69	141	2.07	164	2.41	305	4.48
70 and over	139	2.04	154	2.27	293	4.31
Total	**3,284**	**48.26**	**3,512**	**51.64**	**6,796**	100

(Source: Field Survey, December 2023)

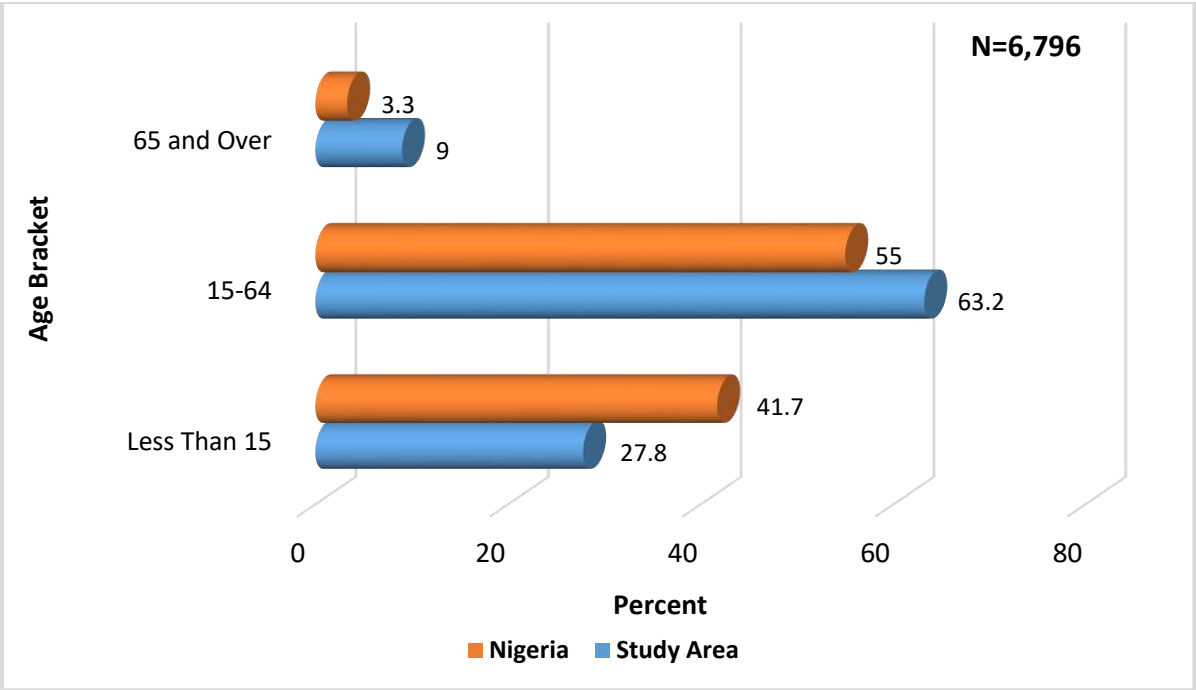


Figure 4.48: Population Structure of the Study Area Compared to National Condition

(Source: Ltd. Field Survey, December 2023; [30]World Fact Book, 2022)

Table4.37: Demographic Ratios Compared with National Averages

Ratio	Study Area	Nigeria
Dependency Ratio	86%	86[31]
Sex Ratio	93.5%	102[32]

(Source: Field Survey, December 2023)

The Dependency and Sex Ratios were computed for the study area. Dependency ratio was 86:100, while Sex ratio was 93.5:100. Corresponding dependency and sex ratios at the national level 86:100 and 102:100, respectively. Thus, sex ratio in the study area was less than the national average, while dependency burden mirrored the national average.

4.6.7 Education

Table 4.38 shows household educational attainment. The modal educational attainment for males, females and the population as a whole, was "Secondary Completed" accounting for 20.6%, 20.5% and 20.5%, respectively. Table 4.39 shows literacy levels for male, female and the general population at 79.5%, 76.9% and 78.3%, respectively. These figures compare favourably with national averages which stand 71.3%, 52.7% and 62%,

[30] Nigeria. http://www.cia.gov/the-world-factbook/about/archives/2022/countries/nigeria. Accessed February 27, 2024.World Fact Book
[31] Nigeria. http://www.cia.gov/the-world-factbook/about/archives/2022/countries/nigeria. Accessed February 27th, 2024.World Fact Book
[32] Nigeria. http://www.cia.gov/the-world-factbook/about/archives/2022/countries/nigeria. Accessed February 27th, 2024.World Fact Book

respectively as at 2018 (CIA World Fact Book, 2023). The obvious implication, especially for males, is the presence of a high proportion of persons who can be employed in the formal sector, with the associated positive social impacts to the community.

Table 4.38: Percentage Distribution of Educational Attainment by Households

Categories	Male		Female		Total	
	N	%	N	%	N	%
No Formal Education	29	1.0	64	2.0	93	1.5
Pre-primary Education	269	8.6	292	9.1	561	8.8
Primary Uncompleted	336	10.8	385	12.0	721	11.4
Primary Completed	552	17.7	466	14.4	1,018	16.1
Secondary Uncompleted	523	16.8	564	17.5	1,087	17.2
Secondary Completed	641	20.6	658	20.5	1,299	20.5
Tertiary Uncompleted	356	11.4	321	10.0	677	10.7
Tertiary Completed	361	11.6	378	11.8	739	11.7
Teachers Grade 2	45	1.4	86	2.7	131	2.1
Trade Test Certificate	0	0	0	0	0	0
City & Guilds Certificate	0	0	0	0	0	0
Total	**3,112**	**100**	**3,214**	**100**	**6,326**	**100**

(Source: Field Survey, December 2023)

Table 4.39: Male and Female Literacy Levels Compared with National Averages

Gender	Study Area	Nigeria
Male	79.5%	71.3%
Female	76.9%	52.7%
General Population	78.3%	62%

(Source: Field Survey, December 2023)

4.6.8 Employment Status

Figure 4.49 shows unemployment amongst males and female in the study area. The values for male and female were similar, accounting for 62.4% and 63.2% for male and female, respectively. Full-time housewives in the study area accounted for 13.6%. Family members who are employed accounted for 30.4% and 19.2% for males and females, respectively. The unemployment rate for male, female and the general population was 67.2%, 76.7% and 72%, respectively. The unemployment figures are than the current national unemployment rate of 5.0 % (National Bureau of Statistics, 2024) and is a pointer

that job creation should rank high in the priority list of government and companies operating in the area.



Figure 4.49: Household Employment Status in the Study Area

(Source: Field Survey, December 2023)

4.6.9 Occupation

Table 4.40 shows the percentage distributions of primary occupations in the study area. The modal occupation in the study area was farming, accounting for 37.8% and 30.6% for males and females, respectively. Business and Trading were the next most popular occupations in the study area, accounting for 14.6% and 13.4% of the distributions, respectively. This is not strange given that 82% of communities in the study area are rural communities with agriculture as their main occupation including petty trading and business.

Table 4.40: Distribution of Occupation Household Members in the Study Area

S/No	Categories	Male		Female		Total	
		N	%	N	%	N	%
1	Farmer	485	37.8	399	30.6	884	34.2
2	Fisher folk	88	6.8	12	1.0	100	3.8
3	Hunter	101	7.9	34	2.6	135	5.2
4	Artisan	94	7.3	77	5.9	171	6.6
5	Trader	149	11.6	197	15.1	346	13.4
6	Business	194	15.1	183	14.0	377	14.6
7	Junior civil servant	25	2.0	14	1.1	39	1.5
8	Senior civil servant	63	5.0	39	3.0	102	4.0
9	Junior worker in private companies	41	3.2	17	1.3	58	2.2

S/No	Categories	Male		Female		Total	
		N	%	N	%	N	%
10	Senior worker in private companies	43	3.3	332	25.4	375	14.5
Total		**1,283**	**100**	**1,304**	**100**	**2,587**	**100**

(Source: Field Survey, December 2023)

4.6.10 Income

Table 4.41 gives the percentage distribution of monthly household income in the study area. Mean monthly income was N71,472. Modal Income stood at N100,000. Thus, over three quarters of households in the study area earned less than ₦ 71,000 monthly, which translates to USD 47.3 per month. The average income converts to about US$ 1.60 per day (at the rate of US$ 1.00= ₦1,500.00), which means that the area is still ravaged by poverty given that the average respondent falls below the poverty line of US$ 2.15 (World Bank, 2022).

Table 4.41: Percentage Distribution of Monthly Household Income

S/No.	Income Categories (₦)	N	%
1	Less than 8,000	7	1.6
2	8,000 – 17,999	0	0
3	18,000 - 27,999	41	9.3
4	28,000 - 37,999	23	5.2
5	38,000 - 47,999	26	5.9
6	48,000 - 57,999	34	7.7
7	58,000 - 67,999	35	8.0
8	68,000 - 77,999	19	4.3
9	78,000 - 87,999	23	5.2
10	88,000 - 97,999	6	1.4
11	98,000 - 107,999	24	5.5
12	108,000 – 117,999	10	2.3
13	118,000 – 127,999	7	1.6
14	128,000 and more	45	10.2
15	Non-Response	140	68.2
Total		**440**	**100**

(Source: Field Survey, December 2023)

4.6.11 Facilities, Infrastructure and Services

4.6.11.1 Classification of Infrastructure

Idachaba (1985) attempted a three-fold classification of infrastructure into physical, social and institutional. Physical forms include transportation facilities (roads, railways, bridges,

ferry services, canals, and footpaths), 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 centres, 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 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.).

4.6.11.2 Availability of Infrastructure in the Study Area

PHYSICAL INFRASTRUCTURE

(a) Transportation Facilities

There are major (Trunk A) Federal Government Roads traversing the study area: The East-West Road passes through Akpajo, the Port-Harcourt –Aba Expressway, passes through Rumuokwurusi and Elelenwo. Most intra- and inter-community roads in the study area were tarred and in good condition (Table 4.42). However, some communities in the study still lack good roads. Table 4.43 presents other transport –related infrastructure in the study area.

Table 4.42: Important Access Roads in the Study Area

S/No	Access Road	Category	Estimated Length (km)	Tarred/ Un-tarred	Condition
1.	East-West Road	Trunk A	100>	Tarred	Good
2.	Port Harcourt – Aba Highway	Trunk A	100>	Tarred	Good
3.	Igwuruta – Eneka Road	Trunk B	20>	Tarred	Good
4.	Igwuruta-Igbodo	Trunk B	23	Tarred	Good
5.	Eleme – chokocho	Trunk B	20	Graded	Fair
6.	Igbo – Umuebulu	Trunk B	14	Un-tarred	Poor
7.	Imeh/ Chokota/Umuebulu	Trunk B	25	Tarred	Poor
8.	Omagwa/ Ozuaha/Ubima	Trunk B	12	Tarred	Poor
9.	Port Harcourt – Owerri	Trunk A	30	Tarred	Good
10.	Ikwerre Road	Trunk C	7	Untarred	Poor
11.	Ubub – Umuokne	Trunk B	25	Untarred	Poor

S/No	Access Road	Category	Estimated Length (km)	Tarred/ Un-tarred	Condition
12.	Umuozu - Obitti	Trunk B	10	Untarred	Poor

(Source: Field Survey, December 2023)

Table 4.43: Forms of Transportation Infrastructure in the Study Area

S/No	Community	Type			
		Jetty	Bridge	Culvert	Pontoon
1.	Akpajo	0	0	5	0
2.	Elelenwo	0	0	2	0
3.	Rumuokwurusi	0	0	0	0
4.	Atali	0	0	2	0
5.	Chokocho	0	2	1	0
6.	Abara	0	0	0	0
7.	Omuodogo	0	0	0	0
8.	Umuakuru	0	0	0	0
9.	Ime	1	0	1	0
10.	Edegelem	0	0	1	0
11.	Umuechem	0	2	3	0
12.	Ipo	0	0	3	0
13.	Omademe	0	0	0	0
14.	Ozuaha	0	0	0	0
15.	Omuanwa	0	0	0	0
16.	Ubima	0	0	0	0
17.	Omerelu	0	0	0	0
18.	Omuapu	0	0	0	0
19.	Awara I	0	0	0	0
20.	Awara II	0	0	0	0
21.	Ochia	0	0	0	0
22.	Asa	0	0	0	0
	Total	**1**	**4**	**11**	**0**

(Source: Field Survey, December 2023)

SOCIAL INFRASTRUCTURE

(a) Recreational Facilities

There were no organised recreational facilities available in the study area. community playgrounds attached to community halls, and open spaces/fields attached to educational institutions and religious centres were very common throughout the study area.

(b) Housing

Table 4.44 presents key attributes of typical houses found in the study area.

TABLE 4.44: DISTRIBUTION OF HOUSING ATTRIBUTES (PERCENTAGE DISTRIBUTION)

HOUSING ATTRIBUTES	N	%
House Type		
Rooming House (Courtyard)	27	8.8
Rooming House (Wagon)	84	27.3
Bungalow	113	36.7
Block of Flats (Multi-family)	53	17.2
Storey Building	31	10.1
Total	**160**	**100**
Type of Walling Material		
Corrugated iron sheets	40	14.4
Wood	13	4.7
Mud	10	3.6
Blocks	215	77.3
Total	**278**	**100**
Roofing Material		
Corrugated iron sheets	152	65.5
Wood	27	11.6
Slate	6	2.6
Thatch	14	6.0
Decking	20	8.6
Other	13	5.6
Total	232	100
Type of Foundation		
Strip	221	87
Raft	6	2.4
Pile	0	0
None	0	0
Total	**254**	**100**
House Condition		
Good (needs no repair)	24	12.3
Fairly Good (needs minor repair)	83	42.6
Bad (needs major repair)	75	38.5
Very Bad (beyond repair)	13	6.7
Total	**195**	**100**
Source of Energy		
Firewood/ Charcoal	175	46.3
Kerosine	124	32.8
Gas	56	14.8
Electricity	23	6.1
Total	**378**	**100**

(Source: Field Survey, December 2023)

The table shows that throughout the study area modal house type, walling, roofing material and foundation type were Single family detached bungalow, Blocks, Corrugated iron sheets and Strip foundation, respectively. Modal rating of house condition was "fairly

good" (needing minor repairs). Plate 4.22 shows a typical modern house type in the study area.

Overcrowding is not a problem in the study locations as most of the communities were rural and communal living arrangements eliminates the possibility of overcrowding. However, we recorded an average of 3 individuals occupying a room in the rural areas and 4 in the urban parts of the study area. The WHO guideline provides for minimum of 3.5 square meters per person. A typical living room in the rural area is about 12x12 ft (13.3 square meters), and can accommodate 3 – 4 persons.

(c) Other Social Infrastructure

Table 4.45 shows the distribution of educational, religious, healthcare and social welfare-related facilities in the study area. The area had a sprinkling of educational facilities, both government and privately-owned Schools (See Plates 4.23 to 4.24). There were numerous churches in the study area (See Plates 4.27 and 4.28), emphasizing the strong Christian influence, as well as few mosques for Muslims living in the area.



Plate 4.22: Police Officers' Lodge Built by INDORAMA at Ubima, Ikwerre LGA, Typical Modern Building in The Study Area (Source: Field Survey, December 2023)



Plate 4.23: State School II, Omademe, Built by Ikwerre LGA.



Plate 4.24: Community Secondary School, Omuanwa, Ikwerre LGA, Built by Rivers State Government. (Source: Field Survey, December 2023)

Table4.45: Distribution of Social Infrastructure Items

Social Infrastructure Items	Community																						Total
	Akpajo	Elelenwo	Rumuokwurusi	Atali	Chokocho	Abara	Omuodogo	Umuakuru	Ime	Edegelem	Umuechem	Ipo	Omademe	Ozuaha	Omuanwa	Ubima	Omerelu	Omuapu	Awara I	Awara II	Ochia	Asa	
Educational																							
Nursery School	3	0	0	1	13	7	0	4	4	6	4	8	7	3	9	6	8	3	6	5	5	6	108
Primary School	3	0	3	1	13	1	1	0	5	1	6	1	3	2	11	8	8	3	2	3	2	7	84
Secondary School	2	0	1	0	11	3	1	0	2	1	1	0	3	1	4	5	1	2	1	1	2	1	43
Adult Education Centre	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	4
Teacher Training College (2-4 years)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
College of Education (NCE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polytechnic	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
University	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Religious																							
Church	33	43	97	35	24	8	0	11	9	12	23	22	18	0	0	0	0	21	30	0	0	0	386
Mosque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Seminary/Christian Training Institute	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Islamic School	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
Bethel	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	4
Spiritual Healing Home	2	0	0	0	1	0	0	1	0	0	0	3	1	0	1	5	4	3	5	0	0	2	28
Kingdom Hall	1	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	1	1	0	0	0	1	9
Health Care																							

Social Infrastructure Items	Community																						Total
	Akpajo	Elelenwo	Rumuokwurusi	Atali	Chokocho	Abara	Omuodogo	Umuakuru	Ime	Edegelem	Umuechem	Ipo	Omademe	Ozuaha	Omuanwa	Ubima	Omerelu	Omuapu	Awara I	Awara II	Ochia	Asa	
Hospital	2	0	0	0	0	1	0	0	5	0	0	0	0	0	0	1	0	1	0	0	0	0	10
Maternity	4	0	2	0	0	4	0	0	10	5	0	2	3	0	0	1	2	1	0	0	1	0	35
Dispensary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health Centre	1	0	1	0	1	1	0	0	1	0	1	1	1	1	2	1	1	1	4	1	1	1	21
Clinic	3	0	0	3	3	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	14
Patent Medicine Store	15	0	0	33	33	8	16	3	20	15	0	9	12	10	8	30	28	26	18	5	0	13	386
Traditional Healing Centre	2	0	0	5	5	2	1	1	0	5	1	5	1	2	1	2	3	2	5	2	1	1	47
Teaching/Specialist Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social Welfare-Related																							
Day-care Centre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheshire Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Motherless Babies Home	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Orphanage	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Home for the Elderly	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Home for the Disabled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(Source: Field Survey, December 2023)



Plate 4.25: Government Secondary School, Akpajo, Eleme LGA, Built by Rivers State Government. (Source: Field Survey, December 2023)



Plate 4.26: State School I & 2, Akpajo, Eleme LGA, Built by Rivers State Government. (Source: Field Survey, December 2023)



Plate 4.27: Anglican Church, Omuanwa, Ikwerre LGA, R/S.

(Source: Field Survey, December 2023)



Plate 4.28: St. Michaels Catholic Church, Ozuaha, Ikwerre LGA, R/S.

(Source: Field Survey, December 2023)

INSTITUTIONAL INFRASTRUCTURE

Tale 4.46 Presents the Institutional facilities in the study area. Banks were the only institutional infrastructure found in the study area (About 3 of them) There were no other types of institutional infrastructure in the study area. There were also some police stations/posts in the study area.



Plate 4.29: Police Station at Ubima, Built by Ikweere LGA.

(Source: Field Survey, December 2023)

Table 4.46: Distribution of Some Institutional Infrastructure Item

S/No	Institutional Infrastructure Items	Akpajo	Elelenwo	Rumuokwurusi	Atali	Chokocho	Abara	Omuodogo	Umuakuru	Ime	Edegelem	Umuechem	Ipo	Omademe	Ozuaha	Omuanwa	Ubima	Omerelu	Omuapu	Awara I	Awara II	Ochia	Asa	Total
1.	Farmers Cooperatives	0	0	0	0	0	0	0	0	0	0	0	8	0	6	0	0	0	0	0	2	0	0	**16**
2.	banks	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
3.	Post office	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	**2**
4.	Police Post/station	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
5.	Agricultural Extension	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**2**
6.	Agricultural Research Station	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
7.	Customary Court	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
8.	Magistrate Court	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	High Court	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(Source: Field Survey, December 2023)

4.6.11.3 Disposal of Household Refuse

Table 4.47 shows respondents' stated methods of disposal of household refuse. Throughout the study area the modal method was tipping at Family –designated temporary dumpsite, accenting for 61% of the distribution.

Table 4.47: Methods of Disposal of Household Refuse

S/No.	Method	N	%
1.	Tipped at the nearest street corner	40	11.6
2.	Tipped at government-designated temporary dumpsite	20	5.8
3.	Tipped at the marketplace	0	0
4.	Tipped into family designated dump site	210	61
5.	Tipped into stream /river	0	0
6.	Burned at designated site	23	6.7
7.	Disposed by Private Waste Collection Vendors	20	5.8
8.	By Burying	31	9
Total		**344**	**100**

(Source: Field Survey, December 2023)

4.6.11.4 Disposal of Human Waste

Table 4.48 shows methods of disposing of human waste. The modal method of disposal of human waste was by the modern Water Closet (WC) system, accounting for 56.6% of the distribution. However, the "Pit Latrine", "Holes in the Ground" and "Direct Defaecation in the Bush", are still very popular in the rural parts of the study area, accounting for 23.6%, 6.5% and 11.4% of the distribution, respectively.

Table 4.48: Percentage Distribution of Methods of Disposing of Human Waste

S/No.	Type	N	%
1.	Pour flush	7	1.8
2.	Water Closet (WC)	218	56.6
3.	Pit Latrine	91	23.6
4.	Holes in the ground	25	6.5
5.	Direct defaecation in the bush	27	11.4
Total		**385**	**100**

(Source: Field Survey, December 2023)

4.6.11.5 Public Utilities

Most Communities in the study area were connected to the national grid. However, the actual supply of power to the communities was very epileptic in most places and in some communities, there had not been power supply for years, due to damaged transformers or fallen electricity poles. Residents also complained of overbilling by power distribution companies and subsequent disconnection for non-payment.

The study found that in some communities, especially the rural ones, communal water systems were common, even though most of them have become moribund (Plate 4.30), including those built by Indorama. However, in the urban parts of the study area (i.e. Cluster 1 – Akpajo, Elelenwo, Rumuokwurusi and Atali), there were no functional community-wide piped water system; the area being rather served by private boreholes, private (commercial) boreholes, and water vendors (*Merua*). The Mono-pump type of communal water system appears to be the only functional public water system in the communities (Plates 4.32 and 4.33).



Plate 4.30: Community Water Project built by NDDC at Omademe, Ikwerre LGA.

(Source: Field Survey, December 2023)



Plate 4.31: Moribund Community Water Project built by NDDC at Omuanwa, Ikwerre LGA.

(Source: Field Survey, December 2023)



Plate 4.32: Community Water Sytem (Mono Pump) built by NDDC at Omuapu (Akanu), Ohaji/Egbema LGA, Imo State.

(Source: Field Survey, December 2023)



Plate 4.33: Mono Pump at Ochia Community, Ohaji/Egbema LGA, Imo State.

(Source: Field Survey, December 2023)

4.6.12 The Economy

4.6.12.1 Basic and Non-Basic Sectors

It is traditional to divide an economy into two sectors: a *basic* sector (sometimes called an *export* sector) whose income is derived from transactions which take place across the boundaries of the area under consideration; and a *non-basic* (sometimes called *local or service)* sector, whose income is derived from transactions within this area (Masser, 1972: 62). The non-basic sector was found to be dominant in the study area as subsistence agriculture was the mainstay of the economy.

4.6.12.2 Agriculture

The subsistence agriculture observed in the area still employs primitive equipment, comprising the age-old machete, hoe and iron rods. There is no mechanised agriculture. Farm holdings are small, averaging about 0.25 hectares per peasant farmer.

4.6.12.3 Crop Farming

Crop farming in the area is based on the rotational bush fallow system; mixed cropping is practised. In the past, after farming an area, farmers moved to another, leaving the land to lie fallow for up to seven years to allow the land to replenish nutrients. The fallow period has since declined to about five years or less, because of development-induced dwindling stocks of farmland and population pressure, especially in the urban communities.

The most important subsistence crops cultivated were cassava, yam, cocoyam, corn and vegetables. The farming calendar starts in January/February when the bush is cleared for planting. Planting follows immediately with yam (March), cassava (February/March), maize (February/March), pumpkin, Okro (March), Plantains and bananas during the rainy season. Plantations of plantains and bananas are often found close to built-up areas or interspersed with residential buildings (Plate 4.34).

Harvesting of the various crops took place at different times of the year. Yam is harvested between November/December; maize in June/July, cassava usually 1½ years after planting. Yams were stored in barns, maize is hung on top of the fireplace in the kitchen for consumption, and preservation for planting during the next farming season. Cassava is converted to *Garri* and *Fufu* for both domestic and commercial use.

There were no known Cooperative Societies in the study area. The marketing of products is in the daily and periodic markets. The Etche people are well known for their agrarian prowess just as their Ikwerre neighbours and most traders travel from Port Harcourt and other neighbouring states to buy the food produced from Etche and some Ikwerre Markets (See Plate 4.35).



Plate 4.34: Plantain Section of the Umuapu Market, in Ohaji /Egbema LGA, Imo State.

(Source: Field Survey, December 2023)



Plate 4.35: Fruits Section at Omuapu Market in Ohaji /Egbema LGA, Imo State.

(Source: Field Survey, December 2023)



Plate 4.36: Cassva Market in the Etche Axis of the Study Area

(Source: Field Survey, December 2023)

Despite some challenges like as bad road, poor financing, absence of extension serices, fertilizer shortage etc, e a farmer can, reportedly, earn about ₦120, 000 during the harvest season. The seasonality of this income means that it can hardly sustain the household all year round and they must venture into another livelihood activities.

4.6.12.4 Lumbering

Lumbering takes place in the forests of the study area. Important timber trees are Iroko, Mahogany, Ohi, Igboni, Black Afara, White Afara, Orji, etc. Marketing of timber takes place within and outside the communities. Local use of timber includes furniture making and building construction. The leftovers from the timber are burnt and converted to charcoal while branches are cut and sold as firewood for domestic use.

4.6.12.5 Fishing

Fishing activity takes place in the rivers, streams and ponds found in the study area. Fishing was carried out mostly by means of nets, hooks, fish traps, baskets, and spears. Pond fishing also takes place. Species of fish typically caught include Catfish, Tilapia, Crayfish and Electric Fish. Fishing craft comprised dug-out canoes, each typically manned by two persons, one to paddle the canoe, and the other to set the hooks and traps. Fish preservation is done by drying and smoking, and nowadays, sometimes by refrigeration.

The marketing of fish – fresh and smoked – took place in the daily and periodic markets, and sometimes by the roadside. Contract fishing is unknown in the study area. A fishing crew could typically earn ₦50,000 – ₦150,000 monthly. However, much of the fishing in

the area was done at the subsistence level and as a secondary activity. Small scale aquaculture was also popular in the area and catfish being the main species produced.

4.6.12.6 Livestock Farming

Animals commonly kept in small quantities in the area are goats, sheep, and poultry, some of which are confined, and others left to roam free. Animals are kept for food, commerce and as gift items.

