CHAPTER ONE

INTRODUCTION

1.1 Project Background

The Transit Gas Nigeria Limited (TGNL) was incorporated in 2014 as a limited liability company and a subsidiary of Axxela Nigeria Limited, is the owner of the project. Its principal place of business is at the 8th Floor, The Wings Complex, East Tower, 17a Ozumba Mbadiwe Avenue, Victoria Island, Lagos, Nigeria.

1.2 The Proposed Project Information and project area

In order to meet the request for the supply of Natural Gas by Rite Foods Nigeria Limited, Ososa, Ogun State, and the future requirements of potential customers for use of Natural Gas, Transit Gas Nigeria Limited (TGNL), a subsidiary of Axxela Nigeria Limited in partnership with Nigerian Gas Marketing Company (NGMC) intend to construct a 12" x 135km Pipeline Network from KP312 of Escravos Lagos Pipeline System's Above Ground Installation at Ibefun, Ogun State, to Rite Foods Nigeria Limited Ososa, Ogun State. This main line is to serve as a backbone for Natural Gas supply to;

i. KP312 of the Escravos Lagos Pipeline System, Ibefun to Rite Foods Nigeria Limited, Ososa, Ogun State.
ii. Sagamu Interchange to Abeokuta, Ogun State
iii. Sagamu Interchange to J4, Ogun State
iv. Sagamu Metering Station, Sagamu-Benin Express Junction, Ogun State.

The vegetation on the Sagamu LDZ Ibefun project area forest is or flooded forests, which are inundated with freshwater either permanently in some part or seasonally in another part. The vegetation is found in tropical climates and belongs to Afrotropic freshwater swamp forest. There is an enormous supply of freshwater from inland rivers and rainfall runoffs. The intricate network of creeks and lagoons results in inaccessible swamps of forest vegetation in some parts of the study area.

Transit Gas Nigeria Limited (TGNL) proposes to carry out an Environment and Social Impact Assessment (ESIA) study of the engineering, construction, operation, and ultimate abandonment of this proposed project in compliance with its corporate policy on environmental protection, the Federal Ministry of Environment (FMEnv) guidelines on ESIAs for projects of this nature, and the environmental and safeguard requirements of International Finance Corporation's Guidelines on ESIAs. TGNL had secured the services of a reputable ESIA Consultant - ELOHIM

SABAOTH LTD to perform the ESIA study. The ESIA study has been be designed in line with the procedures provided in the PART VIII. A of Environmental Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN, 2018).

The proposed Natural Gas Supply Pipeline Network will be located along the communities:-

- Kajola, Bara, Logbara, Onilemo, Idofin, Oba, Ajetutu, Jibowu, Onibata, Shiun, Iyana Ashipa, Kobape, Abeokuta in the Sagamu Interchangep to Abeokuta Sagamu segment.
- Sagamu, Ikenne, Ilishan, Odogbolu, Ososa, Ijebu Ode, Itele Ijebu, Ogbere J4 in Sagamu Interchange to J4 Sagamu segment.
- Sagamu in the Sagamu Metering Station to Sagamu Interchange Segment.
- Ibefun, Ilado, Imagwen, Odo Agin, Odo Raguwa, Imodin Ijasin, Ososa, Epe Local Government, Odogbolu Local Govemment, in the Segamu Benin Express Junction taking off from the City Gate at Ibefun KP'312, of the Escravos Lagos Pipeline System to Rite Foods Nigeria Limited Ososa Segment.

1.3 Project

The project is to supply natural gas from the Transit Gas Nigeria Limited's regulation and metering facility (R&M) from KP312 of Escravos Lagos pipeline system, Ibefun to Rite Foods Nigeria Limited, Ososa and other future customers within the axis. The Natural Gas will be used as fuel gas to power gas generators & boilers and feed stock to plants with emphasis on operational safety, efficiency and flexibility with a view to providing industry standard remote supervision and control.

1.4 Objectives of the ESIA

- This ESIA is commissioned by the Transit Gas Nigeria Limited (TGNL), a subsidiary of Axxela Nigeria Limited in partnership with Nigerian Gas Marketing Company (NGMC). The objectives of this ESIA are to:
- Acquire baseline data of the environment as well as the socio-economic and health conditions in a bid to characterize the project area:
- Determine and evaluate the potential impacts of the activities proposed in this project on the environment, on the level of the complete project.
- Establish the existing ecological and socio-economic conditions of the area;
- Identify, evaluate and predict the impacts of the project on the environment including socio-economic aspects with adequate interfacing and project interaction;

- Establish the environmental/socio-economic and health sensitivities of the area to the new project; Develop control strategies with a view to mitigating and amelioration significant impacts which the project would have on the totality of measurable environmental characteristics. and

- Recommend appropriate mitigation measures and monitoring activities
- Develop an Environmental and Social Management Plan (ESMP) that will ensure environmental sustainability throughout the project lifespan.

1.5 The ESIA Team

This ESIA study report is compiled by Elohim Sabaoth Limited. Paradigm Elohim Sabaoth Limited carried out the approved one season study in order to meet the FMEnv standard and requirement for approval. The study team is comprised of Engineering, Environmental and Social Sciences specialists with a combination of experience in undertaking ESIAs for oil and gas infrastructure developments and other projects in Nigeria.

1.6 The ESIA Study

1.6.1 Overview of the ESIA Process

The ESIA study for Transit Gas Nigeria Limited (TGNL) was concerned with identifying, predicting and evaluating foreseeable impacts, both beneficial and adverse, that are likely to emanate from all aspects of the Project. Also inclusive were proffered mitigating measures to eliminate or minimize negative impacts while maximizing the positive impacts. This study is required purposely to provide information on the environmental, socio-economic and health effects of the TGNL pipeline project and to make sure that the proposed operations of the facilities are within acceptable limits set by the Federal Ministry of Environment and the Department of Petroleum Resources (DPR), the host State Ministry of Environment and the international limits set out by the IFC and other international bodies.