4.6.12.7 Non-Timber Forest Products Exploitation

HUNTING

Hunting is an important activity in the area. It is undertaken individually and by hunting parties both during the day and at night.

Animals commonly caught include Grass-cutter, Duiker, Antelope and Bush Pig, which are sold as caught or roasted before sale.

PALM OIL EXTRACTION

Palm oil extraction took place all year round. There were individually owned small mills for oil extraction; output depends on the season of exploitation. During the rainy season, yield is low, ranging from 22-35 bunches of palm fruit a week per exploiter. However, during the dry season, yield soars to 120-310 bunches, at average earnings of ₦2, 500 per bunch from the extracted oil and a further ₦1000.00 worth of kernels per bunch.

An exploiter could invest as much as ₦50, 000 per week in the business, the money being applied to payments to labour and oil-palm bush landlords. There were challenges in the form of insufficient labour, only a few people were skilled in the art of climbing palm trees and the number is dwindling steadily. There is always the risk of death or serious injury from falling from the palm tree. Perhaps, not surprising, most of the youths are reluctant to engage in this type of business, thereby driving up the cost of labour.

GATHERING OF MEDICINAL HERBS, SNAILS, EDIBLE LEAVES AND FRUITS

The gathering of medicinal herbs, edible leaves (such as the popular Okasi); snails and edible fruits (e.g. Ogbono) takes place in the rural parts of the study area.

Traditional healers gather medicinal herbs, as they alone can identify the plant species used to heal different kinds of ailments. Increasing loss of forests because of development and population pressure poses a challenge to this activity. Furthermore, the advent of modern medicine and Christianity has reduced the popularity of the village medicine man and, concomitantly, the intensity of exploitation of such plants. Challenges associated with exploitation of these forms of Non-timber Forest Products (NTFPs) centre on snakebites and other forms of animal attack.

4.6.12.8 Rural Non-Farm Activity

Rural non-farm activity takes many forms. It may be classified into commercial and light industries, Grocery Stores, Hair Dressing/Barber Shops, and Restaurants were the most abundant commercial outfits. Also, Tailoring, Welding/Fabrication, Carpentry/Furniture, mechanical workshops etc. A characteristic feature of these businesses is that they are owned by individuals and small-scale in nature – typically manned by a few people, including apprentices. Table 4.49 shows prices of common commodities in the area.

Table 4.49: Prices of Some Food Items in the Study Area

S/No.	Item	Price/Quantity(₦)
1a.	Garri	200 per cup
1b.	Garri	10,000 per basin
2.	Vegetable	200 per average bunch
3.	Plantain	3000 per bunch
4.	Banana	3000 per bunch
5.	Palm Oil	1,600 per bottle

(Source: Field Survey, December 2023)

4.6.13 Community Health Aspects

This section covers the health status, as well as health infrastructure in the study area. Health is defined by the World Health Organization's (WHO) as a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity. This definition is also consistent with the relevant environmental and health laws in Nigeria.

The specific objectives of the study include:

- To determine the baseline health status of host communities' population
- To ascertain presence and prevalence of risk factors to health in the host communities
- To assess the quality of health services in the host communities

4.6.13.1 Data Collection Methods

Data was collected from the Twenty-two communities in the study area. Structured questionnaires and checklists were used to gather relevant data (Primary and Secondary). Secondary data sources for this study include:

- Data from Health facilities in the study area
- Population demography of the area, as obtained from the National Population Commission (NPC).

Primary data for this study were derived from field survey conducted in the study area and supervised by the Reps of State and Federal Ministries of Environment. Rapid rural appraisal methods such as Focus Group Discussions, Key Informant Interviews with health workers and direct observations were adopted to achieve the objectives of this study.

4.6.13.2 Housing Conditions

The Overall housing condition in the study area was *fairly good*, with over 42% of the buildings being either *Good* (Needing no repairs) or *Fairly Good* (Needing minor repairs). Floors were mostly cemented or tiled (78%), while about 22% were floored with earth / mud.

4.6.13.3 Access to Safe Drinking Water

Water is a key community health indicator and is Sustainable Development Goal No. 6 (SDG-6). Most households in the host communities were able to supply 20 to 40 litters of water per day to suit their needs. The communities' primary sources of drinking water included boreholes (private and communal – 67.3%), Mono-pumps (23%) and others (sachet, bottled water, well and rain – 9.7%).

4.6.13.4 Human Waste Disposal

The waste products of the human digestive system, menstruation, and metabolism, such as urine and feces, are referred to as human waste (or excreta). Due to a lack of other options, many people in rural communities are forced to engage in open defecation, which involves disposing of human waste in the environment.

Sustainable Development Goal 6 is centered on improving "water, sanitation, and hygiene" (WASH) globally. This is a critical public health concern in the context of international development. Figure 4.50 presents the methods of human waste disposal in the study area. The two main human waste disposal methods are "Flush to Septic tank" and "Pit Latrine", representing 49.5% and 20.7%, respectively. However, defecation in the bush and holes in the ground were also present in the community, representing 6.1% and 5.7% of the distribution, respectively. The human waste disposal methods in the study area are impressive as open defecation was on the low side. Toilets are shared mainly by household members in the study area. The Pit latrines can be shared most times by multiple households especially in the rural communities.

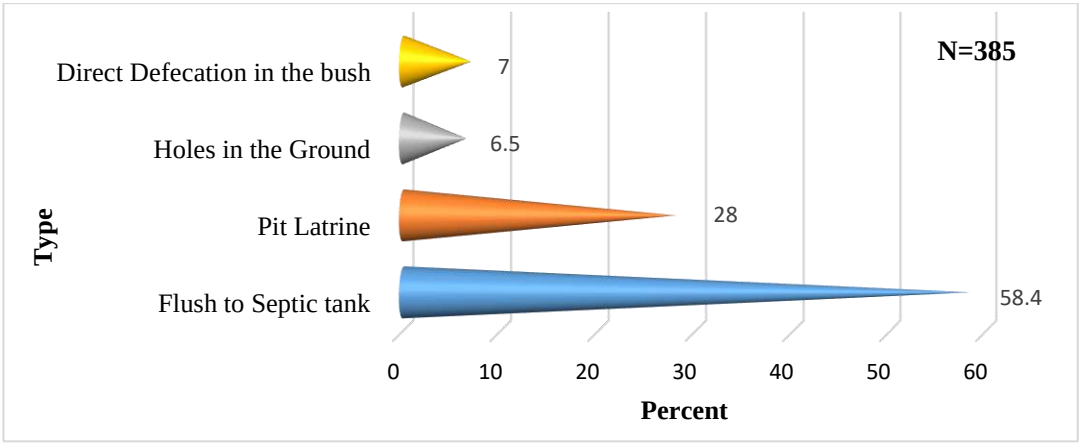


Figure 4.50: Method of Human Waste Disposal (Percentage Distribution)

(Source: Field Survey, December 2023)

An improved sanitation facility is that which hygienically separates excreta from human contact and is used by only members of one household: toilets flushing to sewer systems or septic tanks, ventilated improved pit (VIP) latrines, pit latrines with a slab, and composting toilets (UNICEF/WHO, 2015).

4.6.13.5 Pest/ Vector Control

Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host, after the pathogen has replicated (WHO,2020). Over 17% of all infectious diseases are vector-borne, and they are responsible for over 700,000 annual deaths. They may be brought on by bacteria, viruses, or parasites (WHO,2020). The most common vectors found in the studied communities were - Anopheles mosquito (Vector for Malaria), Tsetse Fly (Vector for sleeping sickness), Housefly (vector for enteric diseases like dysentery, diarrhoea etc.) and Sand flies (the vector for Leishmaniasis). The popular vector control measure in the communities was the use of locally produced insecticides (Sniper), use of mosquito treated bed nets and basic home sanitation. Respondents were asked to state their level of knowledge of vector-borne diseases. Apart from Malaria, which is caused by the female Anopheles mosquito, 78% of respondents were unaware of the diseases carried by other vectors.

4.6.13.6 Non-Human Waste Management practices

Waste management or waste disposal includes the processes and actions required to manage waste from its inception to its final disposal. The commonest method (59.1%) of disposal of household generated refuse was by *dumping at family-designated site*. In the urban communities however, *private waste collection vendors*, *Immediate burning of waste* and *Disposal at government designated dumpsite*, were common, accounting for 12.5%, 5.2% and 23.2% of respondents (Figure. 4.51).

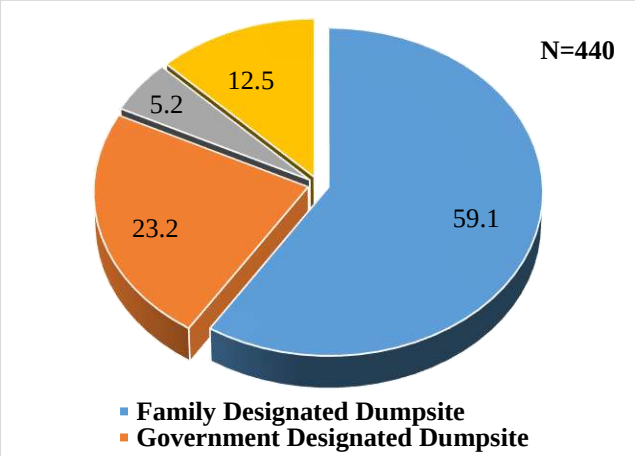


Figure 4.51: Method of Non-Human Waste Disposal (Percentage Distribution)

(Source: Field Survey, December 2023)

4.6.13.7 Nutrition and Food Security

Rivers State and Imo State are two proximate states that share a lot in common. Both states engage in inter-state trade in agricultural produce. The staple foods in the study area were Garri, Rice, beans, yam, plantain and cocoyam. The main sources of protein were cow meat, goat meat, chicken and bush meat. The indicators stunting, wasting, overweight and underweight are used to measure nutritional imbalance; such imbalance results in either undernutrition (assessed from stunting, wasting and underweight) or overweight. Child growth is internationally recognized as an important indicator of nutritional status and health in populations. To achieve this measure, the Mid Upper Arm Circumference (MUAC) is employed.

The Mid-upper arm circumference, often shortened to MUAC, is a measurement that allows health workers to quickly determine if a patient is acutely malnourished. This anthropometric measure tool was used to rapidly determine the nutritional status of under-five children in the communities.

Two-hundred infants and children who were 6–59 months of age were assessed across the twenty-two communities in the study area. Over (16%) of the children had a mid-upper arm circumference <12.5cm (Red Section of the MUAC tape) (Fig. B.8). This situation might be due to poor intake of protein-rich food as households depend mostly on carbohydrate-rich foods. Only roughly 55% of households seemed to have food security in the study area.

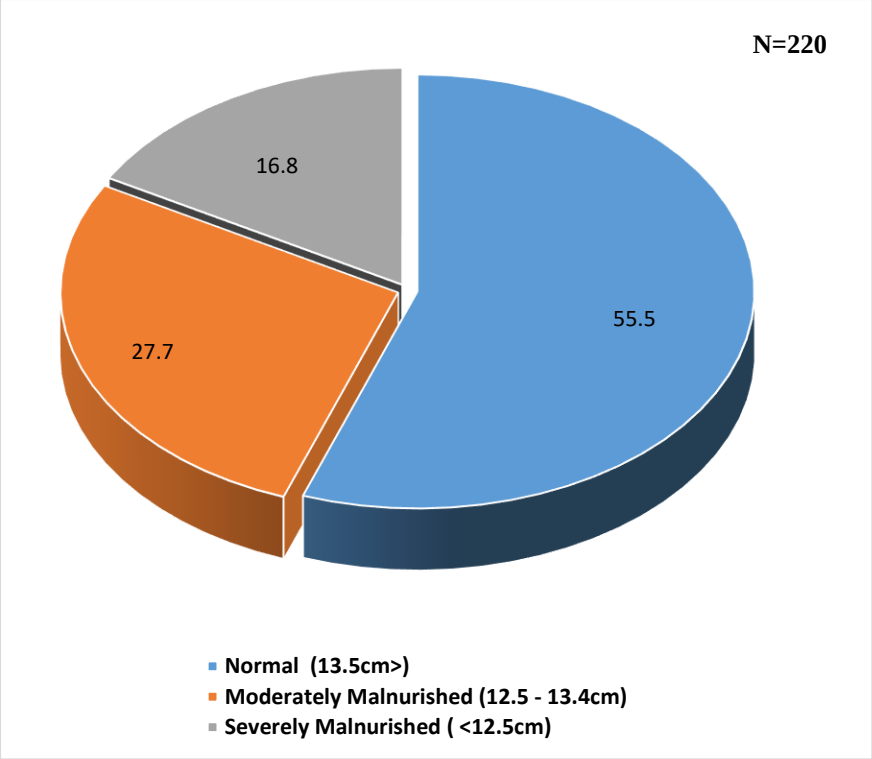


Figure 4.52: Under-Five Nutrition Status in the Communities (Percentage Distribution) (Source: Field Survey, December 2023)

4.6.13.8 Risky Behaviours

KNOWLEDGE OF HIV/AIDS AND SEXUALLY TRANSMITTED INFECTIONS

In Nigeria, HIV/AIDS and the acquired immunodeficiency syndrome (AIDS) have grown to be major public health issues. Nevertheless, the study area lacks data on sexual practices, knowledge, and attitudes around HIV/AIDS and other sexually transmissible infections (STIs). However, from focus group discussions and key informant interviews with health workers in the communities, there is sufficient knowledge on transmission modes, management and treatment of HIV/AIDS and other Sexually Transmitted Infections (STIs).

ALCOHOL CONSUMPTION

Like most communities in Nigeria, the study area also has a high record of alcohol consumption. Alcoholic beverages, including foreign gin and the locally produced gin called *kaikai* were accessible in the study area. In the communities, alcoholic drinks were consumed during social gatherings and during ancestor worship. In addition, alcohol is commonly used for the preparation of medications, which range from aphrodisiacs to pain relievers.

USE OF TOBACCO AND OTHER HARD DRUGS

Smoking is very common in the study area, making it a popular habit. Smoking is more popular amongst men. Old women and men still use *Snuff* (tobacco powder), although it is becoming increasingly unpopular considering that less and less people demand for it and people are more aware of the health effects on the old people. The use of hard drugs is a major problem in the communities, as youths engage in the use and abuse of all kinds of drugs. The most common in the area is Crystal Methamphetamine / Ice (local name: *Nkpurumiri*, Tramadol, loud (Weed), Shisha (water pipe), etc. However, The National Drug Law Enforcement Agency (NDLEA) appears to be achieving some success in the study area.

SEXUAL BEHAVIOR

Risky sexual bevahiours such as Infidelity among men in the study area is still high. It is very common to see young men and young women having multiple sex partners. Unprotected sex is also very high as there appears to be a hatred for use of condoms in the area. Polygamy is still noticeable in the study area, though people are moving away from the practice due to the prevailing harsh economic realities in the country.

4.6.13.9 Disease Burden in the Study Area

The health facilities serving the study area provided records attesting to the health issues raised by respondents. Figure 4.53 presents the most common health conditions in the study area. The most common health issues in the community were Malaria, Typhoid, Hypertension, Eye Diseases and Diabetes, were the most common ailments in the study area.

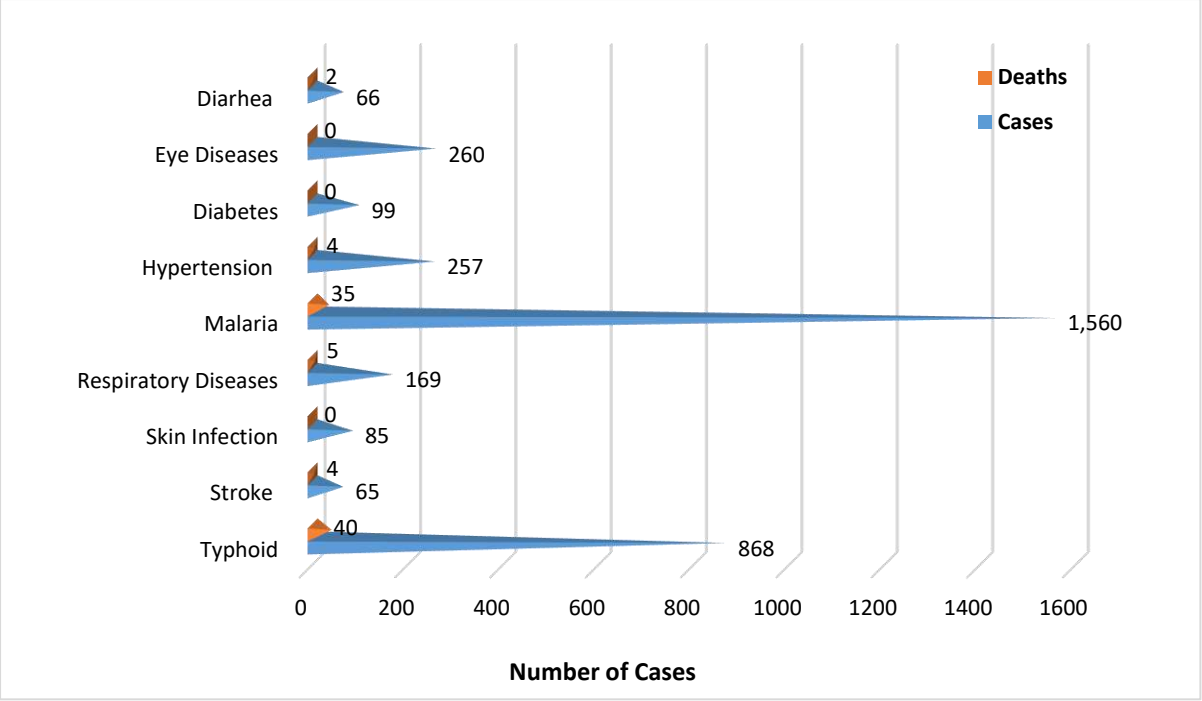


Figure 4.53: Disease Pattern in the Study Area

(Source: Field Survey, December 2023)

4.6.13.10 Mortality Patterns

Maternal mortality rates (MMR) was zero in the study area. This can be attributed to the increased awareness of pregnant women to take up antenatal care, more training of Traditional Birth Attendants (TBAs) and general improvement in the healthcare systems of Rivers and Imo states.

Although infant mortality rate (IMR) was previously reported to be very high, the field study revealed an IMR of 3,8 per 1000 live births. This could be attributed to improved medical care and vaccinations. Gastroenteritis (vomiting and diarrhea), malaria and its consequences, including anemia and febrile convulsions, and diseases that can be prevented by vaccination (such as measles) are among the major causes of mortality among children under five.

Life expectancy in the study area, according to participatory research appears to be in the region of 60 years for men and 65 years for women.

4.6.13.11 Access to Immunization Services and Uptake

Most children under five years (89%) have received some kind of immunization against the five child-killer diseases in the study area. Most pregnant women alike, reported to have received their BCG and TT shots. During the National Immunization days (NIDs), health workers from the local government headquarters visit the communities for the

exercise and the uptake is really encouraging. Children are followed to religious houses, school, community halls and their homes to ensure that every child is vaccinated.

4.6.13.12 Health infrastructure and personnel

The study area is well served by Primary Health facilities, especially in Rivers State where almost every community has a functional Model Primary Health Care facility within 3km radius (See Plate 4.37) built during the administration of former Governor Rotimi Chibuike Amaechi. There is access to primary healthcare though with the challenges of shortage of manpower and equipment. More serious cases are referred to other secondary and tertiary health facilities littered within the study area.



Plate 4.37: Model Primary Health Centre, Akpajo, Built by the Rivers State Government (Source: Field Survey, December 2023)

4.6.14 Perceptions and Expectations of Host Communities

PERCEIVED BENEFITS OF THE PROPOSED PROJECT

Table 4.50 summarises perceived benefits of the proposed Project by host communities.

Table 4.50: Perceived Benefits (Percentage Distribution of First, Second & Third Mentions)

S/No	Benefits	First Mention		Second Mention		Third Mention	
		N	%	N	%	N	%
1.	Employment Opportunity	269	74.5	33	9.6	0	0
2.	Opportunity For Contracting	4	1.1	120	34.9	9	3.7
3.	Social Infrastructure /Development	70	16.6	106	30.8	118	48.8
4.	Skills Acquisition by Youths	0	0	13	3.8	36	14.9
5.	Promote God Relationship with Indorama	0	0	5	1.5	22	9.1
6.	It Would Attract Other Companies	0	0	7	2.0	0	0
7.	Construction of Football Field/Stadium	0	0	4	1.2	0	0
8.	Economic Growth	0	0	27	7.8	34	14.0
9.	Scholarship For Youths	0	0	3	0.9	0	0
10.	Reduction In Youth Restiveness	0	0	6	1.7	3	1.2
11.	It Would Help Reduce Flaring	0	0	3	0.9	0	0
12.	Good Roads, Water and Light	10	2.8	7	20	0	0
13.	Boost Education of Youths	0	0	10	2.9	0	0
14.	Solar Street Light	18	5.0	0	0	0	0
15.	It would foster women empowerment	0	0	0	0	13	5.4
16.	Building of Market	0	0	0	0	4	1.7
17.	It would attract more CSR Projects	0	0	0	0	3	1.2
Total		**361**	**100**	**344**	**100**	**242**	**100**

(Source: Field Survey, December 2023)

For the first mentioned items, the mode was "Employment Opportunity", accounting for 74.5% of that distribution. This is not surprising given the unemployment rate of the country and the shared lack of opportunities for employment in the formal sector in the rural communities. For the second and third mentions, the modal perceived benefits of the proposed project were "Opportunity for Contracting" and "Social Infrastructure/ Development", accounting for 34.9% and 48.8% of the distributions, respectively.

PERCEIVED ADVERSE EFFECTS OF THE PROPOSED PROJECT

Table 4.51 summarises the perceived adverse effects of the proposed project.

Table 4.51: Perceived Adverse Effects (% Distribution of First, Second & Third Mentions)

S/No	Adverse Effects	First Mention		Second Mention		Third Mention	
		N	%	N	%	N	%
1.	Risk of Explosion and Fire	211	66.1	18	5.9	7	2.8
2.	Air Pollution	30	9.4	224	73.2	15	6.0
3.	Destruction of Crops During Construction	36	11.3	10	3.3	122	48.8
4.	Conflict Within Community	4	1.3	17	5.6	51	20.4
5.	Ground Water Pollution	10	3.1	14	4.6	4	1.6
6.	Perpetual Loss of Farmland Land	7	2.2	0	0	0	0
7.	Influx of People into the Community	11	3.4	0	0	13	5.2
8.	Decrease in Crop Production	4	1.3	9	2.9	10	4.0
9.	Vandalism of Pipeline and its attendant destruction of farmland	6	1.9	0	0	0	0
10.	Increase in vices due to influx of strangers	0	0	14	4.6	0	0

S/No	Adverse Effects	First Mention		Second Mention		Third Mention	
		N	%	N	%	N	%
11.	Damage to roads	0	0	0	0	15	6.0
12.	Displacement of wildlife	0	0	0	0	13	5.2
Total		**319**	**100**	**306**	**100**	**190**	**100**

(Source: Field Survey, December 2023)

For the first mentioned items, "Risk of gas explosion" emerged as the modal perceived adverse effect of the proposed pipeline project, accounting for 48% of the distribution. Amongst second and third mentions, "Air Pollution" and "Destruction of Crops During Construction" were the modal perceived adverse effects by respondents, accounting for 73.2% and 48.8% of the distributions, respectively.

PLEASURE/ DISPLEASURE WITH PROPOSED PROJECT

Respondents were asked to state their pleasure or otherwise about the proposed project Figure 4.54 presents their response across the study area. most respondents were either very pleased or somewhat pleased, accounting for about 60% of respondents. some respondents (17.3%) were indifferent. however, about 23% of respondents expressed their displeasure. They were further asked to state reasons for their displeasure and the modal three reasons amongst others were, "no employment of indigenes", "no internal roads in the community" and "no electricity", representing 25.8%, 16.7% and 15.2% of the distribution, respectively.

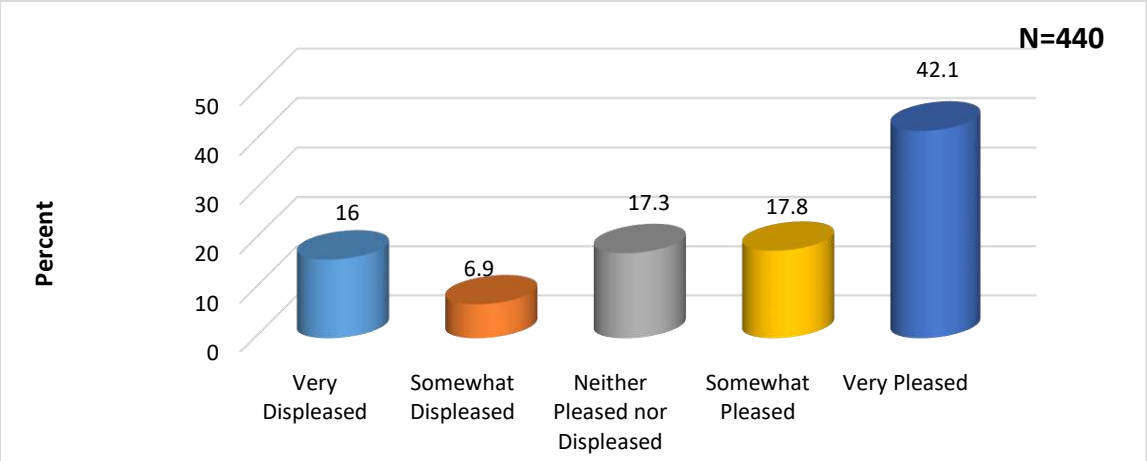


Figure. 4.54: Host Communities' Perception of the Proposed Porject

(Field Survey, December 2023)

NEEDS AND EXPECTATIONS OF COMMUNITIES FROM THE PROJECT

Table 4.52 shows host communities' stated needs and expectations and red, orange and green color were used to indicate the first, second and third mentioned communities' most important needs.

S/No.	Community Expectation	Akpajo	Elelenwo	Rumuokwurusi	Atali	Abara	Chokocho	Umuodogo	Umuakuru	Ime	Edegelem	Umuechem	Ipo	Omademe	Ozuaha	Omuanwa	Ubima	Omerelu	Omuapu	Awara I	Awara II	Ochia	Asa
1.	Youth empowerment																						
2.	Skills acquisition with starter packs																						
3.	Internal Roads construction																						
4.	Building of secondary School																						
5.	Electricity supply																						
6.	Health centre																						
7.	Contracts for indigenes																						
8.	Employment of skilled and unskilled workers																						
9.	Scholarship																						
10.	More projects																						
11.	Market																						
12.	Potable drinking water																						
13.	Grant to Women																						
14.	Empowerment of Farmers																						
15.	Welfare for the elderly																						

Table 4.52: Three Most Important Host Communities' Stated Needs/Expectations (Key: Red= 1st Mention, Orange=2nd Mention and Green=3rd Mention)

4.7 Cultural Heritage

This Section of the Report provides the Cultural Heritage baseline and assess the nature, distribution, and value (significance) of cultural heritage resources for the establishment of the Project. The baseline was derived using desktop-based research, as well as infield baseline studies undertaken during the social assessment studies. The aim of the infield assessment was to gather information on the following intangible Cultural Heritage: Places that might be of spiritual importance, for example shrines, places of worship, ancestral places etc.