1.6.2 Baseline Data Collection

The ESIA report provides a description of the existing environmental and socio-economic conditions as a basis against which the impacts of the project can be assessed. The baseline includes information on receptors and resources that were identified during scoping as having the potential to be significantly affected by the proposed project. The description of the baseline has the following main objectives:

- To identify the key environmental and socio-economic resources and conditions in areas potentially affected by the project (such as atmosphere. geology and soil, groundwater, surface water, fauna and flora, and the marine environment).
- To describe, and where possible, quantity their characteristics i.e. their nature, condition, quality, and extent.
- To provide data to aid the prediction and evaluation of possible impacts.
- To make informed judgments about the importance, value, and sensitivity or vulnerability of resources and receptors.

For this ESIA, secondary data collection was obtained from existing sources including the following:

- Stakeholders including government agencies, community chiefs, Elders, Women, and youths in various communities and community-based organizations (cooperative, societies, development committees. etc.);
- Local experts and research and academic organizations
- Existing and approved ESIA reports, and other published sources.

Additional primary baseline data process involved sampling and data gathering for information on socio-economics, terrestrial soils, and geology, surface water, groundwater, air quality, noise, fauna and flora, traffic and waste surveys. The exercise also included water quality and sediment sampling and testing.

1.6.3 ESIA Terms of Reference

The ESIA terms of Reference (ToR) was approved by the Federal Ministry of Environment. The FMEnv approved Terms of Reference (ToR) is attached as Appendix 1. This is in line with FMEnv standards. The ToR contained the following:

- The scope of work for the ESIA including the overall data requirements on the proposed project and affected environment:
- The environmental regulations guiding the project:
- The plans, procedures, and protocols for identification and assessment of associated and potential impacts and also for selecting mitigation (prevention, mitigation, control) measures for adverse impacts; and
- An effective Environmental and Social Management Plan for the project.

1.6.4 ESIA Scope of Work

The work scope for this ESIA study was:

- Review of national and international environmental regulations, standards. codes and conventions relevant to the proposed project activities:
- Establish the baseline/status of the project area through literature research;
- Laboratory analysis of samples collected during the field survey;
- Impact identification, prediction, interpretation, and evaluation;
- Development of cost-effective mitigation measures, monitoring programmes and
- Environmental and Social Management Plan (ESMP) covering the project life cycle; and
- Preparation of detail draft report to meet FMEnv permitting requirements.

1.7 Legal and Policy Framework in Nigeria

- Environmental Impact Assessment Act No. 86 of 1992.
- EIA Procedural Guidelines of 1995.
- Waste Management and Hazardous Waste Regulations (S. 1. 15) 1991.
- EIA Sectoral Guidelines for Power Generation and Transmission Projects, 1995.
- Interim Guidelines and Standards for Environmental Pollution Control in Nigeria, 1990.
- Land Use Act, 1990.
- Nigeria Inland Waterways Authority (NIWA) Act, 1987.
- Forest Act, 1937.
- State Ministry of Environment Edicts, 2005.
- Factories Act Cap 126, LFN, 1990.
- The Electricity Act Cap 106, Laws of the Federation, 1990.
- The National Electricity Power Authority Act.
- Electricity Amendment Decree No. 28 of 1998.
- International Finance Corporation (IFC) Performance Standards (PS)
- World Bank Operational Directive 4.01 'Environmental Assessment' 1991.
- African Development Bank (ADB) Environmental and Social Assessment Procedures (June, 2001).
- All International Conventions on Environmental Protection to which Nigeria is a signatory.
- Wild Animals Preservation Act, 1916.
- Endangered Species (Control of International Trade and Traffic) Act, 1985. (CITIES)
- Kyoto Protocol, 1997.

- Stockholm Convention on Human Environment (1972).
- World Summit on Sustainable Development (Rio, 1992).
- World Bank Operational Directive 4.01 'Environmental Assessment' (1991).

1.7.1 General Institution Framework

The principal bodies responsible for environmental matters and saddled with regulating, implementing, coordinating, monitoring and certifying environmental permits for Petroleum industries in Nigeria are the Department of Petroleum Resources and the Federal Ministry of Environment. These functions are carried out in collaboration with the State and Local Government Environmental Protection Agencies. This ESIA study has been undertaken in line with statutory requirements for environmental management in Nigeria. These are the National Environmental Policy the ESIA Act Cap El2 LFN 2004. The FMEnv ESIA Sectoral Guidelines for Manufacturing Industries (FMEnv, 1995), Environmental Guidelines and Standards for Petroleum Industries in Nigeria (EGASPIN. 2018). the National Environmental Standards and Regulations Enforcement Agency (NESREA, 2007). The following subsections outline the guiding policies and regulations entranced by these Regulatory bodies and Agencies which are relevant to this proposed Transit Gas Nigeria Limited project. Also presented are other national statutes and conventions on environmental protection.

1.7.2 The Federal Ministry of Environment

The Federal Environmental Protection Agency (FEPA) presently subsumed into the Federal Ministry of Environment (FMEnv) was inaugurated in 1988 by Act No. 58 of 1988 and subsequently amended through Act No. 59 of 2004. The body is charged/empowered with the overall responsibility, for environmental matters in Nigeria. It has developed instruments of intervention to halt environmental degradation in the form of policies. Standard, guidelines and r-regulation and programmes. With the initiation of these instruments, enforcement by FMEnv has become the most effective tool to bring industries and developers into compliance through compliance promotions. The relevant policies, guidelines, and regulations of the ministry are outlined below.