- Traditions, crafts, festivals, or rituals in the area that may be impacted; and
- Land farmed or managed in a particular way or tradition that is unique to a specific location.

All identified Cultural Heritage resources within the Study Area with the potential to be directly or indirectly affected are considered. The extent and value (significance) of archaeological and paleoenvironmental remains, historic buildings, the built environment and historic landscape are also considered. The outcome of detailed literature review of Nigerian archaeology studies to date and archaeology & history of the region is presented in Annexure 4.10, whereas the tangible and non-tangible cultural heritage of the study area is discussed below.

4.7.1 Tangible cultural Heritage

There were some tangible cultural properties in the study area (Plate 4.38). Most of these were sacred forests, Shrines and a few items of worship. Artefacts were not common in the study area as this is unpopular in Rivers State and Imo State.



Plate 4.38 *Nsi Eji Ekee*, Sacred Objects of Ancestral Worship at Akpajo in Eleme LGA, Rivers State. (Source: Field Survey, December 2023)



Plate 4.39: The Ancient Sacred Shrine, Nkwarama- Aja Onu'ebo bin Rumukamala, Atali Community, Obio Akpor LGA.

(Source: Field Survey, December 2023)



Plate 4.40: Otoor Ogbe Mata Shrine, Akpajo Community in Eleme LGA, Rivers State. (Field Survey, December 2023)

However, shrines and sacred forests were very common in all communities in the study area (Plates 4.41)**.** Shrines and sanctuaries were restricted to only the Chief priests and community leaders when occasion demands that they consult the gods and ancestors of the land. It was sacrilegious to farm or defecate in the forests where these shrines and sanctuaries were located, as they were commonly revered and dreaded in the communities. Heavy penalties are common for trespassers. Table 4.53 presents some of the sacred forests and shrines in the study area.



Plate 4.41: Akpajo Sacred Forest (Mmu Osila) in Akpajo Community in Eleme LGA, Rivers State (Source: Field Survey, December 2023)

Table 4.53: Sacred Forests and Shrines in the Study Area

S/No.	Name	Location
1.	Ogugu Shrine	Ogugu, Akpajo Community
2.	Onumu Sacred Forest	Onumu, Akpajo Community
3.	Atali Shrine	Atali Community
4.	Atali Sacred Forest	Atali Community
5.	Chokocho Shrine	Agip/Chkicho Community
6.	Edegelem shrine	Edegelem Community
7.	Ala Ubi Shrine	Umuechem Community
8.	Ala Otamiri Sacred Forest	Umuechem community
9.	Ushi Wanti Shrine	Umuechem Community
10.	Omuanwa Shrine	Omuanwa Community

S/No.	Name	Location
11.	Nkiripo Akatali	Omuanwa Community
12.	Umuokeduru Scred Forest	Awara I Community
13.	Obor Scred Forest	Awara I Community
14.	Ijmuobi shrine /sacred forest	Awara II Community
15.	Obech Shrine /sacred forest	Awara II Community
16.	Obegwe Srine sacred /forest	Awara II Community

(Source: Field Survey, December 2023)

4.7.2 Intangible cultural Heritage

FESTIVALS AND INSTITUTIONS

The Ikwerre communities had traditional festivals, notably dances *(Igweregwu)*, wrestling *(Egelege)* (Plate 4.42), and masquerade *(Ozurumba)* for the Ikwerre speaking communities. Traditional marriage entailed presentation of drinks and payment of bride price to the family of the bride by that of the bridegroom, marked by celebration and merriment in the form of traditional marriage and white wedding ceremonies. Polygamy still existed in the community, in spite of in-roads made by Christianity, which preaches monogamy.

Traditional festivals in the Egbema cluster included wrestling to mark the end of farming season. *Ita Aji* festival is celebrated by women and involved exchange of wrappers as a demonstration of love and unity and New Yam Festival after new yam have been harvested. This was marked with masquerade display and other traditional dances by both men and women. Traditional marriage was the commonest practice and involved presentation of drinks and payment of a token as dowry by the bridegroom's family to the bride's family, despite the inroad made by Christianity, polygamy still persisted.

At Akpajo, the major festivals in the community were:

- *Asun* festival which involved offering sacrifice to the gods of the land and the forefathers of the community;
- *Ogbo Nja* festival was different as it involved exchange of visits by age mates and friends to strengthen the bond of good relationship amongst them.

Ngeleuna and *Oja-nu odo* were the types of marriages in practice. It involved payment of dowry by the groom's family to the bride's family. Lately, white weddings seem to be taking more prominence.

In the study area, other non-tangible cultural heritage dominating the region cultura activities includes food, marriage, dance, dress, and music:

FOOD

Bitterleaf Soup: This is a traditional Nigerian soup made with bitter leaves, palm fruits, and assorted proteins like fish, meat, or pomo (cow skin).

Ofe Owerri: This is a traditional Igbo soup made with a combination of different vegetables, cocoyam, assorted meats, and fish.

Ukwa: This is a delicious African breadfruit dish cooked with spices, palm oil, and various meat or fish.

MARRIAGE

Igba Nkwu (Igbankwu): This is the traditional Igbo marriage ceremony that involves the exchange of marital vows and the bringing together of both families.

Wine Carrying: During the marriage ceremony, the bride carries a cup of palm wine to her groom's family as a symbol of acceptance and respect.

Breaking of Kola Nut: The kola nut is broken and shared among both families as a sign of unity and peace.

DANCE

Egwu Owerri: This is a traditional Igbo dance performed during festivals to entertain and celebrate cultural heritage.

Ekpe Masquerade: This dance is performed by the Ekpe masquerade, which is a prominent masquerade in the region known for showcasing traditional movements and gestures.

DRESS

Isiagu: This is a pullover shirt worn by Igbo men during cultural events. It is decorated with embroidery and symbols representing bravery and success.

George Wrapper: This is a brightly colored cloth worn by women during special occasions. It is usually wrapped around the waist and can be styled in various ways.

Akwa Ocha: This is a traditional Igbo attire worn by both men and women. It consists of a white cloth wrapped around the body, symbolizing purity and peace.

MUSIC

Highlife Music: This is a popular genre of music characterized by vibrant dance rhythms, catchy melodies, and storytelling lyrics. It is often played at social gatherings and celebrations.

Ogene Music: This is a traditional Igbo music genre that utilizes the distinctive Ogene instrument, a metal gong. It is known for its rhythmic and energetic beats.

Ekpe Music: This music is associated with the Ekpe masquerade and is performed using drums, flutes, and other traditional instruments. It accompanies the dance of the masquerade.

Generally, the culture of the study area is deeply rooted in tradition and pride, with food, marriage, dance, dress, and music serving as important elements that define and celebrate their cultural heritage.




Plate 4.42: Wrestling (*Egelege*) Festival at Atali Community in Obio/Akpor LGA, Rivers State (Source: Field Survey, December 2023)

4.8 Stakeholder Engagement

4.8.1 Introduction

This Chapter presents a summary of the stakeholder engagement activities planned as part of the Project ESIA process. It also serves as a summary of a more detailed Stakeholder Engagement Plan (SEP), which presents the engagement approach and identifies stakeholders and the mechanisms through which stakeholders have been engaged.

The engagement process has been designed to meet both Nigerian ESIA regulations for public participation and international requirements for engagement as outlined in the IFC PSs and AfDB OSs. More specifically, IFC PS1 requirements place an emphasis on broad engagement and disclosure of findings to stakeholders and require that a SEP be developed. The existing SEP will be updated to include new host communities.

Stakeholder engagement is an inclusive and culturally appropriate process, which involves sharing information and knowledge, seeking to understand the concerns of others and building relationships based on collaboration. It assists stakeholders in understanding Project risks, impacts and opportunities to avoid, minimise or mitigate negative outcomes, and maximise positive outcomes.

4.8.2 Objectives and Principles of Stakeholder Engagement

The key objectives of stakeholder engagement for this Project are to:

- To understand the interests, influence, and concerns of various Project stakeholders.
- To ensure effective, transparent, and timely communication between the Project and its stakeholders, to engender an environment of trust and mutual respect.
- To engage stakeholders on their concerns regarding the Project, and appropriately address these through dialogue and corrective actions.
- To establish effective means of communication to disseminate information from the Project to stakeholders.
- To design stakeholder engagement mechanisms and standards that respect local traditions and cultural norms.
- To effectively manage the expectations of stakeholders regarding socio-economic benefits derived from the Project.
- Establish the appropriate management mechanisms and identify necessary capacity building and training requirements for the effective implementation of the SEP.

The key principles guiding the Project's approach to stakeholder engagement are as follows:

- **Transparency**: to be open and transparent with stakeholders.
- **Accountability**: to be willing to accept responsibility as a corporate citizen and to account for impacts associated with the Project activities.
- **Trust**: to have a relationship with stakeholders that is based on mutual commitment to acting in good faith.
- **Mutual Respect**: to respect stakeholders' interests, opinions, and aspirations.
- **Collaboration**: to work cooperatively with stakeholders to find solutions that meet common interests.
- **Responsiveness**: to coherently respond in good time to stakeholders.
- **Proactiveness**: to act in anticipation of the need for information or potential issues.
- **Fairness**: to engage with stakeholders such that they feel they are treated fairly, and their issues and concerns are afforded fair consideration.
- **Accessibility**: to be within reach of stakeholders so that they feel heard and to provide meaningful information as needed.
- **Inclusivity**: to proactively anticipate, identify and include all relevant stakeholders.

These principles have informed the Project's approach to stakeholder engagement.

4.8.3 Identification of Stakeholders

A stakeholder is defined as any individual or group who is potentially affected by the Project, or who has an interest in the Project and its potential impacts.

Different issues are likely to concern different stakeholders, so stakeholders have been grouped based on their connections to the Project. Given that the Project will majorly use existing RoW, thus identification of stakeholders for Projecct has leveraged and built on the stakeholders engaged for existing RoW. The stakeholders for the 11 km new RoW have been identified and included in the engagement structure since the beginning. The stakeholders for the Project have therefore been extracted from the existing stakeholder database for the existing RoW and newly identified are presented in Table 4.54 below. It should be noted that the stakeholder identification, mapping, and engagement will be a continuous process throughout the Project lifecycle.

Table 4.54: Stakeholder Identification[33]

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
Government	• Federal Ministry of Environment • Nigerian Midstream and Downstream Regulatory Authority (NMDPRA) • Rivers State Ministry of Environment • Imo State Ministry of Environment • Eleme Local Government • Obio/Akpor Local Government • Ikwerre Local Government • Etche Local Government • Ohaji/Egbema Local Government	• Director, Environment Assessment Department, Federal Ministry of Environment • Chief Executive and related Directrates of NMDPRA • Director, Pollution Control & Environment Health Department, Federal Ministry of Environment • Commissioner, Rivers State Ministry of Environment • Commissioner, Imo state Ministry of Environment • Director, Environment Assessment Department, Rivers State Ministry of Environment • Director, Environment Assessment Department, Imo State Ministry of Environment • Executive Chairman / Environmental Supervisors of Local Governments	Environmental Regulatory bodies are of primary importance in terms of establishing policy, granting permits or other approvals for the Project, and monitoring and enforcing compliance with Nigerian law throughout all stages of the Project life cycle. Regional and Local Governments may input into the permitting process and may have a role in monitoring the implementation of Project commitments included in the ESMP.
Traditional Rulers and Community Leaders	• Council of Traditional Rulers • Clan Heads	• Kings/Traditional Rulers	Local community leaders as representatives of their local community.

[33] A full database of all stakeholders should be maintained separately from the SEP and should be updated as new stakeholders are identified, or at least on an annual basis.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
	• Community Development Committees	• Clan Heads of following twenty-two (22) Host Communities: • Akpajo • Elelenwo • Rumuokwurusi • Atali • Chokocho • Abara • Omuodogo • Umuakuru • Ime • Edegelem • Umuechem • Ipo • Omademe • Ozuaha • Omuanwa • Ubima • Omerelu • Omuapu • Awara I • Awara II • Ochia • Asa	Traditional rulers play vital role in community development, civil administration, and socio-economic wellbeing in their domain by interfacing with the government. Traditional rulers are custodian of cultures, customary territorial rights, and privileges of people in their communities. Traditional rulers preside over civil and customary grievance / dispute resolution processes. Traditional rulers represent and protect the socio – economic interest of the communities before government and external agencies. Traditional rulers participate in Public Forum discussions and Technical Panel review as part of ESIA. Traditional rulers' interface with Indorama for MOU and its implementation. Management of communication in the communities with respect to project.
Directly Impacted Communities	• Communities originally impacted with the acquisition of land for existing RoW (65km) and new communities for 11km RoW.	• Twenty-Two (22) host communities	Originally the land was acquired by the owners of the existing Right of Way (NAOC) (65km will be used) and land has acquired for new 11km RoW. Cluster heads (CLOs) is entrusted with the responsibility to interface with Indorama on behalf of communities for the following:

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
			• Participation in ESIA Public forums to discuss positive / negative impacts of the project and the mitigation measures. • Participation in ESIA Technical Panel review to observe the evaluation process of mitigation measures set out to address the adverse impacts be social / economic / environmental impacts by experts and regulatory authorities. • Manage communications in the communities regarding the outcome of public forums and technical panel review. • Memorandum of Understanding (MOU) • Monitoring implementation of MOU for the following: a. Community Development Projects b. Contracts and supplies c. Employment during construction and operation phase. d. Scholarship programmes for youth studying in universities. e. Micro Grant for women for micro business f. Skill development programme for young men and women.
Vulnerable Groups	• Women • Youth	• Women Leaders • Youth Forum	Women have representation in Host Community Youth Forum as representative body participate in the discussion and decision-making process of ESIA public forum, technical panel review, adverse impacts / mitigation measures, MOU, community development projects, employment, skill acquisition programme, subcontracts & supplies and grievance management process during ESIA / construction / operation phase of the project. Women leaders exclusively participate in discussion and decision-making process of Micro Grant Scheme. Host Community Youth Forum exclusively participates for discussion and implementation MOU for the Youth.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
Civil Society and Interest Groups	• Community-Based Organisations / Association • Non-Governmental Organisations (NGOs)	• Farmers Association • Hunters Association • Graduate Forum	These groups participate in skill development programmes and receive financial assistance under Youth Entrepreneurship Scheme. Graduate Forum like Eleme Graduate Forum is a Non-Government Organisation (NGO) which in general represent the interest of members for employment
Employment and Business Associations	• Workers Unions • Employment Forums • Business Forums • Business Associations	• Welders and Fitters Association • Indigenous Suppliers Forum	Elected representatives of unions participate in collective bargaining agreements for betterment of condition of service, discussion on betterment of working condition, grievance management process, disciplinary management process, conflict and dispute resolution process during the construction and operation phase of the project. Elected / nominated members of Indigenous Suppliers represent their members for access to information with regards to contracts, supplies, grievance management dispute / conflict resolutions.
Other stakeholders	• Academia • Media	• Professors / teachers • Radio and Print media	Linkage between theory and practical thru industrial training, new skill development and recruitment and funding for research and development. Information from source via direct meeting or site visit, coverage of CSR events via invitation to events

4.8.4 Approach to Stakeholder Engagement

It is not practical, and not necessary, to engage with all stakeholder groups with the same level of intensity all of the time. Analysing and prioritising stakeholders is important to determine appropriate engagement methods. Given the dynamic nature of stakeholder and community contexts, stakeholder analysis will be revisited throughout the Project lifecycle.

Given that the proposed natural gas pipeline is majorly in the same locality (RoW), it was considered wise to adopt elements of the stakeholder analysis previously conducted. Stakeholder engagement conducted thus far for the ESIA process of 76km gas pipeline have also been analysed to update previous analysis. The broad groups of stakeholders identified in Table 4.54 have been further analysed below in terms of potential influence on Project activities and level of support for the Project (Table 4.55). An engagement approach is also suggested for each category of stakeholder in Table 4.56.

Table 4.55: Impact-Support Matrix

Stakeholder Cluster	Influence Level	Support Level	Engagement Approach
Environmental and Permitting Authorities	**High**	**High**	Work Together
Regional Government	**High**	**High**	Work Together
Local Government	**High**	**Medium**	Keep Engaged
Traditional Leaders	**High**	**Medium**	Keep Engaged
Community Leaders	**High**	**Medium**	Keep Engaged
Directly Affected Communities	**Medium**	**Medium**	Keep Engaged
Women	**Low**	**Medium**	Keep Informed
Youth	**Medium**	**Medium**	Keep Informed
Existing Natural Resource Users	**Low**	**Low**	Keep Informed
Civil Society Groups	**Low**	**Medium**	Keep Informed

Table 4.56: Summary of Potential Engagement Approaches

Engagement Approach	Process
Work Together	• Share information. • Consult on key Project issues. • Collaborate on Project delivery.
Keep Engaged	• Share information. • Consult on key Project issues.
Keep Informed	• Share information.
Show Consideration	• Share information. • Consult on key Project issues.

Priority should be given to stakeholders that are highly influential including those that are both supportive and unsupportive.

Engaging stakeholders who are unsupportive and influential, or those with deep-rooted challenges, requires engagement with pro-active and hands on approach. Effective engagement typically combines approaches - from informing to activities such as consultation or collaboration. In analysing these stakeholders and developing an approach to engagement, consideration has also been given to:

- Level of interest in the Project construction/operation
- Anticipated impact of the Project on the stakeholder
- Vulnerability status of the stakeholder; and
- Relationships with high influence stakeholders, including their ability to influence these stakeholders.

Stakeholders that have low influence but are unsupportive should be monitored closely, with a particular focus on their ability to influence, and their relationships with, other stakeholders. Less intensive forms of engagement such as monitoring or disseminating information will be adequate for engaging less influential, supportive stakeholders. Individual stakeholders can share a collective voice and access to legal guidance and resources thereby becoming more influential. Considering the outcomes of the stakeholder analysis, the high priority stakeholders for this Project are:

- Environmental and Permitting Authorities
- Federal government
- State government
- Local government
- Traditional leaders; and
- Community leaders.

4.8.5 Summary of Previous Engagement

As the Project is an extension of an existing operational pieline, stakeholder engagement by Indorama has been ongoing since 2006 for most of the stakeholders and since 2012 for pipeline host communities. Relational contexts, ways of working, and perceptions of the existing operations will all influence the perceptions of the Project, and should be taken into consideration when implementing the SEP.

In terms of engagements specific to the 76km NG Pipeline Project, Table 4.57 highlights what has taken place to date. The stakeholder engagement report is annexed as Annexure 4.11.

Table 4.57: Summary of Previous Engagements

Date	Stakeholder	Purpose	No. of attendees
21 September 2023	• Federal Ministry of Environment • Rivers State Ministry of Environment	Site verification required for Project categorization	8
19 October 2023	FMEnv, ISMEnv RSMEnv, LGAs and Council of Chiefs, Paramount Rulers of respective Communities, Elders, Women and women leaders, Youths, NGOs, Civil societies, Farmers, Traders, Fishers, students etc.	Scoping workshop for ESIA, Terms of Reference and Scope of Work A broader engagement to further educate participants on the proposed Pipeline project scope, environmental, social, economic and health aspects. Possible impacts of the project and community perspective (expectation, benefits, and perception etc.)	145
9 December 2023	Cluster Heads	Inform the Cluster of the proposed Pipeline Project scope; environmental, social, economic and health aspects. Clarify the roles and responsibilities of the Cluster Heads with regards to the Project.	4
15 December 2023	Cluster 1 communities' stakeholders: • The Paramount Ruler • Community Chairman • Youth President and Executives • Women group • Youth Rep. of Youth Council • Community Members	Inform participants of the proposed Pipeline Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	53
14 December 2023	Cluster 2 communities' stakeholders: • The Paramount Ruler • Community Chairman • Youth President and Executives • Women group • Youth Rep. of Youth Council • Community Members	Inform participants of the proposed Pipeline Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	87
20 December 2023	Cluster 3 communities' stakeholders: • The Paramount Ruler	Inform participants of the proposed Pipeline Project scope;	135

Date	Stakeholder	Purpose	No. of attendees
	• Community Chairman • Youth President and Executives • Women group • Youth Rep. of Youth Council • Community Members	environmental, social, economic and health aspects. Discuss possible impacts of the project and obtain community perspectives (expectations, benefits, perceptions etc.).	
19 December 2023	Cluster 4 communities' stakeholders: • The Paramount Ruler • Community Development Committee (CDC) Chairman • Youth President and Executives • Women group • Youth Rep. of Youth Council • Fishermen and Hunter • Community Members	Inform participants of the proposed Pipeline Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	91

4.8.6 ESIA Engagement

This phase involves engagement activities related to the completion of the ESIA process, and subsequent disclosure of the ESIA findings. Engagement activities include:

- **Public Involvement in Scoping Workshop** – as per Nigerian environmental regulations, a public hearing may be requested during the scoping phase to adequately determine the Terms of Reference of the ESIA. This requirement was made known to Indorama by the FMEnv, and the workshop in question was held on 19 October 2023 with 145 stakeholders.
- **Further Public Participation and Stakeholder Engagement** – where the ESIA process has identified information gaps or further public participation requirements, these must be completed by Indorama prior to the completion of the ESIA and records and findings should be attached as an addendum to the ESIA document. This should be conducted as per the FMEnv requirements. Stakeholder Engagement was carried out during the ESIA study as shown in Table 4.57.
- **ESIA Disclosure** – following the completion of the ESIA, findings should be disclosed to all stakeholders. In compliance with the EIA Act CAP E12, LFN 2004 and S.I. No. 109, Environment Impact Assessment Procedures and Charges Regulations,2021, once the ESIA is under review by the FMEnv the ESIA documents may be requested

by the FMEnv to be disclosed publicly for 21 working days. Locations to display the documents should include:

- Local Government Area offices
- Rivers State Ministry of Environment Offices
- Imo State Ministry of Environment Offices
- The Federal Ministry of Environment, Rivers State (Zonal) Office; and
- The Federal Ministry of Environment Headquarters.

- **ESIA Comment and Objection** – Indorama must make reasonable opportunity available to stakeholders to comment or object to the ESIA findings. This will be conducted in compliance with EIA Act of 1992 (amended 2004) and will include advertisements in local newspapers and the radio to invite the public to participate in the ESIA review process, where necessary. Where the comments or objections are deemed reasonable and eligible, IFF will endeavour to address them through an updated Project design or through further engagement with the objecting stakeholders.

4.8.7 Post-ESIA Engagement

A summary of post ESIA engagement activities is presented in Table 4.58. It should be noted that the plan for post-ESIA engagement will be updated should the need arise for more intensive engagement with certain stakeholder groups or should there be a substantial change to the Project plan.

Table 4.58: Stakeholder Engagement Phases and Activities

Engagement Phase	Engagement Activities
Pre-Construction	Monitor implementation of subsisting MOU 2023 – 2025
	Engagement with Cluster Heads/CLOs on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant etc.
	Project update and Review of grievance and grievance tracking
	Engage local authorities, traditional rulers and community leaders for briefing the completion of ESIA process and commencement of construction phase of the project
Construction Phase	Periodic engagement with Cluster Heads/CLOs on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant, etc.
	Project updates and Monitoring of grievances
Operational Phase	Project updates and Monitoring of grievances
	Periodic engagement with Cluster Heads/CLOs on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant etc

Engagement Phase	Engagement Activities
Decommissioning Phase	Announcement of intended decommissioning
	Provide broader decommissioning updates as required and monitoring of grievances
	Periodic engagement with Cluster Heads/CLOs on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant etc

4.9 Corporate Social Responsiveness of Indorama, Nigeria

Corporate Social Responsibility (CSR) is an integral part of business strategy and the Company's culture. Stakeholder mapping and engagement plans have been the building blocks of the CSR framework in the Company, which aids in the sustainable economic development of the country and specifically the community it operates in. The stakeholders' mapping and engagement plans are in compliance with the MOU signed with Host Communities. Key components of CSR programmes in Indorama are as given below:

4.9.1 Community and Stakeholder Policy

- At the core of business philosophy is ensuring social well-being, adding value to communities, and respecting human dignity. Indorama is committed to respecting the rights, cultures, customs, and values of the employees and communities affected by her activities and will manage businesses in a fair and equitable manner to meet social responsibilities.
- Proactively engage key stakeholders on sustainable development challenges and opportunities in an open and transparent manner.
- Comply with the regulatory requirements in the jurisdictions in which Indorama operate.
- Develop systems to identify, manage, and mitigate risks and adverse impacts on communities and stakeholders.
- Foster leadership, learning and growth to deliver value to the organization and to society in a responsible manner, including training people and providing resources to meet social responsibility objectives and targets.
- Respect the social, economic, and cultural rights of communities and seek broad-based support for her operations by consulting and informing stakeholders in matters that affect them.
- Ensure that effective grievance management systems are in place.

- Adopt sustainable development as an integral part of the business plan and put in place appropriate structures to plan and implement community development initiatives, prioritizing local needs and long-term sustainable benefits to communities

4.9.2 Highlights of CSR for Pipeline Communities

- **Memorandum of understanding (MOU)**: Company has a history of MOU with its Pipeline Host communities since 2015. Subsisting MOU 2023 – 2025 between the company and the host communities is an operating manual that provides commandment and the financial framework for CSR initiatives.

4.9.3 Coverage of CSR

The CSR programs covers the community development in-terms of Infrastructure, Healthcare and Educational facilities development, including scholarship and socio-economic financial empowerment. The CSR programs are also extended beyond the host communities and supported Rivers State Government and other institutions for various developmental projects. Few of these are Renovation of Nchia General Hospital, drugs and other items to Daughters of Charity, medical equipment to University of Port Harcourt Teaching Hospital, furniture to Nigerian Navy Basic Training School Onne, support to rehabilitate Eleme-Onne axis highway etc. The details of ongoing CSR programs are presented below.

- **Community Development Projects:** The objective of community development projects is to empower host communities in the process for identification and construction of projects that will be instrumental in the capacity building amongst indigenes and pave way for further socio-economic development in the region. Communities collectively through traditionally laid down democratic process select the project. Key thrust areas of community development projects have been construction of Community Secondary Schools, Community Health Centers, public roads, public market, extension of electricity, drinking water projects, civic centers etc.

Highlights of community development projects currently in progress for Pipeline Communities.

Community	**Total Spend**	**Projects**
Cluster 1	**FOR 2022,** ₦37.5 Million for three (3), Akpajo community no project for 2022 due to pending litigation	Extension of Electricity in Atali Community, Construction of five (5) Classroom Block in Elelenwo Community School, Construction of 300 Meters Rumuwutche, Apamini Rumuwogo, Concrete Road in Rumukwurusi.

Community	Total Spend	Projects
Cluster 2	₦87.5 Million	Construction of Fence around community Health centre in Abara Community, Extension of Electricity in Chokocho Community, Extension of Electricity in Umuogodo Community, Extension of Electricity in Imeh Community, /Renovation of Health Centre in Umuechem community, Construction of ICT Training Centre in Umuakuru community and Construction of Health Centre in Edegelem Community.
Cluster 3	₦75 Million	Construction of 5 Nos Overhead Tank Stands for Community Water in Ipo Community, Construction of Modern Market in Omuawa Community, Construction of Shops Inside Market in Omademe Community, Construction of 12 Lock Up Shop in Ozuaha, Construction of Civil Centre Phase II in Omerelu Community and Construction of Police Quarters in Ubima Community
Cluster 4	₦12.5Million	Construction of Community Development Centre/Conference Hall in Akanu community
Cluster 5	₦100 Million	Rehabilitation of Technical Workshop Building in Modern Boys Secondary School in Omoku 1 Community, Construction of Health Centre in Omoku 2 Community, Construction of Drainage System in Obrikom Community, Renovation of Community Health Centre in Egbogoro Community, Construction of Administrative Office for Teachers & Classroom in Okpurukpuali Community, Extension of Electricity in Okansu Community, Construction of Administrative Block in Uju community and Construction of Market Complex in Obor Community

- **Micro Grant for Women:** Gender diversity and inclusion is an important business philosophy in our organization. Commitment of women empowerment in the host communities is an integral part of CSR programmes. The objective of Micro Grant Scheme is providing financial support to enterprising women who are into self-sustaining small scale and micro businesses such as home bakery, tailoring, food stalls, shops, local trading etc. this scheme is immensely benefiting the women from our host communities and pipeline communities.
- **Scholarship Programme –** capacity building among youths and youth empowerment is another kingpin CSR program in our MOU. Every year many young men and women benefit in the form of financial assistance for their tertiary education.
- **Youth Entrepreneurship Scheme (YES) –** this is a specialized and advanced programme for small scale professional entrepreneur. The objective of this programme is to provide financial support for new startups as well as working capital for existing businesses such as mechanized bakery, poultry, fishery, agro business, vehicle maintenance workshop, carpentry workshop etc.

- **Skill Acquisition Programme –** the objective of this programme is to enhance individual capability and career building through vocational training programme. The focused areas for vocational training are welding & fabrication; pipe fitting & erection, Scaffolding, Rigging, Electrical Wiring & Installation, Grinding, Tile fixing, Paint Production & Painting, Fish Farming, Catering, Bead Making, Cake Baking & Pastry, Hair Dressing, Tying of Gele and Soap / Perfume making etc. After completion of vocation majority of the youths get skilled level jobs under ongoing projects.
- **Homage for Traditional Institutions –** traditional institutions are the pillars of socio – economic structures of all communities. Traditional institutions ensure collaborative process of engagement and participation for collective decision making. Company has a well-defined structure to empower traditional institutions to empower them and thereby enhance peace and promote collaboration and collective decision-making process.
- **Social Welfare –** we strongly believe that socio-economic, religious and sports events and festivals are very important for peace and harmony in the society. Company has well-structured social reach out programmes to achieve peace and harmony in the communities and goodwill for our organization. Also, company has distributed exercise books and Celebrated World Environment Day-2022 with host community senior secondary schools.

4.9.4 Other Contingency based Social Outreach Programs

- **Covid Palliative Measures:** During pandemic company supported host communities by proving palliative measures to communities and below is the details of Phase-1 beneficiries.

Rice (50 kg Bag)	Beans (50 kg)	Garri (50 kg)	Noodles (cartons)	Beneficiaries
1,320	880	880	4,400	6 Host Communities; 2 Jetty Communities; 30 Pipeline communities; 6 other communities from Eleme LG

- **Flood Relief Measures:** In the wake of the 2022 flood that hit some states in Nigeria and caused untold hardship, Indorama through its Community Relations & Development department donated some relief materials to the flood victims in its Cluster V Pipeline communities as well as some neighbouring Communities within her sphere of influence and operations as a support to cushion the effects of flood induced challenges. A total of nine (9) Cluster V pipeline communities were affected and they include, Omoku I, Omoku II, Uju, Obor, Okansu, Ebogoro, Obrikom, Egbada,

Okpurukpuali. Also, three (3) more neighboring communities were served with relief measures, and they are Ebocha, Ahoada and Ahoada - West Communities.

Conclusively, Annexure 4.12 has been attached to show details of CSR programs and projects executed to the Pipeline host communities.

CHAPTER FIVE

IMPACT ASSESSMENT

5.1 Impact Identification and Scoping/Screening

The activities associated with the proposed construction and operation of the 76km Natural Gas Pipeline traversing 22 communities in two states Rivers and Imo state, Nigeria, will inevitably result in varying degrees of impacts on the bio-physical and social environment. In this Chapter, the potential impacts of the proposed project are identified and assessed in order to determine their significance. Subsequently, mitigation measures are proffered to avoid, reduce or compensate for all potentially significant impacts in the subsequent Chapter.

Three high-level categories of project receptors likely to be impacted were identified:

- Physical: including air, surface water, groundwater, soils, etc.
- Biological: essentially terrestrial ecology (i.e., habitat, flora and fauna); and
- Human: including residents of host and nearby communities, local economy, community health and safety etc.

The impact identification was based on the project interaction with individual receptors within these broad groups while the value, sensitivity and importance of these receptors form the bases upon which the impacts were assessed to determine their significance and the proposed mitigation measures.

5.2 Scoping

Scoping seeks to identify those aspects of the proposed activities, which based on past experience, literature searches or intuitive perception could have significant impacts on the environment. The scoping process attempts to obtain answers to such questions as: What impacts will occur as a result of the execution and operation of Gas Pipeline Project?

- What will be the extent, magnitude, and duration of the impacts?
- Which of these impacts will be important within local and national contexts?
- What can be done to mitigate, reduce or avoid altogether the adverse impact or to enhance/ maximize positive impacts?

Scoping was thus an important part of the impact assessment process and involved identification and "narrowing down" of potential environmental impacts to ensure that the assessment focuses on the key issues for decision-making. Thus, scoping is an activity aimed at identifying those components (biological, physical, chemical, health, and social) of the environment, which may be impacted by the project and for which there are

common concerns by stakeholders including regulators. The project proponent in attempt to elicit stakeholders in the scoping process facilitated and held separate consultation meetings/workshops at the Golden Tullip Hotel Port Harcourt with all stakeholder present at the meeting on the 19th of October 2023. Technical presentations on the project and the EIA were taken by the proponent and the EIA consultant respectively. The nature of the proposed project was clearly explained to stakeholders including references to the previous EIA studies for the 83km existing pipeline. The EIA process was also described to the stakeholders. The following priority issues/impacts identified by stakeholders emerged from the scoping workshops:

Negative Impacts

The potential negative impacts will include but not limited to:

- Loss of vegetation
- Possibilities of soil/groundwater/surface water contamination from spill/leakages/vandalization
- Possible reduction in local air quality from construction activities especially CO, NO_2, PM10/2.5
- Increased competition from migrant workers for employment, leading to fewer opportunities for the local population.
- Increased exposure to radiation during welding
- Increase in noise from operation of machine and equipment during trenching, cutting, welding and pipe laying
- Potential effect of influx of migrant and contract workers on capacity of community, communicable disease and cultural values.
- Possible alteration of surface water/Sediment quality through release of contaminants
- Potential effect of waste generation.

Positive Impacts

- Potential creation of temporary and permanent jobs
- Potential contract/business opportunities
- Stimulation of local economy due to contract/business opportunities

5.3 Methodology

For the physio-biological spheres, the modified Leopold Matrix method was used. Two stages were involved in assessing the impacts. The first stage classified the impacts as either adverse or beneficial, short term or long term, reversible or irreversible). An (X) was used to indicate these classifications. Adverse impacts are those, which impact negatively on the biophysical, health, and social environments while beneficial impacts are those which enhance the quality of the environment. For this study, short term means a

period of time less than three months while any period greater than three months is considered long term. By reversible/irreversible, is meant whether the environment can either revert to previous conditions or remain permanent once the activity causing the impact is terminated.

5.3.1 Impact Characterization

The identified impacts of the proposed activities were further characterized as explained below. The characterization was based on the nature, characteristics and observed duration of the various activities on the biophysical and socio-economic components of the environment.

Table 5.1: Identified potential and associated impact classification

S/No	Impacts	Characterization
1	Adverse	Negative Impacts
2	Beneficial	Positive
3	Short term	Impacts that are removed after mitigating measure have been applied (< 3 months)
4	Long Term	Impacts that are removed after mitigating measure have been applied (>3 months)
5	Reversible	Impacts over which environmental components can recover
6	Irreversible	Impacts whose effects are such that the subject (impacted Environmental component) cannot be returned to its original state even after adequate mitigation measures are applied
7	Localized	Impacts within 10km
8	Widespread	Impacts above 10km

The results of the identified potential and associated impacts and their characteristics based on the characterisation criteria above are presented in Table 5.3 below. The impacts characterisation table is structured in the outline project development phases of site preparation, construction, pre-commissioning and decommissioning

The second stage involved evaluation to determine whether or not the impact is significant. The criteria and weighting scale used in evaluating this significance are as follows:

- Legal/regulatory requirements (L)
- Risk factor (R)
- Frequency of occurrence of impact (F)
- Importance of impact on an affected environmental component (I) and
- Public perception/interest (P).

The quantification scale of 0, 1, 3 and 5 was used. This is a modification of the arbitrary scale proposed by Vesilind, et al. (1994). The ratings are as described below and are adapted from The International Organization for Standardization ISO 14001 – Environmental Management System Approach.

These criteria and ratings are as follows:

Legal/Regulatory Requirements (L) – Is there a legal/regulatory requirement or a permit required?

- 0 = There is no legal/regulatory requirement
- 3 = There is legal/regulatory requirement
- 5 = There is a legal/regulatory requirement and permit required

Risk Factor (R) – What is the risk/hazard rating based on the Risk Assessment Matrix?

- 1 = Low risk
- 3 = Intermediate risk
- 5 = High risk

Frequency of Impact (F) – What is the frequency rating of impact based on the Risk Assessment Matrix?

- 1 = Low frequency (rare)
- 3 = Intermediate frequency (likely)
- 5 = High frequency (very likely)

Public interest/perception (P) – What is the rating of public perception and interest in proposed project and impacts based on consultation with stakeholders?

- 1 = Low interest/perception
- 3 = Intermediate interest/perception
- 5 = High interest/perception

Importance of affected environmental components and impacts (I) – What is the rating of importance based on consensus of opinions?

- 1 = Low
- 3 = Medium
- 5 = High

This approach was adopted considering its interactive and descriptive analysis of the relationship between the proposed project activities and the ecosystem components. It combines the following factors in assessing the overall impact rating of the project on the environment:

- The sensitivity/vulnerability of the ecosystem components.
- The productivity evaluation/rating of the ecosystem components.
- Knowledge of the possible interactions between the proposed project and the environment.
- Envisaged sustainability of the project environment.
- The economic value of the proposed project; and

- Projected duration of the impact of each project activity on various environmental components.

Overall Significance Ranking

This approach combines the following factors in assessing the overall impact rating of the project on the environment:

- The sensitivity/vulnerability of the ecosystem components.
- The productivity evaluation/rating of the ecosystem components.
- Knowledge of the possible interactions between the proposed project and the environment.
- Envisaged sustainability of the project environment.
- The economic value of the proposed project activities; and
- Projected duration of the impact of each project activity on various environmental components.

Table 5.2: Significance Ranking

Impact Value	Cut off values	Impact Value Definition	Impact Rating
(L+R+F+I+P)	<8	Sum of weight of legal requirements, risk factor, frequency of occurrence, importance and public perception less than 8.	low
L+R+F+I+P)	≥ 8<15	Sum of weight of legal requirements, risk factor, frequency of occurrence, importance and public perception greater than or equal to the benchmark (8) but less than the bench mark (15)	Medium
(L+R+F+I+P)	≥15:	Sum of weight of legal requirements, risk factor, frequency of occurrence, importance and public perception greater than or equal to the benchmark (15) High Impact	High
(F+I)	>6:	Sum of weight of frequency of occurrence and importance of affected environmental component exceeds the benchmark (6).	High
P	= 5:	Perception equal to 5	High

The frequency of occurrence of each impact was determined from historic records while the importance of affected environmental component was determined through consultation and consensus of opinions. The manner in which the host communities and the general public would perceive each potential impact and its effects were again determined through consultation with the host communities and consensus of opinions of environmental professionals.

Analysis of Potential and Associated Impacts

The analysis of potential and associated impacts of the project from Site preparation, Construction (considered in its major aspects: trenching /pipeline laying, and Horizontal Directional Drilling), to Pre-commission, Operation and Abandonment are presented in Table 5.3. The potential impacts identified in the Project are identified, ranked and quantified as indicated in Table 5.3

Table 5.3: Potential impacts identified in the Project are identified, ranked and quantified

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
Site Preparation	Opportunity for Contracting and Supplies		x	X	X			X	x								Positive
	Employment opportunity for skilled and unskilled labour.		x	X	X			X	x								Positive
	Opportunity for Skill enhancement/ acquisition		x	X	X			X	x								Positive
	Increase in income for individuals and community		x	X	X			X	x								Positive
	Removal of vegetation, disruption of riparian habitat along Pipeline ROW	X		X	X			x		1	1	1	3	5	11	4	Medium
	Potential for erosion and loss of soil nutrients due to stripping of vegetation cover	X		X	X			X		1	1	1	3	3	9	4	Medium
	Deterioration of surface water quality (turbidity) from surface run – off on bare soil at the river	X		X				X		1	1	1	3	3	9	4	Medium
	Changes in soil characteristics from movement of heavy-duty machinery	x		X	X			X		1	3	1	3	3	11	4	Medium
	Increase in noise from operation of machines & equipment	x		X				X		3	5	1	3	3	15	4	Medium
	Wildlife migration due to disturbance	x		X		x		X		1	5	1	3	3	13	4	Medium
	Loss of Vegetation including economic spp.	x		X		x		X		1	5	1	3	3	13	4	Medium
	Third party agitation	x		X	X			X		1	5	5	3	5	19	6	High

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
Site Preparation	Influx of laborers and followers (dependents, bounty seekers, CSWs, etc.)	x		X						1	5	1	3	3	13	4	Medium
	Increased risk of prevalence of HIV,	x		X						1	1	1	3	3	9	4	Medium
	Increased risk of malaria, dysentery, and other diseases	x		X						1	1	1	3	3	9	4	Medium
	Increased pressure on existing social amenities/ infrastructure.	x		X		x				1	1	1	3	3	9	4	Medium
	Loss of biodiversity due to activities of laborers e.g. hunting and fishing.	x		X						1	1	1	3	3	13	4	Medium
	Increase in social vices	x		X		x		X		1	5	5	3	5	19	6	High
	Potential for socio-cultural conflict	x		X						1	1	1	3	3	9	4	Medium
	Hydrocarbon contamination of environment from accidental spills e.g. faulty processes of refueling and lubricants use	x		X		x				1	1	1	3	3	9	4	Medium
	Loss of aesthetics due to waste dumping	x		X						1	1	1	1	3	7	4	Low
	Loss of habitat to soil fauna/loss of soil arability from soil inversion	x		X						1	1	1	3	3	9	4	Medium
	Potential for disruption of ecological balance during site preparation for HDD at wetlands	x		X						1	1	1	3	3	9	4	Medium
	Workplace accidents leading to injury	x		X		x		X		1	5	5	3	4	18	6	High

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
Site Preparation	Potential for socio-cultural conflict	x		X		x		X		1	5	5	3	5	18	6	High
	Potential for kidnapping of workers	x		X		x		X		2	5	2	3	5	17	5	High
	Waste generation	x		X		x		X		1	5	2	3	3	19	6	Medium
	Visual impacts of heavy equipment to farmers	x		X						1	2	1	3	3	10	4	Medium
Construction																	
Construction	Employment opportunity for skilled and unskilled labour.		X	x	X												Positive
	Opportunity for Skill enhancement/ acquisition		X	x	X												Positive
	Increase in income		X		X												Positive
	Potential for changes in physico-chemical properties of surface water bodies due to inflow of runoffs bearing excavated soil	x		x						1	1	1	3	3	9	4	Medium
	Increase in SPM during dry season trenching activities	x		x						1	1	1	3	3	9	4	Medium
	Soil compaction and Loss of habitat to soil fauna and flora due to movements of heavy-duty equipment	x		x		x				1	1	1	3	3	9	4	Medium
	Soil strata inversion during back filling with risk to erosion	x		x						1	1	1	3	3	9	4	Medium
	Increased risk of road traffic accident	x		x		x				1	1	1	3	3	9	4	Medium
	Increase in noise from operation of machines &	x		x						3	1	1	3	3	11	4	Medium

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
	equipment during trenching, cutting, welding, pipe laying etc.																
	Air pollution from exhaust fumes/greenhouse gases	x		x						3	1	1	3	3	11	4	Medium
	Obstruction of access routes to villages and farmlands	x		x						1	1	1	3	3	9	4	Medium
	Fragmentation of habitat for wildlife	x		x						1	1	1	3	3	9	4	Medium
Construction	Third party agitation	x		x	X			X		1	5	5	3	5	19	6	High
	Influx of laborers and followers (defendants, bounty seekers, CSWs, etc.)	x		x						1	5	1	3	3	13	4	Medium
	Increased risk of prevalence of HIV	x		x						1	1	1	3	3	9	4	Medium
	Increased pressure on existing social amenities/ infrastructure.	x		x						1	5	1	3	3	13	4	Medium
	Loss of biodiversity due to activities of laborers e.g. hunting and fishing.	x		x						1	1	1	3	3	9	4	Medium
	Increase in social vices	x		x	X			X		1	5	5	3	5	19	6	High
	Potential for socio-cultural conflict	x		x		x				1	1	1	3	3	9	4	Medium
	Hydrocarbon contamination of environment from accidental spills e.g. faulty processes of refueling and lubricant usage	x		x		x				1	1	1	3	3	9	4	Medium
	Loss of aesthetics due to waste dumping	x		x						1	1	1	1	3	7	4	Low
Construction	Increased exposure to radiation during welding	x		x						1	1	1	3	3	9	4	Medium

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
	Potential for disruption of soil structure due to deposition of soil/clay from inadvertent returns; on riverbank at crossing	x		x						1	1	1	3	3	9	4	Medium
	Potential for vegetation change due to primary succession at deposition sites (on banks and riparian habitat)	x		x		x				1	1	1	3	3	9	4	Medium
	Improper waste management leading to loss of aesthetics, habitat disruption and death of aquatic/land organisms	x		x		x				1	1	1	3	3	9	4	Medium
	Accidental release of drilling mud (bentonite) into wetlands, land	x		x		x				1	1	1	3	3	9	4	Medium
	Potential for pollution of surface water which is a source of water for domestic use	x		x		x				1	1	1	3	3	9	4	Medium
	Air pollution from exhaust/greenhouse gases	x		x		x				1	1	1	3	3	9	4	Medium
	Potential for disruption of aquifers that feed in stream upwelling at the crossing	x		x		x				1	1	1	3	3	9	4	Medium
Construction	Possible erosion, deterioration of physico-chemical properties of surface water, and increased sediment deposition upstream, from poor runoff control at construction site	x		x		x				1	1	1	3	3	9	4	Medium

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
	Potential for disruption of surface water flow dynamics and creation of artificial ponds, flooding, due to inadvertent returns of drilling mud on bank and riparian habitat	x		x		x				1	1	1	3	3	9	4	Medium
	Potential for introduction of foreign or undesirable organism (including disease, parasites, or pests) from contaminated equipment; detrimental to aquatic life	x		x		x				1	1	1	3	3	9	4	Medium
	Risk of physical damage (dents, coating damage, or rupture) during excavation, trenching or drilling leading to spills, gas leaks, fire and/or explosion.	x		x		x		x		1	1	1	3	3	9	4	Medium
Pre-Commission																	
Pre-Commission	Increase in temperature of receiving environment	x		x		x				1	1	1	3	3	9	4	Medium
	Environmental contamination and loss of aesthetic value due to fuel and lubricant spillage or valve and seal failure	x		x		x				1	1	1	3	3	9	4	Medium
	Environmental contamination (water and land) from disposal of waste e.g. hydro-test water, and condensate	x		x		x				1	1	1	3	3	9	4	Medium

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
	Odor and aesthetic devaluation due to waste dumping	x		x		x				1	1	1	3	1	9	4	Low
	Air pollution from exhaust gases	x		x		x				1	1	1	3	3	9	4	Medium
	Potential for surface water degradation preventing domestic use	x		x		x				1	1	1	3	3	9	4	Medium
	Exposure to radioactive materials during weld testing, NDT	x		x		x				1	1	1	3	3	9	4	Medium
Operational Phase																	
Operational Phase	Hiring of skilled and unskilled labour		x	x	X												Positive
	Increased income																Positive
	Opportunities for contracting and supplies		x	x	X												Positive
	Changes in air quality may occur from release of gaseous/misty by products during pigging	x		x		x				1	1	1	3	3	9	4	Medium
	Condensate may contaminate soil/water bodies due to spillage or valve and seal failure	x		x		x				1	1	1	3	3	9	4	Medium
	Injuries and death from gas leaks and explosion	x		x		x				3	5	1	5	5	19	6	High
	Corrosion and pipeline rupture	x		x		x				1	1	1	3	3	9	4	Medium
	Environmental Pollution as a result of pipeline interference by third parties (Vandalization	x		x		x				1	1	1	3	3	9	4	Medium

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
	Loss of biodiversity due to activities of laborers e.g. hunting.	x		x		x				1	1	1	3	3	9	4	Medium
	Odor and aesthetic devaluation due to waste dumping	x		X		x				1	1	1	3	3	9	4	Medium
	Destruction of assets and property from gas leak/ fire.	x		X		x				1	5	5	3	5	19	6	High
	Destruction of forest resources from gas leak/ fire	x		X		x				1	1	1	3	1	9	4	Low
	Potential for increase in incidence of malaria, typhoid, dysentery, and other diseases	x		X		x				1	1	1	3	3	9	4	Medium
	Increased extreme heat	x		X		x				1	1	1	3	3	9	4	Medium
	Increase water stress and drought	x		X		x				1	1	1	3	1	7	4	Medium
	Increased in both flooding and wildfire events	x		X		x				1	1	1	3	2	8	4	Medium
	Fugitive methane emissions from valves, flanges and instrument connections	x		x		x				1	1	1	3	3	9	4	Medium
	Accidental gas releases arising from equipment failure	x		x		x				1	1	1	3	3	9	4	Medium
	Noise from pressure regulation and venting activities	x		x		x				1	1	1	3	2	8	4	Medium
	Potential safety hazards associated with high-pressure gas operations	x		x		x				1	1	1	3	1	7	4	Medium
	Potential Encroachment on the Pipeline Right-of-Way (RoW)	x		x		x				1	1	1	3	3	9	4	Medium
Decommissioning/Abandonment																	
	Increased income		x	X	X			X	X								Positive

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
Decommissioning	Hiring of skilled and unskilled labour		x	X	X			X	X								Positive
	Opportunity for Contracting and Supplies		x	X	X			X	X								Positive
	Increased risk of road traffic accident due to transportation of removed structures from site	x		X		x				0	1	1	3	3	9	4	Medium
	Excavation to remove pipeline could lead to contamination of soil	x		X		x				1	1	1	3	3	9	4	Medium
	Third Party agitation	x		X		x				1	1	1	3	3	9	4	Medium
	Influx of laborers and followers (dependents, bounty seekers, CSWs, etc.)	x		X		x				1	1	1	3	3	9	4	Medium
	Increased risk of prevalence of HIV,	x		X		x				1	1	1	3	3	9	4	Medium
	Potential for increase in incidence of malaria, dysentery, and other diseases	x		X		x				1	1	1	3	3	9	4	Medium
	Increased pressure on existing social amenities/ infrastructure.	x		X		x				1	1	1	3	3	9	4	Medium
	Increase in social vices	x		X		x				1	1	1	3	3	9	4	Medium
	Loss of biodiversity due to activities of laborers e.g. hunting	x		X		x				1	1	1	3	3	9	4	Medium
	Loss of employment due to lay off of laborers	x		X			x			1	1	1	3	3	9	4	Medium
	Potential for erosion due to improper backfilling process	x		X		x				1	1	1	3	3	9	4	Medium

Project phase	Potential/Associated Impacts	Adverse	Beneficial	Short term	Long term	Reversible	Irreversible	Localized	widespread	Assessment criteria					Total score	F+I	Category
										L	R	F	I	P			
	Loss of aesthetics due to waste dumping	x		X		x				1	1	1	3	3	9	4	Medium
	Risk of contamination of soil and wetlands	x		X		x				1	1	1	3	3	9	4	Medium
	Risk of physical damage (dents, coating damage, or rupture) during excavation, trenching or drilling leading to spills, gas leaks, fire and/or explosion.	x		x		x		x		1	1	1	3	3	9	4	Medium

5.4 Impact Description

Loss of Habitat

Biodiversity studies in the project area indicates that site preparation activities (and construction activities) on the right of way, which is already existing, will result in some level of fragmentation of habitat for wildlife, and minimal loss of habitat for some flora and fauna that occur along the proposed RoW. Site preparation activities will thus result in migration of wildlife out of the RoW area primarily, due to loss of habitat.

Loss of Flora and Fauna

The vegetation along the RoW would be cleared. This could lead to the loss of economic trees, medicinal plants and food crops. Clearing of vegetation for the pipeline and fabrication could result in the destruction of indigenous plant communities along the proposed RoW. The ROW shall be optimally used such that only the existing RoW of land will be cleared and used for the pipeline installation.

Potential for Soil/Gully Erosion

The data gathering exercise on the characteristics of soil show that the soil structure is very liable to erosion especially when there would be removal of vegetation cover, exposing the soil to direct impact during the rainy season. This is particularly sensitive because this is a high rainfall area. Soil strata inversion during backfilling is another factor that can contribute to the removal of soil during surface runoffs that accompany rains, on bare exposed soil. The erosion is possible primarily along the length of the right of way; in the event of creating a water channel along the RoW, there could be secondary impact of erosion on the adjourning lands to the RoW.