National Policy on Environment (1989, 1999 revised 2016)

This document describes guidelines and strategies for achieving the policy goal of sustainable development by:

- Conserving and using the Natural resources for the benefit of present and future generations;
- Securing for all Nigerians a quality environment adequate for their health and well being
- Raising public awareness and promoting understanding of the essential linkages between the environment, resources and development and

Collaboration with other countries, international organizations and agencies to achieve optimal use of trans-boundary co-operation in order to prevent environmental resources theft?.

National Guidelines and Standards for Environmental Pollution Control in Nigeria

This guideline and standard were initiated in March 1991 sequel to the promulgation of the National Environmental Policy in 1989. This document ls a basic instrument for monitoring and controlling industrial and urban pollution. The guidelines and standards relating to six (6) areas of concern, thus:

- Effluent Limitations:
- Water quality or industrial water use at the point of intake;
- Industrial emission limitations:
- Noise exposure limitations;
- Management of solid and hazardous wastes: and
- Pollution abatement in industries

S.1.8 National Environmental Protection (Effluent Limitation) Regulations, 1991

The National Effluent Limitation Regulation, S.1.8 of 1991(No.42, Vol.78. August 1991), makes it mandatory, for industries as waste generating facilities (including research institutes. clinics, hotels etc.) to install anti-pollution and pollution abatement equipment on site. The regulation is specific tor each category of waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contravention are specified also in the regulation.

S.1.9 National Environmental Protection (Pollution Abatement in Industries Generating Wastes) Regulations, 1991

The pollution abatement regulation, S.1.9 of 1991 (No.42. Vol.78, August, l99l) imposes restrictions on the release of toxic substances and stipulates requirements for pollution monitoring units. machinery for combating pollution and contingency plan by industries; submission of lists and details of chemicals used by industries to FMEnv; requirement of permit by industries for the storage and transportation of harmful or toxic waste; the generator's liability: strategies for waste reduction: permissible limits of discharge into public drains; protection of workers and safety requirements: for environmental audit (or environmental impact assessment for new industries) and penalty for contravention.

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

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

-Environmental Impact Assessment Act CAP 812 LFN, 2004

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

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

The Act gives specific powers to the FMEnv to facilitate environmental assessment of projects. The FMEnv ESIA Sectoral Guidelines for Manufacturing Industries. Sectoral Guidelines for Oil and Gas Industry projects and Sectoral Guidelines for Agriculture (published by FEPA in September 1995) provide assistance in the proper and detailed execution of ESIA study of the proposed project in consonance with ESIA Act of 2004.

1.7.3 DPR Environmental Protection and EIA Requirements

The present Department of Petroleum Resources (DPR) originated as the Petroleum Division of the Federal Ministry of Mines and Power, metamorphosing into the Petroleum Inspectorate in 1977 and later became the DPR in 1988. Since inception, the DPR has been facilitating the growth of the oil industry in conformity with legislation affecting the oil industry by encouraging exploration and explanation activities, which boosted the national reserves and production level.

The Act, by, which the DPR was established, empowers it to ensure that petroleum and petroleum products industry operators in Nigeria do not degrade the environment in the course of their operations. The DPR also enforces the cleanup of oil spills and restoration of 'impacted' environment to acceptable levels and also controls new projects that may adversely impact the environment. Consequently, DPR requires, by legislation, that holders of exploration, prospecting, exploitation, refining, transportation, and marketing licenses of petroleum resources take/adopt practical precautions and all steps practicable to prevent pollution, and cause as little damage as possible to the environment in their areas of operation. As a means to actualizing its mandate, the department developed and issued a set of guidelines and standards for petroleum industry operators in Nigeria.

Environmental Guidelines and Standards for the Petroleum industry in Nigeria (EGASPIN,1991), revised 2002 and 2018. The EGASPIN contains guidelines and requirements specific to hydrocarbon processing, oil and gas transportation, marketing of petroleum products operations. The DPR, which also controls the conception, planning and execution of new projects that may impact the environment makes the conduct of ESIA mandatory for all proposed oil and gas related developmental activities as an environmental management tool and an additional enforcement strategy before permission can be granted for the commencement of operations. EGASPIN states that Chlorofluorocarbons (CFC) and Halons are not to be used. If viable alternatives exist, Hydrochlorofluorocarbons (HCFCs) and Hydrofluorocarbons (HCs) will also be avoided. Annexes VIII D l-6 of the EGASPIN provide guidelines for laboratory

analysis procedures, parameters and safety measures. The EGASPIN requires that all laboratories used for analysis are EGASPIN accredited.

Table 1-1 Gaseous Emission Guidelines

Pollutant	8 hour mean (□g/m^2)
Suspended particle matter-Black smoke	
Total suspended particle matte	60-90
Carbon monoxide*	
Sulfur dioxide	100-150
Nitrogen dioxide*	150
Lead	

1.7.4 The Nigerian Urban and Regional Planning Act, CAP N138, LFN 2004

Decree 88 of 1992 established a Development Control Department (DCD) charged with the responsibility for matters relating to development control and implementation of physical development plans at Federal, State and Local Government Levels within their respective jurisdiction. Specifically, the Act is to ensure that:

- Approval other relevant DCD shall be required for all developments;
- A developer shall submit a development plan for the approval of DCD of Local
- Government. State or Federal Government:
- A developer (whether private or government) shall apply for a development permit in such manner using such forms and providing such information including plans, designs, drawings. and any other information as may be prescribed;
- A developer shall at the time of submitting his application for development submit to an appropriate Control Department a detailed Environmental Impact Statement (EISA) for an application for:
    a. Residential land in excess of 2 hectares, or
    b. Permission to build or expand a factory or for the construction of an office building in excess of 4 floors or 5000 square meters of lettable space, or
    c. Permission for a major recreational development.

The revised Act. CAP 138. LFN 2004 is aimed at overseeing realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. In this regard, the following sections become instructive:-

- **Section 39 (7)** establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.
- **Section 59** makes it an offense to disobey a stop-work order. The punishment under this section is a fine not exceeding N10,000 (Ten thousand naira) and in the case of a company. a fine not exceeding N50,000.
- **Section 72** provides for the preservation and planting of trees for environmental conservation.

Federal and State Ministries of Health

The Federal and State Ministries of Health require employers/employees to comply with the Factories Act, CAP 126, and 1990 Laws of the Federation, which stipulates in Part ll through V. provisions and regulations for health, safety and welfare in the workplace.

Part II - Health (cleanliness; overcrowding; ventilation; lighting; drainage of floors: and sanitary conveniences).

Part III - Safety (prime movers; transmission machinery; powered machinery; other machinery; unfenced machinery: construction and maintenance of fencing; construction and disposal of new machinery; vessels containing dangerous liquids: self-acting machines; training and supervision of inexperienced personnel; chains, ropes and lifting tackle; safe means of access and safe place of employment; precautions in places where dangerous fumes are likely to be present; precautions with respect to explosive or inflammable dust, gas, vapour or substance; air receivers; prevention of fire: and safety provisions in case of fire).

Part IV - Welfare (supply of drinking water washing facilities; accommodation for clothing; first aid; and exemption in an ambulance room is provided).

Parts V - Special Provisions and Regulations (removal of dust or fumes: meals in certain dangerous traces; protective clothing and appliances; protection of eyes in certain processes; power to make regulations for health, safety, and welfare; and power to take samples).

1.7.5 Other National Regulations

Other national regulations on environmental protection relevant to the proposed project are:

Land Use Act, CAP 202, LFN 2004

The Land Use Act of I 978 states that "... it is public interest that the rights of all Nigerians to use and enjoy land in Nigeria and the natural fruits thereof in sufficient quality to enable them to provide for the sustenance of themselves and their families be assured, protected and preserved" and was revised in 2004.

Forestry Act, 1958

This Act of 1958 provides for the preservation of forests and the setting up of forest reserves. It is an offense, punishable with up to 6 months imprisonment. to cut down trees over 2ft in girth or to set fire to the forest except under special circumstances. The policy on forest resources management and sustainable is aimed at achieving self-sufficiency in all aspects of forest products through the use of sound forest management techniques as well as the mobilization of human and material resources. The overall objectives of forest policy are to prevent further deforestation and to recreate forest cover, either for production or for protective purposes" on already deforested fragile land. Specifically, the National Agricultural Policy of 1988 in which the Forestry Policy is subsumed, provides for:

- Consolidation and expansion of the forest estate in Nigeria and its management for a sustained yield;
- Regeneration of the forests at rates higher than exploitation;
- Conservation and protection of the environment viz: forest, soil, water, flora, fauna and the protection of the forest resources from fires. cattle grazers, and illegal encroachment:
- Development of Forestry industry through the harvesting and utilization of timber, its derivatives and the reduction of wastes, and
- Wildlife conservation, management, and development through the creation and effective management of national parks, game reserves. tourist and recreational facilities, etc

Endangered Species Act, CAP 89, LFN 2004

This Act focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction as a result of overexploitation. These sections are noteworthy:

- **Section 1** prohibits, except under a valid license, the hunting, capture or trade in animal species, other presently or likely to be in danger of extinction.
- **Section 5** defines the liability of any offender under this Act.
- **Section 7** provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this Act.

The Nigerian Criminal Code makes it an offense punishable with up to 6 month’s imprisonment for any person who:

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

Inland Fisheries ACT, CAP 1l0, LFN 2004

Focused on the protection of the water habitat and its species, the following sections are instructive:

Section 1 prohibits unlicensed operations of motor fishing boats within the inland waters of Nigeria.

Section 6 prohibits the taking or destruction of fish by harmful means. This offense is punishable with a fine of N3,000 or an imprisonment term of 2 years or both.

Water Resources ACT, CAP W2, LFN 2004

The Water Resources Act is targeted at developing and improving the quantity and quality of water resources. The following sections are pertinent: Section 5 and 6 provides authority to make pollution prevention plans and regulations for the protection of fisheries, flora, and fauna. Section 18 makes offenders liable under this Act, to be punished with a fine not exceeding N2000 or an imprisonment term of six months. He would also pay an additional fine of N100 for every day the offense continues.

Workmen Compensation Act, 1987

The Federal Government of Nigeria, in compliance with its ratification of the ILO convention and its obligations thereunder,enacted the **Workmen Compensation Act** (**1987**) to provide for **compensation** for **workmen** injured in the course of their employment.

Abandonment Guidelines, 1995

Relevant LGA Bye-Laws

Local Government Laws on Environmental Protection

Labour Act, 1999

Nigeria has ratified all eight core International Labour Organization Conventions. The Labour Act (1999) is the primary law protecting the employment rights of individual workers. The Act covers the protection of wages; contracts, employment terms and conditions; recruitment; and classifies workers and special worker types.

Union membership is governed by the Tracie Union Amendment Act (1995). A 1999 constitution includes the stipulation of equal pay for equal work without discrimination on account of sex or any other ground whatsoever.