Potential for air pollution from equipment and machinery operations

The process of excavation for pipeline will result in generation of dust and other suspended particulate matter on the dry land section of the project, especially during the dry season. The use of heavy-duty construction machinery (welding, excavation) and power generating plants as well as vehicular movement are known to produce obnoxious exhaust gases that could lead to air pollution. Some of these possible air pollutants are carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter (PM), and sulphur dioxide (SO_2) with implications for health problems for people in the community and laborers. Greenhouse gases including carbon dioxide (CO_2) can also be emitted.

Generation of noise/vibration with possible hearing loss and migration of wildlife

The values of noise measurements from this study were all within regulatory limits. Increased land transportation activities that would occur during the mobilization of equipment and personnel could lead to increased noise above the ambient level. This could result in impaired hearing in people living around the project area. Also, the noise and vibration may adversely affect noise-sensitive wildlife.

Potential for disturbance of aquatic habitat and fish harvests

A small section of the proposed pipeline RoW has wetlands with no River crossing, thus little or no loose soil, surface runoffs, can easily be washed into the aquatic medium during to site preparation and construction activities like trenching, backfilling and possible erosion. Increased levels of sediments in water can impair phytoplankton activities as well as make the physical properties of the aquatic medium unfavorable for the survival of fish and other important organisms. Fish thus either migrate away or die, and this reduces the chances of catch/quality catch by fisher folks. This possibility of this impact to occur as very minimal as the closest surface water body is over 10km away from the proposed RoW.

Potential for environmental pollution from hydrocarbons and chemicals

Sources of pollutants include spent hydrocarbons (oils) or lube oil from leaking engines on land which can be transported during surface runoff; and accidental release of drilling mud (bentonite)/cuttings into near surface water during horizontal directional drilling activities on road crossing. Furthermore, pre-commissioning activities such as pressure testing, Hydro-testing, pigging, catholic protection etc may result to soil/water contamination from disposal of pressure test water and condensate.

Potential for Hydrotesting water polluting nearby water bodies.

Hydrotesting involves using water to check for leaks. The water in the environment has been confirmed to be fresh (Egbeda and Otamiri River) as a result of which addition of inhibitors will not be necessary in the hydrotesting process. The need for corrosion inhibitors would have arisen if the water had not been fresh. Since no inhibitor is involved, disposal of the hydrotest water into the environment will not constitute any harm to the environment. Furthermore, the period for which the hydrotesting would be undertaken is short (24 hours) and this supports the principle that the hydrotest will not require the use of an inhibitor. However, IFF will treat the hydrotest water in their existing water treatment facility in Indorama complex before it is discharged to a nearby water body.

Traffic obstruction/diversion on land

Increased movement of equipment and personnel particularly during site preparation, construction, and decommissioning could result in hindrance of free flow of movement on land hence posing obstruction also to the socio-economic ambience of the area.

Risk of Road traffic accidents

The movement of vehicles and heavy-duty machinery to and from site also may pose danger to other road users, particularly to those who fail to always remember that the roads will no longer be as free as usual including bicycle riders and children who play on the street.

Third Party Agitations

The high level of unemployment in the region, and the likely influx of non-indigenes, jostling for employment quotas amongst community youths, perceptions about employment, entitlements, and expectations from the company as well as the possibility of dubious transactions amongst themselves and between representatives and the company's agents and contractors, is likely to lead to conflicts of interest and agitations that can result in serious civil unrest, stoppage of work and even death through armed conflict even with security agents of the company. Delayed remittances and communication gap could also result in such conflict. Non-compliance with cultural norms (such as desecration of shrine identified during social assessment) and values of the host communities may like give rise to civil unrest by the communities.

Risk Associated with Sabotage/Vandalization Activities

Risks from such activities are unquantifiable and beyond the Proponent's Control. They are acknowledged to be significant enough to warrant attention. HSE, Technology, and Security management plans which is currently operational on the RoW will be strengthened to proactively manage the risks posed by sabotage and vandalization, especially the use of Technology and Security personnel.

Injuries and death from Gas leaks and explosions

Total loss of gas containment is regarded as unlikely but could occur in the event of major pipeline rupture or Sabotage. The probability of such an event occurring is considered very remote because it would likely occur only as a result of a major explosive event or sabotage. Use of isolation control valves at regular intervals would minimize the loss of

ruptured gas. The sudden release of gases and fluid under high pressure during hydrotests, and operational phases of project (due to sabotage or system failure) could result in explosions and fire outbreak. Injuries such as burns, loss of limbs, or death can occur under such circumstances.

Potential for inhalation of welding fumes, glares, and sparks

Emissions during welding or cutting of metals emit toxic gases as well as glares and sparks. This can result in visual and respiratory complications.

Environmental pollution from Gas leaks

Gas leaks can result from material failure/pipeline rupture due to corrosion, human errors, and sabotage which could lead to environmental pollution and soil degradation.

Potential for disruption of demographic equilibrium

The influx of workers is likely to be skewed in favour of youth, and males. It can also result in influx of commercial sex workers. Thus, population structure and size will likely be affected.

Possible increase in disease incidences and outbreaks

Diseases such as malaria, respiratory tract infections, diarrhoea diseases, skin disease, and sexually transmitted diseases may increase. For instance, vector breeding grounds for malaria can be created by site preparation activities, poor management of sewage can lead to outbreak of diarrhoea.

Possible increase in anti-socio-cultural vices

The influx of workers and job seekers into the community as a result of this project activity could result in the upset of the norms and ethics, as well as the existing traditional and cultural system of community management. Social vices like violence, alcoholism, substance abuse, teenage pregnancies, attraction of commercial sex workers (CSW) and sexual promiscuity which could result in an increase in sexually transmissible diseases like STIs and HIV/AIDS and even thuggery could be precipitated in the community. The activities of commercial sex workers and immigrants may create socio cultural tension and negatively impact the value system in the communities.

Increase in inflation level

Increase in wage earnings of work force, income flows generally, and forces of demand and supply on goods and services are likely to result in increased prices during the project activities, and often these changes do not go away easily, thus making life difficult particularly for those who may not earn directly from the project activities.

Changes in culture, lifestyle and habits

The project area is made up of rural traditional communities. Changes in the culture, lifestyle and habits of the project area communities could easily be brought about by the influx of workers.

Risk of exposure to radiation

During NDT/radiographic weld test, there is the risk of exposure of personnel and passer-by to harmful radioactive emissions.

Hazards of improper waste management

Several streams of waste are expected especially during site preparation, construction, and operation and decommissioning. This could result in soil and water contamination, loss of biodiversity, loss of arability of soil, loss of means of livelihood, foul odour and loss of aesthetics particularly from improper disposal of wastes (condensates, drill cuttings/mud, bentonite) and leakages from faulty processes of fuelling and lubricant use, risk of accidents/injury.

Potential for surface water degradation

The improper handling of sewage, hydrotest wastewater and oily wastes could result in the loss of aesthetics of water and render it unfit for traditional indigenous uses including washing of clothes and bathing. Potential for increase in coliform levels can result in bloom of microorganisms harmful to aquatic life, man and animals.

Cumulative Impacts Assessment

The proposed 76 km natural gas pipeline will be installed along a combination of a new 11 km Right-of-Way (RoW) and approximately 65 km of an existing RoW. As the majority of the pipeline alignment follows an already established utility corridor, the project is expected to result in generally low cumulative environmental and social impacts. The use of the existing RoW significantly reduces the need for additional land acquisition, extensive vegetation clearing, habitat fragmentation, and disruption to surrounding communities

and land uses. Cumulative impacts are therefore anticipated to be largely temporary and confined to the construction phase, including localized increases in dust, noise, traffic, and short-term disturbances to soils, surface water, and vegetation when considered alongside other existing and reasonably foreseeable developments within the area. During the operational phase, cumulative impacts are expected to be minimal and primarily associated with routine maintenance activities and infrequent fugitive emissions, both of which can be effectively managed through the implementation of appropriate engineering controls, pipeline integrity management systems, and environmental and social management measures. Overall, with the application of Good International Industry Practice (GIIP) and the prescribed mitigation measures, the residual cumulative impacts are expected to remain low and not significant, while the project is anticipated to provide long-term cumulative positive benefits through enhanced natural gas transportation, improved energy security, support for industrial development, and increased socio-economic opportunities within the region.

The impact analysis has revealed both positive and negative impacts, with the medium impact rating dominating the list of impacts evaluated as a result of the proposed project implementation. The subsequent chapter (Chapter Six) has proffered mitigation actions to reduce the negative impacts to the barest minimum and to maximise the benefits of the positive impacts.

CHAPTER SIX

IMPACT MITIGATION

6.1 Introduction

This Chapter describes mitigation measures that are technically and financially feasible to address environmental and social impacts associated with the construction and operation of the proposed IFF 76km Natural gas pipeline from AGPC in Ochia Imo State to Indorama complex in Eleme, Rivers State The mitigation measures recommended are commensurate with the nature and magnitude of the potential impacts taking into cognizance the peculiarity of the proposed project and activities as well as environmental and social setting of the project area.

6.2 Mitigation Approach

The approach adopted for selecting appropriate mitigation measures followed a hierarchy that favours the avoidance of impacts over minimization, and where residual impacts remain, compensate/offset for impacts to workers, affected communities and the environment.

6.2.1 Avoidance

To avoid the impact altogether by not using certain type of resources, or areas considered to be environmentally sensitive nor taking certain actions or parts of an action that could result in negative impacts. This is considered to be the most acceptable form of mitigation.

6.2.2 Minimization

To minimize impacts by limiting or reducing the degree, extent, magnitude or duration of adverse impacts. Negative impacts can be minimized through environmental and social measures/treatments/design. Available options to minimize negative impacts include abate, rectify, repair, and/or restore.

6.2.3 Compensation

To compensate for the impact by replacing or providing substitute resources especially for unavoidable and residual impacts. This does not eliminate the adverse impact but seeks to offset it with an (at least) comparable positive one.

6.3 Mitigation and Enhancement Measures

A summary of all identified impacts as well as the proposed mitigation measures is presented in Table 6.1.

Table 6.1: Impact Mitigation Measures

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
Site Preparation	Removal of vegetation, disruption of riparian habitat at HDD sites and outside Pipeline ROW	Medium	• IFF shall ensure minimum land clearing and clearing will be restricted to acquired area. • IFF shall ensure re-planting of riparian plants in areas outside the ROW corridor	Low
	Potential for erosion and loss of soil nutrients due to stripping of vegetation cover	Medium	• IFF shall revegetate cleared areas outside the RoW with erosion control plant. • IFF shall limit de-stumping of trees and riparian plants.	Low
	Deterioration of surface water quality (turbidity) from surface run – off on bare soil at the river	Medium	• IFF shall prevent erosion and water run-off to rivers during construction to minimize turbidity impact.	Low
	Changes in soil characteristics from movement of heavy duty machinery	Medium	• IFF shall ensure appropriate route selection. • IFF shall use only premobbed equipment and equipment in good state of repair • IFF shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use. • IFF shall ensure almost all operations be carried out during the day (Night work shall be controlled and authorized by senior management).	Low
	Increase in noise from operation of machines & equipment	Medium	• IFF shall use only premobbed equipment and equipment in good state of repair • IFF shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use. • IFF shall ensure almost all operations be carried out during the day (Night work shall be controlled and authorized by senior management).	Low
Site Preparation	Wildlife migration due to disturbance	Medium	• IFF shall limit clearing activities to pipeline corridor only • IFF shall enforce no hunting during construction phase of the project arising from their Contractor personnel	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	Loss of Vegetation including economic spp.	Medium	• IFF shall limit the land clearing to strictly pipeline RoW	Low
	Third party agitation	High	• IFF shall facilitate management of public expectations by engaging community's leadership, Rep of Project Affected Persons (PAP), NGOs and CBOs; • IFF shall ensure regular/periodic dialogue sessions with Rep of Project Affected Persons (PAP) • IFF shall ensure adoption of appropriate community entry strategies; including signing of MOUs • IFF shall ensure commitment to transparent adherence to MoU terms and obligations to all parties • IFF shall effectively manage Company-Media relations	Low
	Influx of laborers and followers (dependents, bounty seekers, CSWs, etc.)	Medium	• IFF shall ensure intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol and sexual promiscuity in the community and among workers. • IFF shall ensure that contractor enforces the alcohol and drug policy for staff. • IFF shall ensure regular medical check-up are conducted for project work force	Low
	Increased risk of malaria, dysentery, and other diseases	Medium	• IFF will promote the use mosquito nets within the communities and where necessary support with the provision of mosquito nets • Carry out Health Education for the host communities and the IFF workers during project. • IFF shall provide site clinic for the workers. • IFF shall provide potable water for the site workers and at the accommodation for key personnel within the communities • IFF shall discourage indiscriminate open defecation in to the area by providing clean and hygienic mobile toilet to its worker on site.	Low
Site Preparation	Increased pressure on existing social amenities/ infrastructure.	Medium	• IFF shall use more local labour as much as possible in order to minimize additional demand for infrastructure due to influx workers	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• IFF shall reduce impact on local infrastructure by accommodating construction workers in camp.	
	Loss of biodiversity due to activities of laborers e.g. hunting and fishing.	Medium	• IFF shall limit clearing activities as necessary. • IFF shall avoid game reserves and hunting ban during construction phase of project	Low
	Increase in social vices	High	• IFF shall ensure that contractor enforces the alcohol and drug policy for staff. • IFF shall ensure regular medical check-up are conducted for project work force • IFF shall carryout awareness program through its contractor on sex education.	Medium
	Potential for socio-cultural conflict	Medium	• IFF shall ensure adoption of appropriate community entry strategies; • IFF shall ensure commitment to transparent adherence to existing MoU programmes and obligations	Low
	Hydrocarbon contamination of environment from accidental spills e.g. faulty processes of refueling and lubricants use	Medium	• IFF shall ensure proper mechanism is in place to reduce spillage (Drip pans during loading, unloading and fueling of plants, equipment and vehicles). • IFF shall provide spill response kits on site to manage routine and accidental spills	Low
	Loss of habitat to soil fauna/loss of soil arability from soil inversion	Medium	• IFF shall ensure the approved width of the ROW is not exceeded. Excavated soil are used for backfilling	Low
	Potential for disruption of ecological balance during site preparation for HDD at wetlands	Medium	• IFF shall manage HDD work area to a minimum to minimize impact of HDD operations on riparian habitat	Low
	Workplace accidents leading to injury	High	• IFF shall ensure tool box talks are given to workers on daily basis • IFF shall make provision and enforce the use of PPEs	Low
	Potential for socio-cultural conflict	High	• IFF shall ensure continuous engagement of relevant stakeholders especially project affect persons and other community leadership all through project implementation • IFF shall ensure strict adherence to implementation of MoU signed	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• IFF shall ensure job placement preference are given to the project host communities first.	
	Potential for kidnapping of workers	High	• IFF shall ensure strict adherence to implementation of signed MoU. • IFF shall ensure that project host communities are well carried along during project implementation • IFF shall ensure workers are well secured with both national and local security	Low
	Waste generation	Medium	• IFF shall ensure that waste generated are segregated, recycle and reused especially offcut materials • IFF shall ensure that excavated soils are used for backfilling of the trenches. • IFF shall ensure that waste oil from equipment maintenance is lifted by an accredited waste management firms.	Low
	Visual impacts of heavy equipment to farmers	Medium	• IFF shall ensure that some community reps are part of the project planning • IFF shall ensure scheduling of heavy equipment off peak hour eg during less farming activities/hour • IFF shall ensure the use of existing roads • IFF shall ensure that the host communities are well educated and informed about any scheduling of heavy equipment in their area.	Low
Construction				
Construction	Potential for changes in physico-chemical properties of surface water bodies due to inflow of runoffs bearing excavated soil	Medium	• IFF shall prevent erosion and water run-off to nearby waterbody during construction • IFF shall provide spill response kits to manage any form of spillage that will occur. • IFF shall ensure that both machine/equipment are regularly checked for possible leakage. • IFF shall ensure good housekeeping of construction site • IFF shall ensure that the fuel/oil transfer are down in a dedicated area provided drip pans	Low
	Increase in SPM during dry season trenching activities	Medium	• IFF shall ensure wetting of the dusty area, where applicable, particularly the areas close to communities.	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	Soil compaction and Loss of habitat to soil fauna and flora due to movements of heavy-duty equipment	Medium	• IFF shall limit vehicular movement only on the RoW • Transport route shall be limited to main access route acquired, no unapproved access route shall be used for construction and transportation of equipment and materials.	Low
	Soil strata inversion during back filling with risk to erosion	Medium	• IFF shall limit its activity to the existing RoW • IFF shall restrict the width of the RoW to approved minimum • IFF shall ensure backfilling to proper specification using excavated soil • Construction period will kept on schedule to prevent soil erosion not to prolonged keeping the excavated soil exposed to agent of erosion and weather.	Low
Construction	Increased risk of road traffic accident	Medium	• IFF shall ensure the creation of awareness amongst local communities on the potential of increased traffic on land due to HDD and the need for extra precautions through public enlightenment • IFF shall ensure compliance with IFF journey management policy for land transport • IFF shall ensure Driver Education Programme (DEP) for all IFF/contractor drivers • IFF shall ensure that all vehicles are premobbed and premobilization/compliance certificate issued. • IFF shall ensure the provision of First Aid facilities	Low
	Increase in noise from operation of machines & equipment during trenching, cutting, welding, pipe laying etc.	Medium	• IFF shall ensure regular maintenance of vehicles and equipment • IFF shall ensure vehicles and equipment are turned off when not in use • IFF shall ensure combustion engines are fitted with effective silencers. • IFF shall ensure machinery covers and panels are closed and well fitted at all times • IFF shall ensure equipment with low noise level are used • Night construction work should be prohibited except authorized by senior management • IFF shall provide appropriate PPEs (Ear Protection)	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	Air pollution from exhaust fumes/greenhouse gases	Medium	• IFF shall use only Pre-mobbed equipment. • IFF shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use	Low
	Obstruction of access routes to villages and farmlands	Medium	• IFF shall provide alternative access route to farmlands and villages (where affected) for the community. • Trenching and pipe laying across the access routes (to villages and farmlands) shall be carried out within shortest possible time	Low
Construction	Third party agitation	High	• IFF shall facilitate management of public expectations by engaging with Communities Leadership, NGOs and CBOs; • IFF shall ensure regular/periodic dialogue sessions with active Communities, NGOs and CBOs; • IFF shall ensure adoption of appropriate community entry strategies; • IFF shall ensure commitment to transparent adherence to MoU programmes and projects. • EFCL shall ensure managed company-media relations	Medium
	Influx of laborers and followers (defendants, bounty seekers, CSWs, etc.)	Medium	• IFF shall liaise with the appropriate health agencies to provide health awareness campaign and seminars for the community on STI (including HIV/AIDS) abuse of drugs, alcohol and other relevant health subject matters. • IFF shall sustain and support skill acquisition and empowerment schemes for communities Youths already ongoing.	Low
	Increased risk of prevalence of HIV	Medium	• IFF shall liaise with the appropriate health agencies to provide health awareness campaign and seminars for the community on STIs. • IFF shall engage health personnel on educating workers on HIV/AIDS	Low
	Increased risk of malaria, dysentery, and other diseases	Medium	• IFF shall avoid creating breeding ground for mosquitoes and other diseases carrying vectors by applying stringent occupational hygiene standards throughout the project life cycle. • IFF will carry out campaign/ support campaign on use of Mosquito nets within the project area.	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• IFF shall carryout periodic health education for the host communities and the contractor workforce workers • IFF shall provide site clinic for the construction workers • IFF shall provide potable water for the site workers and at the accommodation • IFF shall discourage indiscriminate defecation in the area by providing functional mobile toilet to its worker on site	
Construction	Increased pressure on existing social amenities/ infrastructure.	Medium	• IFF shall make adequate accommodation agreement prior to mobilization of workforce to reduce pressure on local housing.	Low
	Loss of biodiversity due to activities of laborers e.g. hunting and fishing.	Medium	• IFF shall discourage hunting and fishing by its worker. Institute a no hunting ban to her employees and those of contractors.	Low
	Increase in social vices	High	• IFF shall ensure awareness campaign and health education is undertaken	Medium
	Potential for socio-cultural conflict	Medium	• IFF shall ensure adoption of appropriate community entry strategies; • IFF shall manage Socio – cultural conflict in line with its SOP on Cultural Heritage Management Procedure	Low
	Hydrocarbon contamination of environment from accidental spills e.g. faulty processes of refueling and lubricant usage	Medium	• All maintenance and repair of equipment and vehicle should be carried out in a secure location with clean-up materials such as absorbents pads, container and drip pans. • Fueling operations shall be by use of standard diesel dispensing trucks supported with drip pans • All maintenance work shall be designated at maintenance area with provision to contain lubricate leaks • Maintenance at non-designate maintenance sites shall ensure appropriate spill control measures are place before commencement	Low
Construction	Loss of aesthetics due to waste dumping	Low	• IFF shall ensure proper waste management by providing appropriate waste containers • IFF shall educate worker on the importance of waste management practice • Evacuated waste shall disposed only at a government approved waste dump sites.	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	Increased exposure to radiation during welding / weld test	Medium	• IFF shall ensure that staff undergo routine medical check-ups for radiation exposure. • IFF shall ensure radiation monitors are provided to monitor radiation levels at site. • IFF shall ensure warning signs are provided during radiation emitting activities. • IFF shall provide appropriate PPEs for her workers • IFF shall ensure that radiation emitting activities are carried out in accordance with standard construction specifications	Low
	Potential for disruption of soil structure due to deposition of soil/clay from inadvertent returns; on river bank at crossing	Medium	• IFF shall put in place measures to contain inadvertent drilling mud deposition to the soil (environment) during HDD operation (Mud basin/pan) at various road crossing	Low
	Potential for vegetation change due to primary succession at deposition sites (on banks and riparian habitat)	Medium	• IFF shall ensure trenching and HDD activities are restricted to RoW	Low
	Improper waste management leading to: loss of aesthetics, habitat disruption and death of aquatic/land organisms	Medium	• IFF shall develop and implement waste management plans for all wastes generated in accordance with regulatory requirements and standard practice. • Drilling waste from HDD operation at road crossing shall be managed in line with the plan	Low
Construction	Accidental release of drilling mud (bentonite) in to wetlands, land	Medium	• IFF shall: • Use HDD Rig with good solid and mud control equipment so as to assist in preventing release of mud. • Mud containment equipment to prevent accidental mud discharge to environment	Low
	Potential for pollution of surface water which is a source of water for domestic use	Medium	• IFF shall ensure the rapid completion of the backfilling to minimize run-off water into nearby river/stream • Spill prevention measures shall be implemented and monitored to ensure surface and ground water are not contaminated with mud and hydrocarbons	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	Air pollution from exhaust/greenhouse gases	Medium	• IFF shall: • Use only pre-mobbed and regularly maintained equipment. • Ensure that appropriate PPE are provided and used. • Install mufflers on machineries and use low noise equipment. • Ensure that staff use hearing protection. • Adhere strictly to noise regulations including noise mapping and restriction of entry into high noise zones. • Ensure that all mobile and stationary internal combustion engines are properly maintained. • Inform communities in advance of likely increase in noise level during high noise construction activities • Ensure that water is sprayed regularly to reduce dust levels during dry season.	Low
	Possible erosion, deterioration of physico-chemical properties of surface water, and increased sediment deposition upstream, from poor runoff control at construction site	Medium	• IFF shall ensure that trenches are backfilled with spoils as soon as pipes are laid • IFF shall ensure timely revegetation of exposed areas • Erosion /water run-off measures are put in place to prevent/minimize run-off water into nearby rivers at HDD locations	Low
	Potential for introduction of foreign or undesirable organism (including disease, parasites, or pests) from contaminated equipment; detrimental to aquatic life	Medium	• IFF shall ensure proper washing, and cleaning of all the drilling equipment prior to mobilization to site • Rig and housing units shall thoroughly disinfested prior to site mobilization	Low
	Risk of physical damage (dents, coating damage, or rupture) during excavation, trenching or drilling leading to spills, gas leaks, fire and/or explosion.	Medium	• Conduct comprehensive pre-construction utility and pipeline surveys using existing drawings, Geographic Information System (GIS) data, and underground utility detection methods to accurately locate all existing pipelines and buried services.	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• Maintain continuous liaison with pipeline owners/operators and ensure their representatives are present during work in close proximity to existing pipelines where required. • Maintain the prescribed minimum separation distances between the proposed pipeline and existing infrastructure in accordance with applicable engineering standards. • Use experienced and competent operators for excavation equipment and continuously supervise excavation activities. • Ensure pipeline coatings damaged during construction are repaired and inspected before backfilling. • Maintain emergency response equipment, firefighting facilities, spill response materials, and first-aid kits at all work sites • Immediately stop work and notify the pipeline operator if any damage, coating defect, or suspected leak is identified.	
Pre-Commissioning				
Pre-Commissioning	Environmental contamination and loss of aesthetic value due to fuel and lubricant spillage or valve and seal failure	Medium	• IFF shall put in /place Oil Spill Contingency plan. • IFF shall conduct daily check on fueling and lubricant system • IFF shall conduct regular environmental awareness education to her construction contractor workforce • IFF shall carry out daily check on valve and seal	Low
	Environmental contamination (water and land) from disposal of waste e.g. hydro-test water, and condensate	Medium	• IFF shall ensure the effluent from hydrotest meet the NMDPRA specifications before discharged into land or river/stream • IFF shall put in place spill response plan to control any pollution that may result from the condensate / lubricant spill	Low
	Odor and aesthetic devaluation due to waste dumping	Low	• IFF shall ensure proper waste management by providing appropriate waste containers • IFF shall educate worker on the importance of waste management practice	Low
	Air pollution from exhaust gases	Medium	• IFF shall: • Use only pre-mobbed and regularly maintained equipment	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• Ensure that appropriate PPE are provided and used. • Install mufflers on machineries and use low noise equipment. • Ensure that staff use hearing protection. • Adhere strictly to noise regulations including noise mapping and restriction of entry into high noise zones. • Ensure that all mobile and stationary internal combustion engines are properly maintained. • Inform communities in advance of likely increase in noise level during high noise construction activities	
	Potential for surface water degradation preventing domestic use	Medium	• IFF shall ensure the rapid completion of the backfilling to minimize run-off water into river/stream • Spill prevention measures shall be implemented and monitored to ensure surface and ground water are not contaminated with mud from HDD activities and hydrocarbons	Low
	Exposure to radioactive materials during weld testing, NDT	Medium	• IFF shall ensure that staff undergo routine medical check-ups for radiation exposure. • IFF shall ensure radiation monitors are provided to monitor radiation levels at site. • IFF shall ensure warning signs are provided during radiation emitting activities. • IFF shall provide appropriate PPEs for her workers • IFF shall ensure that radiation emitting activities are carried out in accordance with standard construction specifications	Low
Operational Phase				
Operational Phase	Changes in air quality may occur from release of gaseous/misty by products during pigging	Medium	• Pigging operations shall be sectional and each section of the pipeline will be segmented and pigged separately to minimize gaseous and hydrocarbon mist generated from the pigging operation	Low
	Condensate may contaminate soil/water bodies due to spillage or valve and seal failure	Medium	• Spill containment equipment will be mobilized and used during pigging to prevent condensate spill to the environment • IFF shall ensure safe Handling of Chemicals Cards (SHOC)/Material Safety Data Sheet (MSDS) area available	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			on site to provide information on safe handling of chemicals	
	Injuries and death from gas leaks and explosion	High	• IFF shall ensure that: • Pipeline Maintenance Plan shall be developed and implemented • Routine Operational and Integrity Pigging shall be carried out on the pipeline based on plan • IFF shall remove trees and shrubs including local security surveillance of the ROW to prevent 3rd party interference or breach of the pipeline • Periodically inspect pipeline for the gas leak • Regular patrol to prevent encroachment of ROW • IFF shall ensure emergency response procedures are in place. • Periodic HSE education will be carried out for communities on gas safety and also educate them on IFF pipeline emergency procedures. IFF shall carry out (or update the engineering-stage) Quantitative Risk Assessment (QRA) of the pipeline, covering leak and full-bore rupture scenarios, jet-fire, flash-fire and vapour-cloud consequence modelling, and individual and societal risk along the RoW; its results shall define location class, RoW setbacks, block-valve spacing and ESD logic, and the gas-leak/emergency contingency plan, including community emergency arrangements.	Medium (ALARP)
	Corrosion and pipeline rupture	Medium	• Pipeline Maintenance Plan shall be developed and implemented for safe operation of the pipeline • Routine Operational and Integrity Pigging shall be carried out on the pipeline based on plan • IFF shall conduct periodic check on the pipeline for possible corroded part of the pipeline • Regular integrity checks on cathodic protection mechanism of pipeline shall be carried out	Low
	Environmental Pollution as a result of pipeline interference by third parties (Vandalization	Medium	• IFF shall facilitate management of public expectations by engaging communities, NGOs and CBOs; • IFF shall ensure regular/periodic dialogue sessions with active communities, NGOs and CBOs;	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• IFF shall ensure adoption of appropriate community entry strategies; • IFF shall ensure commitment to transparent adherence to MoU programmes and projects. • IFF shall put in place gas shut down mechanisms at designated manifolds and reversal venting process by flaring at the gas plant • Regular patrol to prevent encroachment of ROW • Emergency response procedures are in place. • Periodic HSE education will be carried out for communities on gas safety and also educate them on IFF pipeline emergency procedures.	
	Loss of biodiversity due to activities of laborers e.g. hunting.	Medium	• IFF shall limit clearing activities as necessary • Develop a Biodiversity Action Plan (BAP).	Low
	Odor and aesthetic devaluation due to waste dumping	Medium	• IFF shall put in place good environmental management plan and strictly implement project management plan	Low
Operational Phase	Destruction of assets and property from gas leak/ fire.	High	• IFF shall implement gas leak/contingency plan • IFF shall immediately isolate the source of leak IFF shall carry out (or update the engineering-stage) Quantitative Risk Assessment (QRA) of the pipeline, covering leak and full-bore rupture scenarios, jet-fire, flash-fire and vapour-cloud consequence modelling, and individual and societal risk along the RoW; its results shall define location class, RoW setbacks, block-valve spacing and ESD logic, and the gas-leak/emergency contingency plan, including community emergency arrangements. IFF shall compensate promptly for any third-party loss or damage to property, crops or assets arising from a gas release or fire.	Medium (ALARP)
	Destruction of forest resources from gas leak/ fire	Low	• IFF shall implement gas leak/contingency plan • IFF shall immediately isolate the source of leak • IFF shall compensate for the loss in property • IFF shall put in place regular pipeline monitoring and corrosion test in place	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• IFF shall regularly educate the community people on safety issue in any fire and gas leak incident	
	Increased extreme heat	Medium	• IFF shall ensure that their operation have little or no impact on climate change	Low
	Increase water stress and drought	Medium	• IFF shall ensure that their operation have little or no impact on climate change	Low
	Increased in both flooding and wildfire events	Medium	• IFF shall ensure that their operation have little or no impact on climate change	Low
	Fugitive methane emissions from valves, flanges and instrument connections	Medium	• IFF shall conduct leak detection and repair, maintain equipment integrity and minimise unnecessary venting.	Low
	Accidental gas releases arising from equipment failure	Medium	• IECFL shall provide suitable isolation and emergency shutdown systems, install gas detection equipment at strategic locations where required, and implement emergency response procedures.	Low
	Noise from pressure regulation and venting activities	Medium	• IFF shall install and maintain appropriate noise-control devices, silencers and acoustic enclosures on pressure regulation and venting equipment, where technically feasible. • IFF shall maintain equipment and implement noise-control measures where necessary. • IFF shall maintain pressure regulators, valves and associated equipment regularly to prevent excessive noise caused by wear, vibration or malfunction. • IFF shall minimise routine venting and depressurization activities through effective process control and operational planning.	Low
	Potential safety hazards associated with high-pressure gas operations	Medium	• IFF shall install and routinely test pressure relief valves, emergency shutdown systems and automatic isolation valves to prevent overpressure and minimise uncontrolled gas releases. • IFF shall implement a comprehensive pipeline integrity management programme, including periodic inspection, corrosion monitoring, leak detection and preventive maintenance.	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• IFF shall provide adequate ventilation in enclosed areas to prevent gas accumulation and oxygen-deficient conditions.	
	Potential Encroachment on the Pipeline Right-of-Way (RoW)	Medium	• IFF shall clearly demarcate the pipeline Right-of-Way (RoW) using appropriate boundary markers, warning signs and pipeline identification posts. • IFF shall conduct routine RoW patrols and inspections to identify and prevent unauthorised development, excavation, farming activities and other encroachments. • IFF shall establish and enforce a pipeline RoW management plan in accordance with applicable Nigerian regulations and approved project requirements. • IFF shall engage host communities, landowners and local authorities through regular awareness campaigns on pipeline safety, RoW restrictions and the consequences of unauthorised activities. • IFF shall liaise with relevant government agencies and community leadership to prevent incompatible land uses and developments within the designated RoW. • IFF shall prohibit unauthorised excavation, construction, heavy vehicle movement and installation of structures within the protected corridor.	Low
Decommissioning/Abandonment				
	Increased risk of road traffic accident due to transportation of removed structures from site	Medium	• IFF shall ensure proper safety procedure and signs are put in place. • IFF shall ensure movement of pipes shall be carried out during shortest possible time • IFF shall ensure strict adherence to road safety and other safety practices by the drivers • Vehicle and boats shall be properly pre-mobbed. • Journey Management Plan will be enforced.	Low
	Excavation to remove pipeline could lead to contamination of soil	Medium	• Use Best Available Technology (BAT) that avoids excavation for removal of pipeline if possible. • IFF shall purge and flush all pipelines prior to decommissioning.	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
Decommissioning/ Abandonment	Third Party agitation	Medium	• IFF shall facilitate management of public expectations by engaging communities, NGOs and CBOs; • IFF shall ensure regular/periodic dialogue sessions with active NGOs and CBOs • IFF shall ensure adoption of appropriate community entry strategies; • IFF shall ensure commitment to transparent adherence to MoU programmes and projects by ensure communities MOU Implementation Committee is constituted • IFF shall ensure managed company-media relations	Low
	Influx of laborers and followers (dependents, bounty seekers, CSWs, etc.)	Medium	• IFF shall liaise with the appropriate health agencies to provide health awareness campaign and seminars for the community on STI (including HIV/AIDS) abuse of drugs, alcohol and other relevant matters. • IFF shall support skill acquisition and empowerment schemes for community.	Low
	Increased risk of prevalence of HIV,	Medium	• IFF shall liaise with the appropriate health agencies to provide health awareness campaign and seminars for the community on STIs. • IFF shall engage health personnel on educating workers on HIV/AIDS	Low
	Potential for increase in incidence of malaria, dysentery, and other diseases	Medium	• IFF shall provide mosquito nets to augment the ones provided by the government • IFF shall carry out Health education for the host communities and the IFF workers • IFF shall provide site clinic for the laborers • IFF shall provide potable water for the site workers and at the accommodation • EFCL shall discourage indiscriminate defecation in to the area by providing mobile toilet to its worker on site	Low
Decommissioning/ Abandonment	Increased pressure on existing social amenities/ infrastructure.	Medium	• IFF shall make adequate accommodation camp with support infrastructure to accommodate key personnel prior to mobilization of workforce to reduce pressure on local housing and other community infrastructure.	Low
	Increase in social vices	Medium	• IFF shall ensure awareness campaign and health education is undertaken	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• IFF shall ensure adoption of appropriate community entry strategies; • IFF shall manage Socio – cultural conflict in line its SOP on Cultural Heritage Management Procedure	
	Loss of biodiversity due to activities of laborers e.g. hunting	Medium	• IFF shall limit clearing activities as necessary • Develop a Biodiversity Action Plan (BAP).	Low
	Loss of employment due to lay off of laborers	Medium	• IFF shall put in place necessary and appropriate compensation for its staff and contract staff • Counseling of workers on how to save and invest earnings from the project.	Low
	Potential for erosion due to improper backfilling process	Medium	• IFF shall ensure proper backfilling of the excavated site being put in place • Re-vegetation of ROW and other cleared area.	Low
	Loss of aesthetics due to waste dumping	Medium	• IFF shall put in place good environmental management plan • Waste Management peculiar to the Decommissioning phase activities shall be developed and strictly implemented after NMDPRA approval.	Low
	Risk of contamination of soil and wetlands	Medium	• IFF shall ensure the rapid completion of the excavation and backfilling to minimize runoff to the nearby waterbody	Low
	Risk of physical damage (dents, coating damage, or rupture) during excavation, trenching or drilling leading to spills, gas leaks, fire and/or explosion.	Medium	• Conduct comprehensive pre-construction utility and pipeline surveys using existing drawings, Geographic Information System (GIS) data, and underground utility detection methods to accurately locate all existing pipelines and buried services. • Maintain continuous liaison with pipeline owners/operators and ensure their representatives are present during work in close proximity to existing pipelines where required. • Maintain the prescribed minimum separation distances between the proposed pipeline and existing infrastructure in accordance with applicable engineering standards. • Use experienced and competent operators for excavation equipment and continuously supervise excavation activities.	Low