Nigerian Free Trade Zone Act No. 63, 1992

In 1992, the Nigerian Free Zone Act (Act No. 63 of 1992) was passed establishing the Nigerian Export Processing Zone Authority (NEPZA). As proposed, free trade zones (FTZ), are expanses of land with improved ports and/or transportation, warehousing facilities, uninterrupted electricity and water supplies, advanced telecommunications services and other amenities to accommodate business operations. Under the FTZ system, enterprises are exempt from custom duties, local taxes, and foreign exchange restrictions, and qualify for incentives-tax holidays, rent-free land, no strikes or lockouts, no quotas in European Union (EU) and United States (US) markets, as iong as end products are exported (although some portion can be sold in the domestic market). The NEPZA is responsible for the regulation of FTZ operations. Its tasks involve policy formulation, licensing and monitoring. The zones are governed by the FTZ Act which stipulates that an extensive ESIA must be carried out before the commencement of any major projects.

Sea Fisheries Act No. 71, 1992

The Sea Fisheries Act (Act No.7l of 1992) repeals the Seas Fisheries Act and makes provision for the control, regulation, and protection of sea fisheries in the territorial waters of Nigeria. The first part of the Act concerns the licensing of motor fishing boats. Section for specifies criteria for issue of a license. The second part of this Act concerns enforcement, the prohibition of certain fishing methods and offenses and penalties.

Sea Fisheries Act, CAP 54, LFN 2004

The Sea Fisheries Act makes it illegal to take or harm fishes within Nigerian waters by use of explosives, poisonous or noxious substances. Relevant sections include the following:

- Section 1 prohibits any unlicensed operation of motor fishing boats within Nigerian waters.
- Section 10 makes the destruction of fishes punishable with a fine of N50.000 or an imprisonment term of 2 years.
- Section 14 (2) provides authority to make for the protection and conservation of sea fishes.

National Inland Waterways Authority (NIWA) Act 1997

This is an Act of the Federal Ministry of Transport on the use of and navigation in inland waterways and permits by NIWA for dredging.

Nigeria Maritime Administration and Safety Agency

The Nigerian Maritime Administration and Safety Agency (NIMASA) is an Agency of the Federal Ministry of Transport with a mandate to protecting the coastal territorial waters and the Exclusive Economic Zone (EEZ) of Nigeria from pollutants like oil and others.

Petroleum Act, CAP P10, LFN 2004

The Petroleum Act and its Regulations remain the primary legislation on oil and gas activities in Nigeria. It promotes public safety and environmental protection. Tire section below is relevant: Section 9 (1) (b) provides authority to make regulations on operations for the prevention of air and water pollution.

There are also other regulations including:

- Wild Animals Preservation Act Cap 132 LFN 1990;
- Explosives Regulations, 1967;
- River Basins Development Authority Act. l9B7; and
- Natural Resources Conservation Act Cap 286 LFN 1990.

The Nigeria National Health Act 2014

The aim of the Act is to establish a national framework for the Regulation, Development, and Management of a National Health System, to set standards for rendering health services in Nigeria. Other key provisions include:

- Establishment of the National Health Systems,
- Provides for an exemption from payment for health services in public health establishments. and
- Provides for the establishment of the Basic Health Care provision fund among others.

Procedure Guide for the Design and Construction of Oil and Gas Surface Production Facilities (2001)

These guidelines, issued by the DPR and pursuant to Regulations 36 and 39 of the Petroleum (Drilling and Production) Regulations (1959), outline permitting procedures for applications for approval of construction of oil and gas surface production facilities in the Nigerian petroleum industry.

The approval process for any project execution covers four sequential stages:

- Conceptual design
- Detailed design
- Pre-commissioning/oil and gas facility operating permit
- Decommissioning

The Oil and Gas Pipelines Regulations (1995), as published in the Federal Republic of Nigeria Official Gazette (No. 49 Gas Pipelines Regulations 1995)

Federal Republic of Nigeria Official Gazette No.26 of 2 October 1995. Vol. 82 [Government Notice No.49], came into effect on 17 June 1995 and enlarges the scope and coverage of the pipeline Act of 1956. These regulations require that pipeline construction is performed in a manner minimizing disturbance to the provisions of API RP 1102 or other recognized equivalent international operating standards.

Associated Gas Re-injection Decree No. 99 (1979)

Section 1(a) of the Associated Gas Re-injection Decree No. 99 (1979) required that by April 1980 every company producing oil and gas in Nigeria furnish the federal government with its preliminary programmes or schemes for viable utilization of all AG produced. Section 3(l) prohibits AG flaring after 1 January, 1984 unless by written permission of the Minister of Petroleum Resources. The Act contains a subsidiary legislation Associated Gas Re-injection of-1985, which regulates continued flaring of RG in Nigeria.

The Oil Terminal Dues Act

The Oil Terminal Dues Act was enacted to provide for the levering and payment of terminal dues on any ship evacuating oil at any terminal at any port in Nigeria with respect to any services provided at those posts, and for all other matters connected therewith. The Act makes it an offense to discharge oil or mixture containing oil into the territorial waters of Nigeria from any oil terminal. The Act applies to all natural persons, whether Nigerian citizen or not and whether resident in Nigeria or not, and to all corporation, whether incorporated or carrying on business in Nigeria or not.

Oil in Nigeria Waters Act (1968)

The Oil in Nigeria Waters Act of 1968 was aimed at the implementation of the terms of the International Convention for the prevention of Pollution of the Sea by Oil (1954 to 1962) and at making provisions for such prevention in the navigable waters of Nigeria.

Oil Pipelines Act, CAP 07, LFN 2004

The Oil Pipelines Act and its Regulations guide oil activities. The following sections are pertinent:

Section 9 (1) (b) establishes the requirement of environmental emergency plans.

Section 11 (5) creates a civil liability on the person who owns or is in charge of an oil pipeline. He would be liable to pay compensation to anyone who suffers physical or economic injury as a result of a break or leak in his pipeline.

Section 17 (4) establishes that grants of licenses are subject or regulations concerning public safety and prevention of land and water pollution.

Nigerian Content Development Board Bill 2010

This Act provides for the development of Nigerian Content in the Nigeria Oil and Gas industry, Nigeria content plan, supervision, coordination, monitoring and implementation of Nigerian content. There is established the Nigerian Content Monitoring Board (in this Act referred to as "the Board") which shall have the functions and power conferred on it by this act.

The Board shall be a body corporate with perpetual succession and a common seal and may sue and be sued in its corporate name.

The functions of the board shall be to:

- Implement the provisions of this Act;
- Implement the regulations made by the Minister in relation to any aspect of this act:
- Supervise, coordinate, administer, monitor and manage the development of Nigeria content in Nigerian oil and gas industry;
- Supervise, coordinate, administer and monitor the implementation and development of Nigerian content as specified in the schedule to this Act in the operation of operators, contractors and all other entities in the Nigerian oil and gas industry;
- Appraise, evaluate and approve the Nigerian content plans and reports submitted to the Board in compliance with the provisions of this Act;
- Award Certificate of Authorization and conduct reviews of the Nigerian content plans and report submitted to the Board in compliance with the provision of this Act;
- Administer and operate the e-marketplace and Joint Qualifications System set up in accordance with the provisions of this Act;
- Assist local contractors and Nigerian companies to develop their capabilities and capacities to further the attainment of the goal of developing Nigerian content in the Nigerian oil and gas industry;
- Make procedures to guide the implementation of this Act and ensure compliance with all the provision of this Act;
- Monitor and coordinate the Nigerian content performance of all operators in accordance with the provisions of this Act;
- Make auditing procedures and conduct regular audits for the purpose of monitoring and implementing compliances with provisions of this Act;
- Provide guidelines, definitions, and measurement of Nigeria content and Nigerian content indicator to be utilized throughout the industry;
- Conduct studies, researches, and investigations that may further the attainment of the goal of developing Nigerian content in the Nigerian oil and gas industry;

- Organize conferences, workshops, seminars, symposia, training, road shows and other public education for a to further the attainment of the goal of developing Nigerian content in the Nigerian oil and gas industry;
- Delegate any of its functions to any agent or operative appointed by the council, and
- Do legally anything necessary to be done to facilitate the carrying out of its functions.

Other Federal laws and regulations include;

- Nigerian Ports Authority Law
- Harmful Waste (Special Criminal Provisions) Act CAP H1 2004

Table 1-2 National Legislations List

Application Regulation	**Year Adopted**
Department of Petroleum Resources (DPR) Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN)	2018
Procedure Guide for the Design and Construction of Oil and Gas Surface Production	2001
Ogun State Government Environmental Laws	2000
Petroleum (Amendment) Regulation	1996
Sectoral Guidelines for Oil and Gas Industry	1995
Oil and Gas Pipeline Act and Regulations	1995
Environmental Impact Assessment Act	1992
DPR procedure Guide for the Construction and Maintenance of Fixed Offshore Platforms	1992
S.I.8 National Environmental Protection (Effluent Limitation) Regulations S.I.9 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations S.1.15 National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations	1991
Interim Guidelines and Standards for Environmental Pollution Control in Nigeria	1991
Federal Environmental Protection Agency Act (FEPA Act)	1989
Federal Environmental Protection Agency Act	1988
Endangered Species (Control of International Trade and Traffic Act 1985	

CAP 108, LFN 1985)	
Associated Gas Re-Injection Regulation	1985
Petroleum Pollution and Distribution (Anti-Sabotage) Act	1975
Petroleum Refining Regulations	1974
Petroleum Drilling and Production Act	1969

1.7.6 Ogun State Environmental Protection Agency (OGEPA)

The Ogun State Environmental Protection Agency is responsible for the oversight of the environment in Ogun State. The Agency registers and monitors development projects throughout the state, and also manages matters relating to waste generated within the State. The Agency is the key to the development of governmental policies for environmental sustainability, and the regulation and enforcement of Federal and State policies regulations.

Specific functions of OGEPA include:

- Advising the State Government on all environmental management policies,
- Giving direction to the affairs of the Agency on all environmental matters:
- Preparing periodic Master plan to enhance capacity building of the agency and for the development and natural resources management;
- Carrying out public enlightenment and educating the general public on sound methods of environmental sanitation and management;
- Carrying out an appropriate test on insecticides, herbicides and other agricultural chemicals;
- Monitoring and controlling disposal of solids, gaseous and liquid wastes generated by both government operations;
- The setting, monitoring and enforcing standards and guidelines on vehicular emission;
- Surveying and monitoring surface underground and potable water, air land and soil environments in the state to determine the pollution level in them and collect baseline data.
- Promoting co-operation in environmental science and technologies with similar bodies in other countries international bodies connected with the protection of the environment; and
- Cooperating with the federal, state and local Governments, Statutory Bodies and Research Agencies on matters and facilities relating to environmental protection.

1.7.7 Ogun State Ministry of Environment

The Ministry of Environment was established in July, 2003 with the aim of creating better living and conducive environment for the entire people of Ogun State. The Ministry has five (5) departments and two (2) sister Agencies namely, Ogun Environmental Protection Agency (OGEPA) and Ogun State Emergency Management Agency (SEMA).