Project phase	Potential/Associated Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• Ensure pipeline coatings damaged during construction are repaired and inspected before backfilling. • Maintain emergency response equipment, firefighting facilities, spill response materials, and first-aid kits at all work sites • Immediately stop work and notify the pipeline operator if any damage, coating defect, or suspected leak is identified.	

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

The Environmental and Social Management Plan (ESMP) for proposed 76km Natural Gas Pipeline from AGPC in Ohaji/Egbema LGA, Imo State to Indorama complex in Eleme LGA, Rivers State is presented in this chapter. ESMP provides the assurance that the mitigation measures developed for reducing the associated and potential adverse impacts to as low as reasonably practicable (ALARP) as well as those proposed for enhancing beneficial impacts are implemented and maintained throughout the project life cycle. The ESMP for the proposed Project, which outlines the strategies for managing hazards, associated and potential impacts and their effects on the environment. Furthermore, the objectives of the ESMP includes:

- Ensure progressive reduction of the impacts of the project activities on the biophysical, socioeconomic and health environment with the aim of eliminating them
- Ensure that all mitigation and enhancement measures prescribed during the impact assessment process for eliminating or minimizing the adverse project impacts as well as optimally enhancing the beneficial impacts are fully implemented
- Provide part of the basis and standards needed for overall planning, monitoring, auditing and review of environmental and socio-economic performance throughout the project life cycle.
- Demonstrate that a systematic procedure ensuring that all project activities are executed in compliance with applicable legislations and policies on Health, Safety, Environment, Security and Community Relations have been established for the project
- Show that mitigation measures for all impacts and effects have been established and shall be maintained throughout the project's life cycle, so that impact risk levels will remain ALARP; and
- Demonstrate that emergency response measures will be in place. This will ensure that adequate responses in case of emergency have been established for the project.

These objectives shall be achieved by:

- Ensuring compliance with all stipulated legislation on protection of health, safety and environment policies
- Integrating environmental issues fully into the project development and operational philosophies
- Promoting environmental management awareness among workers

- Rationalizing and streamlining existing environmental activities to add value to efficiency and effectiveness; and
- Ensuring that only environmentally sound procedures should be employed during the project.

The ESMP has been developed to meet international and national standards on environmental and social (E&S) performance and covers the project implementation phases (i.e., Pre-construction, construction and operation phases) of the project. Furthermore, it details the mitigation and enhancement measures that IFF and its contractors will be committed to implement throughout project life cycle as well as desired outcomes, performance indicators, monitoring, timing for actions and responsibilities.

7.2 Institutional Arrangement for ESMP Implementation

The successful implementation of the monitoring program will depend on the commitment and capacity of IFF and its contractors as well as other third parties/institutions of government to implement the program effectively. The specific roles and responsibilities of those that will be involved in the implementation and monitoring of this ESMP are highlighted below:

7.2.1 Federal Ministry of Environment

The FMEnv will play the role of lead environmental regulator, overseeing compliance requirements, granting consent and monitoring or providing supervisory oversight for the project. Specifically, FMEnv will receive comments (require revisions where necessary), provide ESIA approval and needed clearance for the ESMP and other environmental clearance in collaboration with their state counterpart. FMEnv will ensure that corrective actions are taken for significant environmental and social impacts. Undertake periodic site visits to inspect and verify the nature and extent of impacts and the success or lack of the mitigation measures.

7.2.2 Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)

The proposed project falls with the midstream/downstream sector of the oil and gas sector of the Nation's economy, thus NMDPRA will oversee the proposed project implementation in line with PIA Act 2021. The authority has approvals like License to Establish and License to Construct before the project implementation commence as well as Project Concept Screening Report (PCSR) and Preliminary Environmental Risk Assessment (PERA).

7.2.3 Rivers State Ministry of Environment (RSMEnv) and Imo State Environment

The RSMEnv and Imo state Environment Ministry will be the environmental compliance overseer at the state level. In addition to other statutory functions, The Ministry shall:

- Ensure that all project activities comply with the State environmental laws and requirements.
- Perform regular compliance monitoring and periodic inspection of all the stages of the project

7.2.4 Proponent (IFF)

IFF shall be responsible for the implementation of the ESMP and ensuring that the environmental and social requirements are satisfied. IFF will manage all contractors in an effective manner by:

- Integrating all environmental and social management requirements in tender documents and contracts.
- Ascertaining that all contractors engaged are legitimate and reliable enterprises and have required knowledge and skills to perform their project tasks in accordance with their contractual commitments.
- Contractually requiring contractors to apply the relevant aspects of the ESMP and the relevant management tools, and appropriate non-compliance remedies.
- Monitoring of contractor compliance with their contractual commitments.
- Requiring contractors to have equivalent arrangements with their subcontractors.

7.2.5 Construction Contractor

The contractors shall provide adequate human and financial resources on an ongoing basis to ensure effective implementation of the ESMP and assure continuous improvement of environmental and social performance.

- Ensure that all construction personnel and subcontractors are made aware of ESMP and the required measures for environmental and social compliance and performance.
- Prepare EHS manual and abide by labour laws as set out in the agreement.
- Provide adequate basic amenities and PPEs to workers and ensure that the PPEs are worn by workers during works.
- Prepare and maintain records and all required reporting data as stipulated by the ESMP, for submission to IFF.

7.2.6 LGAs/ Host Communities

Provision of oversight function across project within its jurisdiction for ESMP compliance.

Monitoring of activities related to public health, sanitation, waste management amongst others, others includes:

- Identify issues that could derail the project and support project impacts and mitigation measures, Awareness campaigns.
- Promote environmental awareness.

- Review environmental and social performance report made available by IFF.
- Provide comments, advice and/or complaints on issues of nonconformity.
- Attend public meetings organized by the project developer to disseminate information and receive feedback.

7.2.7 NGOs/CSOs

NGOs/CBOs will Assisting in their respective ways to ensure effective response actions, conducting scientific research alongside government groups to evolve and devise sustainable environmental strategies and techniques.

7.3 Use and Maintenance of the ESMP

The ESMP shall remain a dynamic working tool and will be owned by the proposed gas pipeline project. IFF supervisor is, however, the custodian of the document and may exercise auditing role to verify compliance by the project. The ESMP shall be updated and revised periodically throughout the project's life span to incorporate improved technologies, better environmental regulations, management systems, guidelines and policies. Constructive suggestions by users (contractors, management, line and operating personnel) shall be assessed by the Environmental & Social Management Team and integrated into the ESMP.

7.4 Regulatory Compliance

The ESMP implementation shall be closely monitored by FMEnv, and this shall involve a two-way information flow between IFF and the regulatory body. The FMEnv has the responsibility of enforcing national environmental laws including international environmental laws which Nigeria has subscribed to:

- The FMEnv will serve as a regulatory oversight to the ESMP implementation
- The FMEnv and NMDPRA shall ensure that IFF periodically make available documentation in the form of monthly/quarterly reports or as may be required showing evidence of carrying out monitoring requirements etc. Environment-related regulations as they apply to the Project has been documented and described in this ESIA. IFF management shall ensure compliance with these regulations throughout the project's lifecycle.

7.5 Environmental and Social Management System

The vehicle for the integrated management and implementation of these Management Plans is an Environmental and Social Management System (ESMS). Therefore, the ESMS is a key component of the ESIA process.

An ESMS is also a requirement of the IFCs Performance Standards (PS 1: Assessment and Management of Environmental and Social Risks and Impacts). The objective of PS 1 is to:

"Identify and evaluate environmental and social risks and impacts of the Project, adopting a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimise, and, where residual impacts remain, compensate/offset for risks and impacts to workers, affected communities, and the environment, ..." (Undertaken as part of the ESIA process) *.... "And to promote improved environmental and social performance of clients through the effective use of management systems...."*

The main element of any given ESMS is provided in Figure 7.1 and comprises the following four phases:

- **Planning** – establishing the *objectives* and processes necessary to deliver results in accordance with the Project Guideline for Environmental and Social Management.
- **Doing** – Implementing the processes through defining *mitigation* measures and assigning *responsibilities* for undertaking or implementing such mitigation measures, typically through suites of Management Plans.
- **Checking** – *Monitoring* and *measuring* these processes against the policy, objectives and targets, legal and other requirements (such as those of the IFC), and *reporting* of the results.
- **Acting** – Taking actions to continually improve performance of the ESMS through the *training* of personnel and *auditing* of results.

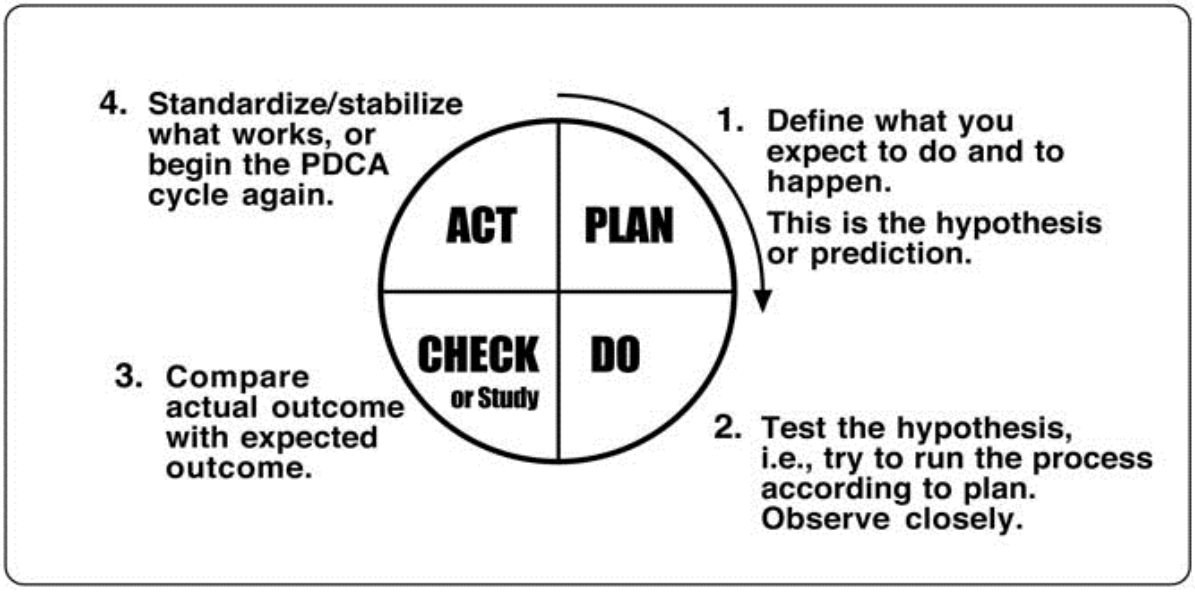


Figure 7.1: The Main Elements of an ESMS

The ESIA process has essentially undertaken most of the initial ***planning*** aspects required by an ESMS by identifying environmental and social impacts and formulating Management Plans.

Further elements of an ESMS related to its implementation (***doing***, ***checking*** and ***acting)***, are described in 7.3 under the following sections:

- **Planning / Doing:** Section 7.2 provides the institutional framework, organisational frameworks and specific roles and responsibilities for implementing the ESMS.
- **Planning / Doing:** Section 7.7 outlines plan for on-going stakeholder engagement including the management of community grievances and concerns.
- **Checking / Acting:** Section 7.6 introduces key components for the implementation of the ESMS including training, monitoring, audits and inspections, and reporting.
- **Acting:** Section 7.7 introduces key components for the implementation of the ESMS; and also explains the system for the management of change during the implementation of the proposed Project.

As such, an ESMS is implemented to:

- Assist management in establishing priorities for environmental and social impacts
- Provide a mechanism for ensuring that measures identified in the ESIA and listed in each Management Plan, are addressed and implemented
- Track changes in Nigerian legislation and/or Lender standards so that they can be addressed in a timely manner
- Provide a framework for compliance auditing and inspection programmes
- Ensure environmental and social (including Project induced health issues) continue to be integrated into business decisions
- Provide a framework for mitigating impacts that may be unforeseen or unidentified until construction or operation is underway
- Encourage and achieve appropriate environmental and social performance and awareness from all employees and contractors; and
- Provide assurance to regulators, stakeholders, and lenders that their requirements with respect to environmental and social performance are being managed.

At this stage, IFF have a number of environmental, social, occupational health and safety and human resource plans, policies and procedures. These plan, policies and procedures relate to all IFF's operations in Port Harcourt. Over the life of all of IFF's operations, the vehicle by which the commitments set out in this ESMP, and other plans, policies and procedures should be developed into specific actions which can be implemented through an overarching ESMS.

Aligned with IFC PS1, as the Project owner IFF, is responsible for the development of an ESMS under which all IFF operations (including the proposed Pipeline Project) will be implemented and shall include:

- **Policy Statement** – which described the environmental and social objectives, which will guide IFF in achieving environmental and social performance.
- **Process for Risk Identification** – which, in addition to the ESIA, shall include a defined process for evaluating and managing environmental and social risks through life of IFF operations.
- **Management Programs** – for environmental and social performance execution which are, in part, detailed for the Pipeline Project below.
- **Organisation Capacity/Competency** – demonstrated through clear division of responsibility and vetting of individual roles holding responsibility and accountability for environmental and social performance execution.
- **Emergency Preparedness and Response** – a plan which addresses how potential risk impacts resulting in emergency response will be managed for life of Project.
- **Stakeholder Engagement Program** – a program which includes stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and ongoing reporting to Affected Communities through life of IFF operations.
- **Monitoring and Review System** – which will detail the process by which IFF will monitor and measure the effectiveness of the management program, including compliance with any regulatory requirements, legal requirements and/or contractual obligations

7.6 Key Components for Implementation of the ESMP

7.6.1 Training

Training is essential for ensuring that the ESMP provisions are implemented efficiently and effectively. IFF shall therefore ensure that all persons that have roles to play in the implementation of the ESMP are competent with appropriate education, training or experience. Training is one of the most important mechanisms for the enhancement of the Project's environmental and social performance will be the continued implementation of a training programme for all Project personnel including all subcontractors and third parties.

The key components of training requirements are to ensure that all Project personnel, including all Contractors and Subcontractors and third parties understand the:

- Environmental and Social policies of IFF
- Environmental and social requirements of the Project and how these will be implemented and monitored on site
- Contents and relevant requirements of Project actions contained within the applicable Management Plans
- Environmental and social sensitivities of the Project Footprint and surrounds

- Procedures to be followed in the event of non-compliance with the environmental and social requirements
- Process for addressing unforeseen environmental and social incidents; and
- Responsibilities with respect to environmental and social issues applicable to their roles.

Training should include:

- Induction training for all staff including modules on health and safety, environmental awareness, worker code of conduct, stakeholder engagement, grievance mechanisms and cultural heritage awareness
- Training on the EHS legal requirements and EHS compliance commitments of the Project. It is critical that all staff on the Project understand the laws and regulations and rules the Project has committed to, and that staff understand the consequences of breaking these rules
- Toolbox training for specific topics and tasks; and
- Training for individuals involved in tasks with specific responsibilities.

Refresher training programmes will also need to be implemented to ensure continual improvement in environmental awareness for all Project personnel.

Training should be provided at each stage of the Project, from initial establishment of logistical facilities through to construction and operation. The training function will assist managers in developing and coordinating training programmes as required. Training records should be maintained by the Project and an assessment of the effectiveness of the training.

7.6.2 Emergency Response and Incident Reporting

An Emergency Response Plan (ERP) must be in place for the Project, covering all incidents such as, but not limited to:

- Workplace accidents
- Spillage
- Traffic accidents
- Flooding
- Hazardous materials release, spills and containment; and
- Community and/or Employee uprisings or strikes etc.

The Project should conduct drills on a periodic basis to test the planned response actions.

An incident is any occurrence that has caused, or has the potential to cause, a negative impact on people, the environment, property, or production (or a combination thereof). It also includes any significant deviation from standard operating procedures. The reporting and investigation of all potential and actual incidents that could have a detrimental impact

on human health, the natural environment or property is required so that remedial and preventive steps can be taken to reduce the potential, or actual impacts, as a result of all such incidents.

All incidents will be investigated for identification of causes and preventative actions. The actions resulting from any formal or informal investigations will be used to update the ERP.

Quantitative Risk Assessment (QRA). Before commissioning of Phase 2, IFF shall complete (or update the engineering-stage) QRA of the pipeline and its above-ground installations. The QRA shall model leak and full-bore rupture scenarios (jet fire, flash fire and vapour-cloud explosion), calculate individual and societal risk along the RoW and at the nearest communities, and confirm location class, RoW setbacks, block-valve spacing and ESD logic. Its results shall be used to design the gas-leak contingency and Emergency Response Plan, including community notification and evacuation arrangements, joint drills with the State Fire Service and emergency agencies, and annual review.