- Waste Management;
- Environmental Sanitation and Protection Services
- Pollution Control
- Ecological and Conservation matters;
- Control and regulation of Outdoor Advertisement
- Drainage services
- De-flooding;
- Sewage Management;
- Coastal and Hinterland Erosion control;
- Evaluation of Environmental Study Impact Assessment (ESIA), and
- Environmental Audit Report (EAR)

Parastatals under this Ministry include:	
Ogun State Ministry of Community Development and Cooperatives	(OGMCDC)
Ogun State Environmental Protection Agency	(OGEPA)
Ogun State Ministry of Environment	(OSME)
Ogun State Water Corporation	(OSWC)

One key function defined for the Ministry as highlighted above is to monitor the implementation of ESIA guidelines and procedures on all development policies and projects within the State. In this regard, ESIA is a regulatory requirement in the State.

1.7.8 Ogun State Waterfront Infrastructural Development Law, 2008

The Law confers the following functions on the Authority managing the waterfront development in Ogun State. They include

- Ensure a balance between economic development and preservation that will permit the beneficial use of waterfronts while preventing the diminution of open space areas or

public access to the waterfront, shoreline erosion, impairment of scenic beauty, or permanent adverse changes to ecological systems;

- Facilitate public access to waterfronts for the recreational purpose;
- Develop infrastructure along waterfronts for recreational purposes
- Minimize damage to natural resources and property from flooding and erosion protection of waterfronts, beaches, dunes, barrier islands, bluffs and other critical coastal and inland waterway features;
- Initiate and develop waterfront restoration and revitalization programs
- Enter into contracts with any person, firm, corporation, or governmental agency

1.7.9 Road Traffic and Vehicle Inspection in Ogun State, 2012

This law was enacted without prejudice to the provisions of Section 11 of the Ogun State Traffic Management Authority Law. The Authority's control and management of vehicular traffic in the Ogun State include:

- Prohibition of restriction of the use of the specified highway by vehicles
- Prohibition of driving or propelling vehicles on any specified highway by vehicles of specified class or description:
- Prohibition of vehicles parking or waiting on any specified highway
- Prohibition or restriction of the use of sirens, and the sound of horns or other similar appliances either in general or during specified hours or in respect of specified areas
- Regulation of the conduct of persons driving. propelling, being in charge of or handling any vehicle or animation on a highway
- Application of breath testing, blood and urine specimen testing devices on any driver to detect whether he is driving under the influence of alcohol, or drugs.
- Demand of a psychiatric evaluation of any person who drives against the normal flow of traffic or who fails to comply with any of the provision of this Law, if in the opinion of any officer of the Authority such an evaluation is necessary for the purpose of determining the person's ability to operate a motor vehicle provided that such shall be at the driver's cost; and
- General regulation of traffic on public highways.

1.7.10 Construction Workers Safety Law, 2003

This law provides for the safety of workers in the construction and allied industries in Ogun state. Essentially, the law is to guarantee the safety of health and the environment. It strives to

protect workers health In addition, the law mandates all employers to compulsorily insure their workers against occupational risks

1.7.11 Other relevant Ogun State Laws

Other relevant Ogun State Laws that are expected to guide the construction, operation and decommissioning of the plant including but not limited to the following:

- Ogun State Environmental Sanitation Law
- Ogun State Pollution Control Law Cap 46 Laws of Lagos
- Road Traffic Law Cap 172 of Ogun State of Nigeria
- Ogun State Safety Commission Law,
- Transportation of Employees Law
- Ogun State Infrastructure Maintenance and Regulatory Agency Law

1.7.12 NGMC HSE Policy

HSE fits strategically into NNPC's mandate by working in the best way possible to balance and integrate all aspects of Environment and Safety considerations into all NNPC business objectives and decisions. We ensure strong HSE management and performance in Engineering designs, construction, and technology selection, continuous development and training of staff. In this regard, we maintain an effective synergy with all our units for effective coordination and monitoring of all aspects of Safety and Environment in all projects and operations.

1.8 International Guidelines and Conventions

In addition to the national laws/regulations, Nigeria is signatory or party to several international conventions and treaties that support the use of ESIA as the key tool for achieving environmentally sustainable development. The ESIA shall be guided by the international environmental and social regulations from IFC/World Bank where applicable.

All other relevant international guidelines and conventions, and industry best management practices shall also apply, including the international financing community.

Examples of such statutes to guide this study include:

- IFC Environmental, Health, and Safety Guidelines for Gas Distribution Systems, 2007
- IFC General Environmental, Health, and Safety Guidelines, 2007;
- IFC Guidelines for Crude Oil and Petroleum Product Terminals, 2007
- IFC Performance Standards for Environmental and Social Sustainability, 2012:
- World Bank Operational Policy 4.01-Environmental Assessment, 2011:

- AIDB Integrated Environmental And Social Impact Assessment Guidelines, 2003:
- IFC Handbook for Preparing a Resettlement Action Plan, 2002:
- AfDB Policy on the Environment. 2004.
- AfDB Environmental Review Procedures for Private Sector Operations, 2000:
- AfDB Gender Policy, 2001:
- AfDB Policy on Involuntary Resettlement, 2003; AIDB Environmental and Social
- Assessment Procedures for African Development Bank's Public Sector Operations, 2001, and
- The Equator Principles, 2003/2006/2011/2013/2020.

In the next paragraphs, firstly, the most important IFC Standards and Guidelines will be highlighted and secondly, an attempt will be made to have a closer look at some of the other international conventions/guidelines and agreements.