7.6.3 Audit and Inspection

An audit programme detailing the aspects to be audited, the area (relevant department or section), and the frequency of audits will be established. The audits will be based on appropriate protocols prepared by the various environmental, social and health and safety functions.

Regular environmental, social and health audits and random spot checks will be undertaken by selected audit team members throughout all phases of the Project. The audit and inspection frequencies will be defined and may be increased or decreased according to the audit findings and degree of confidence in the audit programme and will need to adapt to the Project work scope and locations, and Project activities (some of which will have higher risks). Audits will also assess compliance with agreed objectives and targets as well as the effectiveness of the management plans and their implementation.

Audit findings will be reviewed by the applicable management functions and where corrective actions are deemed necessary; the relevant management plans will be updated.

7.6.4 Reporting

The Project should implement a system of internal reporting that allows for appropriate assessment of the effectiveness of the ESMS. Public reports should also be prepared on defined issues of interest or concern to local communities and /or stakeholders.

During the construction phase, Contractors and associated Subcontractors should take all appropriate measures detailed in the Project ESMS and related plans and procedures to identify and document incidents of environmental, social and health and safety non-

conformance. Non-conformity reports should be produced at an appropriate frequency to ensure non-conformances are corrected. Non-conformity reports should identify the nature of the non-conformities and any subsequent actions taken and review the results or successes of any corrective actions taken. The resultant records should be reviewed in the appropriate management meetings so that required corrective actions can be taken, the results of any such corrective action can be recorded, and to increase management awareness of any opportunities for improvement.

These records are intended to facilitate the purposeful reduction of incidents of non-conformance, leading to a consequential reduction of the root causes of such incidents.

Table 7.4 presents the monitoring plan, which details parameters that should be monitored. Annual reporting should be undertaken to review performance over the previous year and to set targets and objectives for subsequent years.

7.7 Environmental and Social Management Plans

7.7.1 Air Quality Management Plan

OBJECTIVES

The overall objective for air quality management during the construction phases is to manage emissions to the point that impacts are negligible, or at worst, minor. Furthermore, a key objective is to keep local communities and regulators informed of activities (where required) and to respond quickly and effectively to issues and complaints.

Construction and operational activities are to be conducted in a manner that manages impacts on ambient air quality such that emissions are in compliance with the Nigerian legislative and IFC requirements.

PROJECT ACTIVITIES RESULTING IN AIR QUALITY IMPACTS

With regard to the construction phase, there are potential impacts associated with emissions of dust arising from:

- Exposure of soils during site clearance and construction
- Vehicle movement over unpaved surfaces
- Vehicles exhaust emissions
- Exhaust emissions from diesel powered generators used during construction; and
- Transport, handling and stockpiling of friable materials required for construction.

With regard to operations, there are potential impacts associated with emissions of pollutants arising from:

- Pigging activities
- Vehicular emission from surveillance team

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the air quality management system throughout life of the Project. During construction, field implementation of the air quality controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

The primary performance criteria associated with air quality management for the proposed IFF pipeline Project include:

- Implement sufficient controls so as to cause no undue concerns expressed by surrounding stakeholders in terms of atmospheric emissions
- Respond to all atmospheric emission related complaints received from surrounding stakeholders and implement mitigation measures.

With reference to the ESIA, both the relevant Nigerian and IFC standards and guidelines have been used. As such, the Project specific guidelines (which consider Nigerian ambient air quality standards and air quality guidelines from the WHO/IFC and EAE) are presented in Table 7.1.

Table 7.1: Project Specific Guidelines

Pollutant	Averaging Period	Origin of Guideline	Value (µg/m^3)
NO_2	Annual mean	IFC	40
	1 Hour Maximum	IFC	200
PM_{10}	Annual mean	Nigeria	60
	24 Hour	Nigeria	150
$PM_{2.5}$	Annual mean	Nigeria	20
	24 Hour Maximum	Nigeria	40
NH_3	Annual Mean	EAE	180
	1 Hour Maximum	EAE	2,500

MANAGEMENT MEASURES

The construction of the Project is not predicted to result in significant impacts. In terms of construction dust due abundance of vegetation, but with the correct implementation of the appropriate mitigation and management measures, residual impacts are considered to be Negligible. The operation of the proposed Project is not expected to impact on air quality of the project environment. Below is the mitigation measure for all project phases.

- The Project will develop and implement a grievance procedure in the event of any dust complaints being received.
- All potentially impacted receptors will be informed of the nature of works to be carried out, the duration, as well as contact details for a Project representative that be contacted in the event of a complaint. All complaints will be managed as part of the Project's external feedback and grievance mechanism.
- The Project will make efforts to prevent grievances by monitoring conditions and surroundings and taking action to prevent dust emissions from the Project site.
- Impacts associated with construction road traffic during the construction phase will be mitigated by treating (dust suppression) unpaved road, to prevent or minimise dust emission from construction vehicles.
- Where practical and feasible, water will be sprayed on exposed open earthworks.
- Vehicles will be regularly serviced (at least annually or in accordance with manufacturer's recommendations) and maintained in a reasonable working order to reduce emissions. In particular, exhaust emissions should not emit black exhaust fumes or smoke.
- When not in use, vehicles will be switched off, unless impractical for health and safety reasons.

7.7.2 Noise Management Plan

OBJECTIVES

The primary objective for noise management during the construction and operational phase of the Project is to minimise impacts on the closest and/or most affected noise sensitive receptors (NSR's) situated along the pipeline ROW Area are minimised. Furthermore, a key objective is to keep local communities and regulators informed of activities (where required) and to respond quickly and effectively to issues and complaints.

PROJECT ACTIVITIES RESULTING IN NOISE IMPACTS

Predicted noise levels at nearby NSRs due to construction activities are predicted to comply with the relevant criteria at all assessment locations for the daytime. The predicted impact magnitude during the construction phase is anticipated to be Negligible. Predicted noise levels at NSR locations due to the operation of the pipeline are predicted to comply with the relevant criteria for day and night-time period at all locations assessed. The predicted impact magnitude during the operational phase is anticipated to be Negligible.

RESPONSIBILITY

IFF, shall assume responsibility for ensuring the noise management system throughout life of the Project. During construction, field implementation of the noise controls will be

managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

The primary performance criteria associated with noise management for the proposed Project include:

- Implement sufficient controls so as to cause no undue concerns expressed by surrounding stakeholders in terms of noise emissions
- Respond to all noise emission related complaints received from surrounding stakeholders and implement mitigation measures.

With reference to the ESIA, both the relevant Nigerian and IFC standards and guidelines have been used. As such, the Project specific guidelines are presented in Table 7.2.

Table 7.2: Project Noise Criteria for Operational Phase

Receptor	One Hour L_{Aeq} (dB(A))	
	Daytime (06:01 – 22:00)	Night (22:01 – 06:00)
Residential; institutional; educational	55	45

The daytime period will be based on the Nigerian criteria between 06:01 to 22:00 hours and the night-time period will be between 22:01 to 06:00 hours.

MANAGEMENT MEASURES

Given that the predicted impact magnitude for noise impacts during the construction and operational phases is anticipated to be Negligible, no further mitigation or design changes are proposed. The management and mitigation measures required for general construction related activities are listed below:

- The Project will develop and implement a grievance procedure that will address any noise complaints being received.
- All potentially impacted receptors will be informed of the nature of the works to be carried out, the duration, as well as contact details of Project representative that be contacted in the event of a complaint. All complaints will be managed as part of the Projects external feedback and grievance mechanism.
- The Project will make efforts to prevent grievances by monitoring conditions of surroundings and taking action to prevent excessive noise emissions.
- The hours of operation for specific equipment or operations will consider community sensitivities (e.g., trucks or machines operating in or close to community areas).
- Where feasible and reasonable, mobile plant parking near residences and other sensitive land uses will be prohibited.

- Where feasible and reasonable, silencers or acoustic enclosures will be installed on stationary machinery. For example, procure equipment or install suitable mufflers on engine exhausts and compressor components as well as the use of portable sound barriers around equipment like generators.
- Vehicles and equipment will be regularly inspected and maintained to ensure it is in good working order. The condition of mufflers will also be periodically checked.
- Where possible, Project traffic routing through community areas will be avoided and the implementation of speed limits for all construction vehicles shall be ensured
- In addition to the above-mentioned management actions, training in noise control / occupational noise exposure control procedures will be provided to the relevant personnel.

7.7.3 Soil and Erosion Control Management Plan

OBJECTIVES

The primary objectives of the soil management and monitoring plan is to:

- Undertake activities during the pre-construction, construction and operational phases in a manner that minimises impacts on the soil.
- To ensure alignment with the requirements set out in the International Finance Corporation (IFC) Performance Standards and IFC Environmental, Health and Safety Guidelines.

PROJECT ACTIVITIES RESULTING IN SOIL IMPACTS

The following activities could potentially lead to soil related impacts:

- Soil Compaction – due to the increased vehicular movement on site during construction.
- Soil Erosion and Loss of Topsoil – this can occur as a result of site preparation and construction activities, de-vegetation, and the associated increased surface runoff during rainfall events.
- Changes in the Soil-water Balance – this could occur as a result of surface soil compaction and can lead to flooding due to reduced recharge into the soil.
- Soil Contamination – during the construction there is the potential for hydrocarbon leakages from equipment, and/or chemical spills, and the subsequent intrusion of oil and chemical substance into the soil.

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the soil management system throughout life of the Project. During construction, field implementation of the soil and erosion controls will be managed and executed by the Contractor. Other parties, such

as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

As there are no Nigerian specific standards for soil qualities, the screening of the soil qualities during construction and operation should compared to both the baseline soil conditions (pre-construction) as well as against a set of control samples situated in an undisturbed area outside of the proposed Project area footprint, whenever required.

MANAGEMENT MEASURES

The management and mitigation measures listed below will be implemented to reduce soil related impacts from the Project.

- Limit the zone of vehicle and equipment weight impacts (designate an area for parking and stacking of heavy equipment).
- Identify and avoid areas with unstable soil and local factors than can cause soil instability.
- Develop an erosion control and re-vegetation plan to delineate measures to minimize soil loss.
- Contractors must limit vegetation clearing to a minimum and the cleared areas should be re-vegetated with beneficial local species known to mitigate against erosion.
- Implementation of the Spill Prevention, Control and Containment Management Plan

7.7.4 Groundwater Management Plan

OBJECTIVES

The primary objectives of the groundwater management and monitoring plan is to:

- Undertake activities during the pre-construction, construction and operational phases in a manner that minimises impacts on the groundwater.
- To ensure alignment with the requirements set out in the International Finance Corporation (IFC) Performance Standards and IFC Environmental, Health and Safety Guidelines.
- To ensure groundwater qualities remain compliant with the Nigerian Standard for Drinking Water Quality (NSDWQ). This standard sets parameters and maximum allowable limits in drinking water in Nigeria.

PROJECT ACTIVITIES RESULTING IN GROUNDWATER IMPACTS

The following activities could potentially lead to groundwater related impacts:

- Construction Activities Resulting in Spillages of Chemicals and Fuels - during the construction process heavy machinery will be operational within and around the Pipeline ROW. There is a risk of impacts to the groundwater quality through accidental

spills of fuels and oils, as well as other contaminants related to the transportation of equipment and materials during the construction phase. The spill can enter the soil and migrate vertically into the underlying aquifers from where it will migrate away from site.

- Operation of Pipeline – there is a potential to introduce pollutants to the groundwater courses via:
  - Spillage of transported material as a result of sabotage or equipment failure and as such lead to groundwater/surface water contamination.
  - Intentional dumping of solid waste from pigging activities during pipeline maintenance work and surveillance

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the groundwater management system throughout life of the Project. During construction, field implementation of groundwater controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

The performance of groundwater management will be monitored in the following ways:

- Monitoring/recording groundwater quality along the pipeline communities.
- Regular Site observation/inspection along the pipeline RoW as it relates waste management during construction.
- Groundwater sampling procedures and methodology are to be undertaken in line with the Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) issued by DPR, as and when required.

MANAGEMENT MEASURES

The management and mitigation measures listed below will be implemented to reduce groundwater related impacts from the Project.

- The Project will develop and implement a grievance procedure in the event of any water complaints being received.
- All construction areas and associated facilities will be maintained in a good and tidy condition. This will include bunding of vehicle parking areas, oil and silt traps in the workshop area and proper disposal of waste material.
- Chemicals used on site must be stored in a proper area with sealed floor, roofing, and walls where applicable, and access control. Waste chemicals will be disposed by approved waste management facility.
- Implementation of the Spill Prevention, Control and Containment Management Plan

7.7.5 Surface Water Management Plan

OBJECTIVES

The primary objectives of the surface water management are to:

- Ensure that activities during the pre-construction, construction phases are undertaken in a manner that minimises impacts on surface water resources and by association, the riverine sediment.
- To ensure alignment with the requirements set out in the IFC PSs and IFC EHS Guidelines.
- To ensure that the quality stormwater run-off from site to receiving surface waters remain compliant and no oil seen in run-off.
- To ensure that the Project does not contribute to any negative impact on receiving surface water environment, through maintaining the quality surface water run-off from site.

PROJECT ACTIVITIES RESULTING IN SURFACE WATER IMPACTS

The following activities could potentially lead to surface water related impacts:

- Construction Activities Resulting in Spillages of Chemicals and Fuels – during the construction process heavy machinery will be operational on site. There is a risk of impacts to surface water quality through accidental spills of fuels and oils, as well as other contaminants related to the transportation of equipment and materials during the construction phase. Spills can directly impact surface waters, and also indirectly impact through entering the soil and migrating through aquifers ultimately discharging to surface water. Although this impact is not significant considering non-proximity of the pipeline RoW.
- Operation of Pipeline – there is a potential to introduce pollutants to the groundwater courses via:
  - Spillage of transported material as a result of sabotage or equipment failure and as such lead to groundwater/surface water contamination.
  - Irresponsible dumping of solid waste from pigging activities during pipeline maintenance work and surveillance
- Discharge of Stormwater from Hard Surfacing– Spills mixing with stormwater can directly impact surface waters, and also indirectly impact through entering the soil and migrating through aquifers ultimately discharging to surface water.

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the surface water management system throughout life of the Project. During construction, field implementation of surface water controls will be managed and executed by the Contractor.

Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

The surface run-off from site should be uncontaminated and should not alert the baseline quality. The surface water quality will be monitored, as and when required.

MANAGEMENT MEASURES

The management and mitigation measures listed below will be implemented to reduce anticipated impacts from the Project.

- The Project will develop and implement a grievance procedure in the event of any water complaints being received.
- All construction areas and associated facilities will be maintained in a good and tidy condition. This will include bunding of vehicle parking areas, oil and silt traps in the workshop area and proper disposal of waste material.
- Chemicals used on site must be stored in a proper area with sealed floor, roofing, and walls where applicable, and access control. Waste chemicals will be disposed of at an approved waste management facility.
- Surface water and Sediment monitoring will be done, as and when required to monitor any potential construction and operational related impacts.
- Solid waste must be disposed of at an approved waste management facility.
- Stormwater management of the construction site will be planned in such a way to avoid the transport of contaminants and sedimentation into aquatic systems.
- Sufficient temporary toilets will be located in strategic locations near active work sites during the construction phase and sited away from any water bodies or wetlands. These toilets will have doors and locks and will be secured to prevent them blowing over. Temporary toilets will be serviced regularly by a competent and suitably qualified person. Emptied waste will be transported and suitably disposed of.

7.7.6 Biodiversity Management Plan

OBJECTIVES

To promote the sustainable management of biodiversity resources, maintain the ecological integrity of the broader Project Area and maintain the benefits from ecosystem services through the adoption of practices that integrate conservation needs and development priorities.

PROJECT ACTIVITIES RESULTING IN BIODIVERSITY IMPACTS

The following Project activities during the construction and operational phases may result in impacts to biodiversity and ecosystem services:

- The loss of area to be cleared for the proposed IFF 76km Pipeline RoW could directly affect the surrounding ecosystem through siltation, alien invasive species introduction, and changes to the functionality of the systems.
- While little to no direct impact is predicted to occur to the aquatic biodiversity of the Project Area, due to non-close proximity of the pipeline RoW to water body, however wetland exist within the pipeline RoW. Thus, if construction activities within the wetlands are not properly managed may lead to contamination of these systems and thus result to reduction in aquatic biodiversity.

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the biodiversity management system throughout life of the Project. During construction, field implementation of biodiversity controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

IFC PS6 discourages the loss of natural habitats and requires that any impacts to natural habitats are associated with No Net Loss of Biodiversity, which is to be achieved through the avoidance of sensitive features, minimising of impacts, rehabilitation and possible compensation. If Critical Habitat is present, IFC Performance Standard 6 sets out a goal of delivering a net biodiversity gain. Disruption of ecosystem services are to be avoided and engagement with stakeholders is crucial in understanding these effects.

MANAGEMENT MEASURES

The management and mitigation measures listed below will be implemented to reduce the impacts from the Project to negligible. However, below are some highlights of mitigation action to prevent loss of aquatic biodiversity.

- The Project will develop and implement a grievance procedure in the event of any water complaints being received.
- Preclearing checks will be conducted ahead of any vegetation removal.
- Implementation of those management measures included for surface water management
- Toolbox talks for all construction workers regarding fauna and flora, including the fact that collection of plant or animal products is prohibited.
- Implementation of those management measures included for soil and erosion management

7.7.7 Socio-economic Management

OBJECTIVES

To manage the socio-economic aspects of the proposed Project during the construction and operations phases. Project Activities Resulting in Socio-economic Impacts:

- Construction and operation of the Project, as well as the movement of equipment through or near communities.
- The peak demand for temporary contract workforce during construction.
- The demand for temporary contract workforce during the operational life of the asset.
- Improved economic, employment and business opportunities provided by the presence of the Project.
- IFF procurement of goods and services from national, regional, and local service providers and suppliers.
- IFF programmes with respect to local business development as part of their Community Development Plans.
- Influx of migrant workers and job seekers.
- IFF use of state and private security forces to secure their operations.

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the socio-economic management system throughout life of the Project. During construction, field implementation of socio-economic controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

- Implementation of a Local Content / Procurement Plans.
- Engagement with local labour contractors on available skills.
- Registration of local (appropriately qualified) contractors from Host communities.
- Records of training and recruitment processes that reflect host communities.
- Updated and signed MOUs with Project-affected (host) communities.
    - Stakeholder Engagement Schedule, including proposed dates of engagement, key stakeholders/group to be involved, purpose of meetings for construction and operational phases of the Project.
- Monitoring, evaluation, and disclosure on progress against SEP.
- Maintained community grievance register, including timeframe for close out of issues and manage measures.
- Community Health and Safety Plan and Emergency Preparedness and Response Plan in place and effective.
- Record of community incidents, emergency events and responses.

- Updated info on CSR activities / Projects and tracking of all made to stakeholders.
- Recruitment and appointment process in place to meet resourcing requirements for implementation of Health and Safety Plans.
- Reporting and disclosure on influx.

MANAGEMENT MEASURES

The management measures mentioned below will be implemented to reduce socio-economic impacts from the Project.

- IFF will appoint local contractors (where reasonable and practical) and implement a Local Content / Procurement Plan which is in line with existing policies.
- All appointments (direct or through contractors) must abide by international and national labour laws.
- Before the construction phase commences IFF will meet with representatives from the Project-affected communities (through the CLO or other appropriate forum/s) to re-fresh the established data base of skills, local small and medium sized enterprises for the area. This re-fresh database should be made available to the contractors appointed for the construction phase.
- The local authorities, relevant community representatives will be informed of the final decision regarding the Project and the potential job opportunities for locals and the employment procedures that IFF intends following for the construction phase of the Project.
- Where feasible, a training and skills development programmes for local workers should be initiated prior to the initiation of the construction phase.
- The recruitment selection process will seek to promote gender equality and the employment of women wherever possible.
- Update of existing Local Supplier Database to include affected communities.
- Registration of local contractors and service providers from Project-affected communities.
- Record of development support given to local contractors and service providers from Project-affected communities.
- Updated of existing Health and Safety Plans to cover the Pipeline (including Emergency Preparedness and Response Plan).
- Inclusion of community requirements in any new Health and Safety Plans.

7.7.8 Employment and Procurement Management

OBJECTIVES

The Project is committed to ensuring the rights and health and safety of all workers are respected and protected employed by Contractors and their Subcontractors. This

Management Plan has been developed taking into account the requirements of Nigerian law and IFC Performance Standard 2, and seeks to:

- Promote fair and transparent employment and procurement practices.
- Promote reasonable working conditions including health and safety at work, working hours, contracts etc.
- Ensure the fair treatment, non-discrimination, and equal opportunities of all workers.
- Protect Project workers including vulnerable workers from labour abuses.
- Prevent the use of all forms of forced and child labour.
- Support the principles of freedom of association and collective bargaining.
- Provide workers with a means to raise workplace concerns.
- Manage retrenchment / contract termination of contracted workers.

PROJECT ACTIVITIES RESULTING IN EMPLOYMENT AND PROCUREMENT IMPACTS

Regardless of whether people are direct employees, Contractors or subcontractors, workers can be affected either by exposure to insufficient health and safety standards or exposure to insufficient labour and working standards. Exposure to insufficient standards increases the risks of accidents, injuries or of workers not receiving fair treatment.

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring implementation of the requirements under PS2 for employment and procurement management throughout the life of Project. The Contractor will be responsible for ensuring the labour and working conditions of all Project employees (direct employees and subcontractors) are in line with the requirements of Nigerian law, ensuring workplace health and safety and access to grievance mechanisms. Other parties, such as the Engineer, will also assume certain responsibilities in this regard.

PERFORMANCE CRITERIA

- Fair and transparent recruitment and procurement procedures are in place.
- Policies in place related to discrimination, worker rights, freedom of association, including zero tolerance for any form of forced or child labour (direct employees, contractors or subcontractors).
- Primary supplier workers, have a contract in line with Nigerian Law and IFC PS2 outlining the terms and conditions of employment.
- Promote the fair treatment, non-discrimination, and equal opportunity of all workers.
- All workers have the right to associate and collectively bargain.

- Normal working hours and overtime to align with standard construction practices and Nigerian law.
- Wages for all workers are aligned with minimum wages and minimum industry standards.
- Worker Grievance Mechanism should be in place and implemented.
- Measures should be in place to ensure workers receive all necessary documentation at the end of their employment.

MANAGEMENT MEASURES

Labour and Employment Plan and Worker Grievance Mechanism will be implemented. These requirements will also be passed on to any subcontractors. Key issues to be covered by the Human Resource (HR) management will include, but not be limited to the following:

- 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.
- Provision of reasonable working conditions and terms of employment, including measures for working in extreme high temperatures to ensure worker safety. Measures could include rotating staff based outside and shifting working patterns.
- Provision of adequate accommodation (where relevant).
- Provision of employment, compensation/remuneration and working conditions, including working hours, based on equal opportunity and fair treatment, avoiding discrimination.
- Provision of adequate welfare facilities on site (where required).
- Implementation of a grievance mechanism for the Project workers.
- Adoption and implementation of a sexual harassment policy.
- Adoption of open attitude towards freedom of association.

7.7.9 Community Health and Safety

OBJECTIVES

The Project is committed to ensuring the health, safety and security of all stakeholders who are affected by its activities including local communities and the broader public. Specifically, this plan aims to:

- Continuously identify, evaluate, and prioritise the risks and impacts of proposed activities on the health, safety, and security of local communities.
- Proactively prevent and avoid impacts to community health, safety, and security, and enhance any positive impacts related to community health and safety.

- Identify strategies that will support provision of adequate health related information and prevention measures through which communities can manage their own health and safety.
- Implement security that protects Project employees, assets and business continuity in a manner that adheres to Nigerian legislation and is consistent with the Voluntary Principles on Security and Human Rights (VPs).
- Avoid or minimise for the potential for community exposure to communicable and vector-borne diseases as well as accidents and injuries associated with site trespass and road traffic movements.

PROJECT ACTIVITIES RESULTING IN COMMUNITY HEALTH AND SAFETY IMPACTS

Project activities that could result in impacts to Community Health, Safety and Security include:

- Interaction between the workforce (particularly non-local workers) and communities.
- Presence of opportunistic job seekers / migrants in communities, who are attracted by potential Project opportunities.
- Management of work site notably hygiene, sanitation, waste management and environmental changes that could lead to the creation of breeding grounds for vectors and facilitate the transmission of diseases.
- Presence of work sites with large machinery and other equipment/ supplies that could result in accidents and injuries in case members of the public access the site.
- Movement of Project related traffic during construction.

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring implementation of the community health, safety, and security management system throughout the life of the Project. During construction, field implementation of the health, safety and security management controls will be managed and executed by the Contractor. Other parties, such as the Engineer and Safety Officers, will also assume certain responsibilities in identifying best route to deliver materials onsite.

PERFORMANCE CRITERIA

- Monitor Vector borne and sexually transmitted diseases
- No outbreaks of diseases created by construction activities.
- Take preventative measures to avoid road traffic or site-based accidents during construction involving community members or assets created by Project activities.
- Take preventative measures to avoid incidents of use of excessive force by security personnel.
- No reduction in access to health care facilities for communities created by the Project.

MANAGEMENT MEASURES

The management measures listed below will be implemented to reduce community health safety and security related impacts from the Project.

- Pre-employment screening will take place prior to mobilisation. The screening protocols will consider heath conditions related to the nature of the work undertaken, employee country of origin and legal requirements.
- A Worker Code of Conduct will be developed providing a code of behaviour including worker-worker interactions, worker-community interactions, and development of personal relationships with members of the local communities. This would apply to all Project workers and visitors to any Construction Sites.
- Project will put in place measures for creating awareness for vector borne diseases amongst workers through e-bulletins, posters, signages.
- The workforce will be provided with access to treatment at health facilities on site, where feasible. Access to health care will include direct employees, contractors and subcontractors working or based on site.
- Project security will comply with Nigerian laws and regulations as well as the requirements of the Voluntary Principles for Security and Human Rights. The security will include, among other things, selection of personnel based on a careful background screening, training with regards to human rights requirements, and monitoring of performance. As part of the Grievance Mechanism KPIs for grievance resolution will be established which may vary between the Sections to reflect local issues and concerns.
- A Traffic Management Plan will be developed and implemented to ensure the safety of all stakeholders.

7.7.10 Cultural Heritage Management

OBJECTIVES

The objectives of the plan are to:

- Manage the Cultural Heritage in compliance with Nigerian laws and regulations as well as IFC PS8 and Good International Practice.
- Minimise the impact of the Project on the Cultural Heritage through the application of the mitigation hierarchy
- Develop tools, such as a Chance Finds Procedure (CFP) to minimize impacts to not yet identified Cultural Heritage that may be discovered during the Project
- Minimize Project delays by detailing out step-by-step processes to dealing with unexpected discoveries through a Chance Finds Procedure.
- Define the Company and Contractor roles and responsibilities for successfully implementing the plan.

PROJECT ACTIVITIES RESULTING IN CULTURAL HERITAGE IMPACTS

The primary sources of impact in relation to cultural heritage is during construction and mainly attributed to ground disturbance activities (earthworks).

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the cultural heritage management system throughout life of the Project. During construction, field implementation of cultural heritage controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

The Local Regulator (National Commission for Museums and Monuments (NCMM)) is the regulatory body in charge of drafting, proposing, monitoring, and controlling the texts regulating and organising the conservation, management and protection of historical cultural heritage.

PERFORMANCE CRITERIA

Limiting impact to cultural heritage sites through implementation of the proposed Chance Finds Programme and implementation of the cultural heritage training program.

MANAGEMENT MEASURES

The management and mitigation measures mentioned below will be implemented to reduce the minor impacts from the Project.

- The Project will implement a Cultural Heritage toolbox briefing with the objective to manage potential impacts to known and unknown cultural heritage sites by facilitating the identification and reporting of potential Chance Finds encountered during construction works. The programme will consist of; Chance Finds toolbox talks/training for construction worker and should cover:
  - Defining Chance Finds
  - Identifying Chance Finds in the field
  - Local sensitivity on damage to cultural heritage resources
  - Sensitivity of cultural heritage sites to looting and legal penalties for looting or the destruction of cultural heritage sites
  - Chance Finds reporting procedures; and
  - The consultation process with local stakeholders and regulatory agencies.

7.7.11 Waste Management (during the Construction Phase)

OBJECTIVES

The objectives for waste management are:

- To ensure that the waste strategy for the proposed Project complies with the Nigerian legislative requirements.
- To ensure alignment with the good practice requirements set out in the IFC Performance Standards and IFC Environmental, Health and Safety Guidelines.
- Identify high level waste streams associated with the construction phase of the proposed Project.
- Categorise anticipated waste streams and ensure that the waste management hierarchy model is adopted for waste management, i.e., to **REDUCE** the amount of waste produced on site by procuring bulk goods rather than packaged goods and training workers on waste reductions, and to actively promote the **REUSE**, **RECYCLE** and **RECLAIM** waste management concept and subsequently minimising the amount of waste that needs to be disposed of.
- To ensure the end use of waste is as per its waste category assigned.
- To prevent and protect soil; surface water and groundwater from contamination through hazardous substance (including sewage) spills.
- To prevent and protect flora, fauna and people from indirect impacts associated with contaminated soil and water (both surface- and groundwater).
- To prevent health impacts arising via contact with general and/ or hazardous waste.
- To manage waste storage facilities in such a manner to minimise social as well as visual impacts.

PROJECT ACTIVITIES RESULTING IN WASTE

Wastes generated from Project activities can be categorised as non-hazardous or hazardous according to their types and associated risks. The definitions of waste categories are as follows:

- **Non-hazardous Wastes** – wastes that do not exhibit any hazardous properties and are relatively low risk to human health and the environment. This category would include a range of materials that may be recycled or can safely be disposed of in a landfill.
- **Hazardous Wastes** – wastes that exhibit one or more characteristics which mean that the wastes are potentially harmful to human health and/or can cause damage to the environment (air, land, and/or water) or natural ecosystems. For example, the waste may be corrosive, reactive, toxic, mutagenic, teratogenic, infectious, carcinogenic, ecotoxic, flammable, or explosive.

Waste types and estimated quantities during the construction phase are shown in Table 7.3. The duration of construction activities is estimated at about 20 months.

Table 7.3: Waste Types and Estimated Quantities

Activity	Description	Waste Category	Quantity	Destination
Site preparation	Cement / concrete – concrete debris, soil containing cement	Non-hazardous	100 ton	Land fill
Construction activities	Scrap metal / plastic / PVC /wood	Non-hazardous	10 ton	Recycle/Reuse
Maintenance and operation	Pigging waste paints	Hazardous	2.0 ton	Approved waste management facility
Personal Protective Equipment from activities	Used PPE – goggles, gloves, etc.	Hazardous	5.0 ton	Approved waste management facility
Lube oil and seal flushing of machinery	Lube – oil containing weld splatter, chips, welding flux deposits, powered metal oxides	Hazardous	5.0 ton	Approved waste management facility
Kitchen, offices operations	Food waste	Non-hazardous	1.0 ton	Municipal/Approved dump side
	Mixed urban wastes	Non-hazardous	1.0 ton	Municipal/Approved dump side

Note - During the operational phase, no significant wastes generation is expected except from pigging activities which is not frequent, during maintenance.

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring the waste management systems are implemented and aligned with the requirements under Nigerian Law. During construction, field implementation and management/storage/disposal of construction wastes are the responsibility of the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

PERFORMANCE CRITERIA

- Zero incidents of illegal dumping of wastes, both general and hazardous.
- Zero discharge of raw sewage directly into the environment
- No unauthorised access to the waste storage facilities.
- No loss of health to personnel or third parties as a result on inappropriate waste management practices.
- All waste disposal to be carried out by a licensed waste contractor per the Nigerian legislated requirements.

MANAGEMENT MEASURES

The management and mitigation measures listed below will be implemented to reduce waste related impacts from the Project.

- Waste Management Procedure shall be prepared covering all waste expected to be generate during construction. The Waste Management Procedure will need to include methods associated with waste handling; waste transport; waste storage and segregation; and waste disposal / treatment / recycling / reclamation options identified for the proposed project.
- To promote "4Rs" (Reduce, Reuse, Recycle and Reclaim) waste management concept, all waste will be sorted and managed as appropriate, either for reuse, recycling, or disposal.
- The nature, composition and integrity of transport packaging and containers will be appropriate to the type and class of waste being transported.
- Non-hazardous waste will be segregated into specific waste types, for those waste types that can either be recycled, reused, or reclaimed.
- Hazardous waste will be temporarily stored before being collected by an authorised contractor for removal and offsite disposal, in an accredited facility. Removal of hazardous waste from site will follow a regular schedule (frequency to be determined). In this respect, the Contractor will adopt the 'cradle to grave' principle. Tracking documents, proving that the disposal of hazardous wastes has been delivered to an accredited facility, and disposed of in such a facility, correctly, will be retained by the Project for audit and verification purposes.

7.7.12 Spill Prevention, Control and Containment Management Plan (during the Construction Phase)

OBJECTIVES

The objectives for spill prevention, control and containment management are:

- Protect the environment and community members who are dependent on its natural resources through the development of spill response and containment strategies and capabilities.
- Identify the sources of potential land contamination associated with construction activities.
- Categorise potential spill hazards.
- Plan for rapid and efficient response to manage hazardous material spills during construction.
- Identify and document management measures to prevent, control and mitigate spill events during construction.

PROJECT ACTIVITIES RESULTING IN SPILLAGE IMPACTS

During the construction phase of the proposed IFF pipeline, hazardous chemicals may accidently be released into the environment in the form of small spills or a major unplanned event (e.g., oil tanker or cement truck accident). Spillages may occur as a result of leakage of containers used to store or transport the following pollutants:

- Hydrocarbons (including diesel, greases, oils and other lubricants)
- Hazardous chemicals / materials (e.g., paints, batteries, etc.)

RESPONSIBILITY

IFF, as Project owner, shall assume responsibility for ensuring spill management and prevention requirements are established and implemented on the Project. During construction, field implementation of the spill prevention and management controls will be executed by the Contractor.

PERFORMANCE CRITERIA

- No unplanned release of dangerous goods or hazardous substances.
- All transport, storage and handling of dangerous goods or hazardous and dangerous substances is performed in accordance with the materials data sheets for the chemicals and the management measures included in this ESMP.

MANAGEMENT MEASURES

The management and mitigation measures listed below will be for spill prevention, control, and containment management.

- Training regarding proper methods for transporting, transferring, and handling hazardous substances that have the potential to impact surface- and groundwater resources.
- Train personnel with responsibility for hazardous substances. No untrained staff shall be allowed to handle hazardous substances.
- Provide collection systems (i.e., drip trays or impervious linings) under machinery or stationary equipment that may dispense or leak hydrocarbons / hazardous substances (i.e., generators and pumps).
- Transportation vehicles and tanks suitable for the hazardous materials being transported will be used. These vehicles and tanks will be maintained in adequate condition to ensure proper handling and safety of chemicals.
- Drivers will be trained in spill and emergency response and will have a means of communicating with the site, their administrative offices and emergency personnel for the entire transportation route.
- Method Statements/Procedure detailing spill emergency response and clean-up procedures for spills will be developed. Emergency response measures will also include

methods for response and clean-up for release into any natural stream, river, or wetland.

- Areas where spillage of soil contaminants occurs will be excavated (to the depth of contamination) and suitably rehabilitated. If any other minor spillage occurs, the spillage will be cleaned immediately, and the contaminated area will be restored. All contaminated material will be suitably disposed of. Clean-up procedures will need to be fully recorded.
- Spill kits will be provided at any fuel or chemical storage location. Spill kits must be maintained.
- Development, implementation and regular training and testing of a Project wide Spill Response Plan will be implemented.

ESMP Implementation Organogram

IFF has a well-established HSEF Policy, EHS & Social Management system. IFF shall retain the primary responsibility of ensuring that environmental and social commitments are met throughout construction and operational phase. The implementation Organogram defining the line of Communication is presented below.

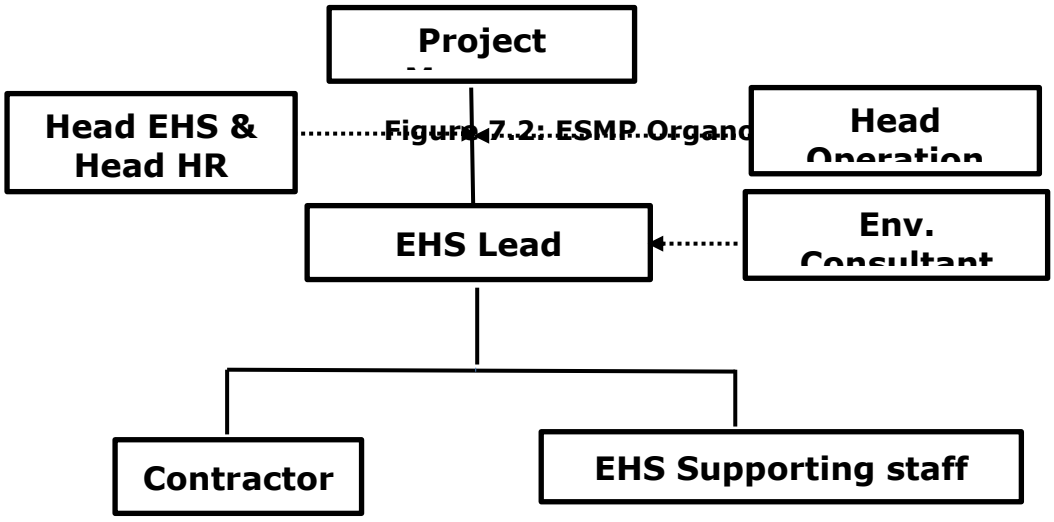


Figure 7.2: ESMP Organo

Table 7.4: Environmental Monitoring Plan

S/N	Environmental Components	Indicator Parameters	Frequency	Location	Responsibility	Time Frame
1	Noise	Sound Pressure	Monthly during Construction and Decommissioning	Along the pipeline RoW/ community	Third Party (Environment Consultant); Quarterly report to Regulators (FMEnv, NMDPRA)	Construction and Decommissioning
2	Ambient Air	NOx, CO, O_3, VOC, SOx, CxHy, PM_{10}, $PM_{2.5}$	Monthly during Construction and Decommissioning	Along the pipeline RoW/ community	Third Party (Environment Consultant) Quarterly report to Regulators (FMEnv, NMDPRA)	Construction and Decommissioning
3	Surface Water	pH, Alkalinity, TSS, TDS, Ammonia, Nitrate Turbidity, DO, COD, BOD, PO_4, Metals etc.	Monthly during Construction and Decommissioning	Three (3) identified waterbody sampled during ESIA study.	Third Party (Environment Consultant) Quarterly report to Regulators (FMEnv, NMDPRA)	Construction and Decommissioning
4	Sediments	pH, Conductivity, Salinity, PO_4, SO_4, NO_3, TOC, THC, Metals etc.	Monthly during Construction and Decommissioning	Three (3) identified waterbody sampled during ESIA study.	Third Party (Environment Consultant) Quarterly report to Regulators (FMEnv, NMDPRA)	Construction and Decommissioning
5	Occupational Health	No of trained first Aiders. Usage of appropriate PPE Usage of signage Accident/Incident Report	Daily	Project site	IFF – EHS Lead Contractor-HSE lead	Construction, Operations and Decommissioning
6	Waste management	Housekeeping, WMP developed. Waste note, reuse/recycling	Daily by Visual Observation & records	Project site	IFF – EHS Lead Contractor-HSE lead	Construction, Operations and Decommissioning

7.8 ESMP Implementation Indicators and Cost

The key implementation indicators and the indicative cost of each ESMP measure are presented in Table 7.5. The total indicative ESMP budget for Phase 2 construction and the first five years of operation is about N522.5 million (including 10% contingency), excluding compensation already paid for the 11 km RoW and engineering costs embedded in the EPC contract.

Table 7.5: ESMP implementation indicators and cost estimate

Key impact / risk	Key management measures	Key implementation indicators	Responsibility	Frequency	Indicative cost (N million)
Vegetation and biodiversity	Pre-clearance survey; clearing limited to 15 m RoW; no-hunting rule; progressive revegetation (Biodiversity Management Plan)	Area cleared vs approved (ha); % disturbed area revegetated; hunting/wildlife incidents (target 0)	Contractor / IFF E&S	Quarterly	20
Surface and groundwater	Bunded storage, drip pans, spill kits; hydrotest water treatment; mud containment	Number of spills; hydrotest discharge vs NMDPRA limits; pH, TSS, oil & grease, THC at SW1–SW3 and boreholes	Contractor / IFF	Quarterly	20
Air quality and dust	Dust suppression; equipment maintenance; idling control	PM10, PM2.5, NO2, SO2, CO at receptors vs limits; dust complaints	Contractor / IFF E&S	Monthly	20
Noise and vibration	Silenced equipment; daytime work; hearing protection	LAeq at nearest receptors (≤55 dB(A) day); complaints	Contractor / HSE	Monthly	10
Community health and safety	Trench barricades and signage; community awareness; community-level ERP	Community incidents/near misses (target 0); awareness sessions held	IFF / Contractor	Ongoing during construction	15

Key impact / risk	Key management measures	Key implementation indicators	Responsibility	Frequency	Indicative cost (N million)
Traffic and road safety	Traffic Management Plan; journey management; flagmen; driver training	Traffic incidents; speed compliance; drivers trained (%)	Contractor	Ongoing during construction	15
Cultural heritage	Avoidance; consultation and rites for graves at Ochia; chance-finds procedure	Chance finds reported/managed; heritage incidents (target 0)	IFF / Contractor	Ongoing during construction	10
Waste management	Waste management plan; segregation; licensed contractors; manifests	Waste by type and volume; % recycled; manifests complete (100%); illegal dumping (0)	Contractor	Ongoing during construction	15
Worker health and safety	HSE plan; PPE; permit-to-work; site clinic; NDT radiation safety	LTIs/TRIR; near misses; toolbox talks; PPE compliance	Contractor / IFF HSE	Ongoing during construction	20
Labour and working conditions	Labour clauses in contracts; worker GRM; welfare facilities	Workforce by origin (target ≥50% local); worker grievances resolved	Contractor / IFF HR	Ongoing during construction	15
Labour influx, GBV/SEA	Code of conduct; GBV/SEA training and referral pathway; STI/HIV awareness	Workers trained (%); GBV/SEA complaints and referrals	IFF / Contractor	Ongoing during construction	10
Pipeline integrity and major accident hazards	QRA; integrity management (pigging, CP surveys); LDAR; RoW surveillance; ERP drills	QRA completed before commissioning; CP potentials ≤ -850 mV; leaks detected/repaired; drills held; response time	IFF Operations / HSE	Six monthly during the construction	120
Stakeholder engagement and GRM	SEP implementation;	Engagements held; grievances	IFF Community Relations	Monthly / quarterly	50

Key impact / risk	Key management measures	Key implementation indicators	Responsibility	Frequency	Indicative cost (N million)
	CLOs; disclosure; GRM	received/resolved within 30 days (%)			
E&S monitoring programme	Third-party environmental monitoring (Table 7.4); reporting to FMEnv/NMDPRA	Monitoring reports submitted on time; exceedances and corrective actions	IFF / accredited consultant	Monthly / quarterly	45
Capacity building	Programme in Table 1.5a	Training sessions delivered; staff in post (if needed)	IFF	As scheduled	60
ESMP audits and lender reporting	Internal/external E&S audits; annual monitoring reports to AfDB	Audits completed; non-conformities closed	IFF	Semi-annual / annual	30
Subtotal					**475**
Contingency (10%)					**47.5**
Total indicative ESMP cost					**522.5 (≈ US$0.35 million)**

Costs are indicative (2026 prices, US$1 = N1,500) and will be refined in the Contractor ESMP and the IFF budget.

CHAPTER EIGHT

DECOMMISSIONING, ABANDONMENT AND SITE RESTORATION

8.1 Introduction

This chapter discusses the activities involved in decommissioning the proposed pipeline project, highlighting the various potential impacts associated with these activities and as well outline the environmental and social measures to mitigate these impact. Furthermore, it provides an overview of the decommissioning plan for the project at the conclusion of its operating life.

8.2 Decommissioning

Decommissioning refers to the process of removing and managing all operating assets of a project after completion of its life cycle. The proposed gas pipeline Project is being developed for a projected 30-year operational life time. However, with regular maintenance, it is anticipated that the useful life of the Project could extend well beyond the designed life span. Planning for decommissioning shall begin from the design stage of the factory and shall continue throughout the lifetime of the facility. When the performance of the system scales to diminishing returns, IFF standard Procedures for decommissioning shall be invoked. A decommissioning team shall be set up to plan and implement the laid down guidelines on decommissioning. An approved decommissioning and abandonment plan shall be obtained from NMDPRA prior to the commencement of the process.

Decommissioning may also be required if natural gas (non-renewable natural resources) which is the pipeline feedstock declines to non-economic levels, such that the project is not economically viable.

The decommissioning activities will typically include the following:

- Dismantling and removal of equipment and structures;
- Removal of any surface installations;
- Waste generation and management;
- Rehabilitation of any impacted environmental component (e.g. water, soil).

8.2.1 Decommissioning Activities

Prior to commencing removal of items of equipment, a decommissioning contractor shall be appointed, the contractor shall ensure that the equipment has been approved for decommissioning by reviewing the equipment decommissioning note. Thereafter, IFF shall be consulted for their decision regarding the disposal of the equipment after removal. The

decommissioning activities shall be carried out in line with the relevant provisions of the National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the FMEnv. Typically, the following steps shall be undertaken for decommissioning:

- An updated plan which takes into account the most cost-effective and best practicable methods, legal requirements and industry practices at that time for the factory decommissioning shall be developed. The plan shall be submitted to the FMEnv and other relevant government agencies for approval, at least one (1) year prior to scheduled abandonment and decommissioning. The plan shall include, but not limited to the following:
  - Description of the site and components to be decommissioned.
  - Description of the decommissioning scope, objectives, end state and strategy;
  - Activities to be performed during the decommissioning;
  - Schedule of decommissioning activities;
  - Estimate of the decommissioning cost;
  - Estimated inventory of waste streams to be generated during the decommissioning and handling techniques;
  - Decommissioning team (qualifications, roles and responsibilities)
  - To ensure that due consideration is given to all options a detailed evaluation of facilities decommissioning options shall be carried out. The options will include facility mothballing, partial facility decommissioning or complete site decommissioning. The evaluation will consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environment friendly options for the Project decommissioning.
  - A risk assessment shall be conducted to ensure that nothing constituted as a hazard for other users of the site or for the environment in general, will be left at the site. The Project site shall be left in a safe and environmentally acceptable condition.
  - Hazard identification and analysis shall be conducted to determine special safety concerns to be addressed.
  - An appropriate Health, Safety and Environment (HSE) plan shall be implemented to ensure that the decommissioning activities are carried out in an environmentally sound manner and in conformity with relevant laws and regulations guiding such operations.
  - Third party notifications shall be carried out before any demolition and shall be conducted in a phased sequence.
  - An effective waste management plan shall be implemented for the decommissioning activities. The decommissioning options for redundant structures and equipment will include: the complete dismantling of structures

and equipment with a detailed record of all suitable recycling materials shall be maintained. The environmental and social management measures for the identified potential impacts of the decommissioning activities are presented in Table 6.1

- Consultation shall be made with relevant stakeholders including IFF, the various Local Government Council, State Ministry of Environment and the Federal Ministry of Environment to determine whether if any of the pipeline component could be useful if left in place. In such instance, the transfer of the responsibility of maintaining such facility shall be considered and documented to avoid any conflicts between interested parties.
- Socio-economic considerations of facility decommissioning shall be carried out. These will include assessment of potential effects associated with termination of employment (at the end of operational phase) and the measures to minimize the effects by: -
  - Ensuring that employees are fully informed about the decommissioning and how it will affect them before the project finally closes.
  - Building community capacity to manage opportunities and impacts arising from the decommissioning and post-decommissioning phase of the gas pipeline.
  - Providing training to build local skills tailored to project decommissioning and post-decommissioning activities (e.g. equipment dismantling, rehabilitation activities, monitoring, etc.).
  - Providing training to transfer project-learned skills to alternative and secondary industries tailored to respond to market economy.

8.2.2 Abandonment plan

Prior to site abandonment, NGL shall establish a standard procedure for incorporating the following practices:

- Identification of the pipeline components to be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the equipment/material applicable;
- Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and
- Appropriate site rehabilitation programs (including re-vegetation of the site with native plant species) to return the Project environment to its original status (as much as practicable).

8.3 Removal and Site Clean-Up

The above ground facilities removal shall be carried out with skill and diligence to avoid spill of hazardous liquids and damage to the environment. At the end of the exercise, various solid wastes shall be sorted according to their types and then disposed of according to IFF waste disposal guidelines.

8.4 Rehabilitation of Site

After all categories of wastes have been satisfactorily disposed of, the topsoil shall be stripped and replaced with topsoil from un-impacted neighborhood. Seedlings of the original vegetation shall be obtained from neighboring areas and planted.

8.5 Remediation Plans After Decommissioning/Closure

Decommissioning and abandonment/closure programmes are integral parts of this EIA. The aim of the decommissioning process is to restore the project area to as close to its original state as possible. An abandonment plan shall be developed at the end of the projects lifecycle. The plan shall conform to the national's/state statutory requirements in force at the time of the decommissioning, and IFF policy. The plan shall include an abandonment execution strategy to identify project components to be decommissioned and/or dismantled and the process to be adopted.

8.5.1 Restoration

A site survey will be carried out on the condition of the soil. Any polluted soil will be treated in situ or removed from the site and treated/disposed of safely and in an environmentally acceptable manner. All cement, steel or wooden structures not left to others for use will be removed. All pits, holes and excavations will be cleaned and filled to ground level and re-vegetated.

Other activities shall include:

- Removal of all waste materials (shrinkable sleeves, pipe off-cuts, welding electrode bids, spent hand gloves, etc. from the ROW.
- All trenches shall be certified as properly back filled with top soil.
- All equipment tracks shall be covered
- All materials that could subsequently prove hazardous to the restoration of the site shall be treated.
- All contaminated material shall be disposed of in a safe and approved manner.

8.6 Conclusion

Generally, the decommissioning, abandonment and/or closure programme shall be managed by a team of competent personnel, including the HSE personnel of IFF and

witnessed by relevant regulatory authorities such as NMDPRA, FMEnv and the various State Ministry of Environment. A close out report shall be prepared and archived for future reference.

CHAPTER NINE

CONCLUSION

The Environmental and Social Impact Assessment (ESIA) study was conducted to evaluate the potential impacts of the proposed 76km Natural Gas Pipeline project on the environment's biophysical, social, and health aspects. This study was carried out in accordance with relevant local and international regulations based on FMEnv approved terms of reference. The methodology applied for the study involved desktop studies, reviews of existing data and fieldwork including community consultations.

To achieve this objective, a multidisciplinary approach was adopted in the assessment of the environmental status and sensitivities of the various ecological components of the project area using extensive literature, two-season field sampling (dry season, December 2023; wet season, 6–9 August 2026), measurements/testing as well as standard use of quantitative/qualitative impact analysis. By conducting this ESIA study, we gain a thorough understanding of how the proposed pipeline project could potentially impact the environment and the surrounding communities for a site specific mitigation actions plan in order to reduce project impacts to barest minimum.

Specifically, the ESIA of the proposed 76km Natural Gas Pipeline Project was conducted in accordance with the Environmental Impact Assessment Act CAP E12 LFN 2004, Environmental Guidelines and Standards for the Petroleum Industry in Nigeria" (EGASPIN) published in 2018 by the erstwhile Department of Petroleum Resources (DPR), the AfDB Integrated Safeguards System (2023) Operational Safeguards and Triggered IFC Performance Standards/General EHS guideline. The prime objective of the ESIA process to this project is to ensure timely provision of information for the project decision makers to contribute to developing the project such that, it is environmentally sound and sustainable. The process undertaken comprised of the following step:

- Scoping and screening
- Stakeholder engagement
- Baseline data gathering
- Laboratory analysis
- Impact assessment
- Management plan
- Reporting and disclosure

In carrying out the study an all-inclusive approach was used whereby IFF, the project affected communities, and the affected Local Governments Areas in Rivers State and Imo States (the primary stakeholders) as well as the regulatory bodies (the secondary stakeholders), CBOs were extensively consulted and provided valuable concerns and inputs throughout the study.

The biophysical characterization of soil, surface water and sediment around the project area showed that the soil, surface water and surficial sediment were consistent across sampling stations and compared well with values recorded in previous studies around similar environments.

The ESIA of the project shows that it would have a significant beneficial impact on both local and national economy. The identified adverse impacts were generally short-term and can be prevented, reduced, ameliorated, or controlled if the recommended mitigation measures are implemented. Further, An Environmental Management Plan (EMP) has been developed to ensure the effective implementation of mitigation strategies and proactive environmental management throughout the project's lifespan. The EMP will serve as the foundation for project execution and ongoing environmental monitoring.

It is anticipated that the execution of the activities of the proposed Project will not cause damage to the environment if the EMP is implemented. The approval of this ESIA report for the execution of the proposed project is hereby recommended.

CHAPTER TEN

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