IFC's Sustainability Framework - 2012 Edition

The Sustainability Framework consists of:

- The Policy on Environmental and Social Sustainability, which defines IFC's commitments to environmental and social sustainability and responsibility in supporting project performance in partnership with clients;
- The Access to Information Policy, which articulates IFC's commitment to transparency;
- The Performance Standards, which define clients' responsibilities for managing their environmental and social risks and includes requirements for IFC support, and
- Environmental, Health and Safety (EHS) Guidelines. This is technical guidance on environmental, health and safety issues, such as ambient air quality, chemical hazards and disease prevention.

IFC's Performance Standards on Social and Environmental Sustainability

The 2012 edition of IFC's Sustainability Framework applies to all investment and advisory clients whose projects go through IFC's initial credit review process after January 1, 2012. IFC's Performance Standards define client roles and responsibilities for managing projects and requirements for IFC support. The standards include requirement to disclose information The Guidance Notes are companion documents to the Performance Standards.

The standards are divided into the following issue-specific sections:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 2: Labour and Working Conditions

- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety and Security
- Performance Standard 5: Land Acquisition and involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples, and
- Performance Standard 8: Cultural Heritage

Together, these eight Performance Standards establish standards what the client is to meet throughout the life of investment by IFC:

IFC PS 1 (Assessment and Management of Environmental and Social Risks and Impacts) PS 1 defines the importance of implementing a robust and effective Environmental and Social Management System on the business activity drawing on the assessment findings of social and environmental impacts from the project to then implement systems to avoid, reduce or remove the impacts identified through mitigation. Particular reference is made towards affected communities, grievance mechanisms, and community consultation.

IFC PS 2 (Labour and Working Standards):

PS 2 recognizes that the pursuit of economic development through job creation and income generation should be accompanied by the protection of the worker's human rights, Safe and healthy working conditions can be a catalyst for tangible benefits for the project.

IFC PS 3 (Resource Efficiency and Pollution Prevention):

PS 3 specifically addresses managing resource efficiency and pollution prevention within project life cycles. It encourages the project to actively utilize current internationally disseminated technologies and good practice.

IFC PS 4 (Community Health, Safety and Security):

PS 4 specify requirements for mitigating any potential for community exposure to risks and impacts arising from equipment accidents, structural failures and releases of hazardous materials. In addition, PS 4 realizes that communities may be affected by impacts on their natural resources, exposure to diseases and the use of security personnel.

IFC PS 5 (Land Acquisition and Involuntary Resettlement):

This Standard outlines a policy to avoid or minimize involuntary physical resettlement as a consequence of the project. Where it is unavoidable, it requires suitable measures to mitigate adverse impacts on affected stakeholders, including appropriate compensation for any economic displacement such as loss of subsistence or commercial livelihood.

IFC PS 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources):

PS 6 sets out an approach to protect and conserve biodiversity including habitats, species, genes, and genomes, all of which have potential social, economic, cultural and scientific importance, as well as means to ensure no net loss/no net reduction and biodiversity offset.

This PS is guided by the Convention on Biological Diversity.

IFC PS 7 (Indigenous Peoples):

This PS recognizes that indigenous people can be marginalized and vulnerable (for example, if their lands and resources are encroached upon by or significantly degraded by a project). Their languages, culture, religions, spiritual beliefs and institutions may also be under threat.

This PS sets out how to avoid this and include the people in the project.

IFC PS 8 (Cultural Heritage):

The PS aims to protect irreplaceable cultural heritage and to provide guidance for protecting cultural heritage throughout a project life cycle.

1.8.1 IFC's Environmental, Health and Safety (EHS) Guidelines (2007)

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC's Performance Standard 3 on Pollution Prevention and Abatement. Reference to the EHS Guidelines by IFC clients is required under Performance Standard 3. IFC uses the EHS Guidelines as a technical Source of information during project appraisal activities, as described in IFC's Environmental and Social Review Procedure.

The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC and are generally considered to be achievable in new facilities at reasonable costs by existing technology. For IFC-financed projects, application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets with an appropriate timetable for achieving them. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become project- or site-specific requirements. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

1.8.2 General EHS Guidelines

The General EHS Guidelines contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors. It is designed and should be use together with the relevant industry sector guideline(s). It sets our specific minimum standard in regards to environmental protection, occupational health and safety, and community heals and safety throughout the project life cycle impacts.

The General EHS Guidelines are organized in 4 main chapters:

- Environmental
- Occupational Health and Safety
- Community Health and safety
- Construction and Decommissioning

1.8.3 Other International Conventions/ Guidelines and Agreements

World Bank Operational Directive

The World Bank Operational Directive 4.01: "Environmental Assessment" of 1991 (revised April 2012), classifies projects according to the nature and extent of their environmental impact.

OECD Common Approaches on Environmental and Officially Supported Export Credits

In December 2003, the Organization for Economic Co-operation and Development (OECD) Council adopted the Recommendations on Common Approaches on Environment and Official Supported Export Credits (the Recommendation). The Recommendation is designed to, among other things, promotes the good environmental practice and consistent approaches for projects benefiting from officially supported export credits, and to encourage the prevention and the mitigation of the adverse environmental impacts of projects including involuntary resettlement. The recommendation prescribes that a benefiting project's Environmental Impact Assessment Repot should indicate the need for a resettlement plan, prepared in accordance to host government standards and the World Bank' Group's Performance Standards.

Equator Principles (EP)

It is a financial industry benchmark for determining, assessing and managing social and environmental risk in project financing.

Principle 2 Social and Environmental Assessment

For each project assessed as being either Category A or Category B, the borrower has conducted a Social and Environmental Assessment ("Assessment") process to address, as appropriate and to the Equator Principles Financial Institutions (EPFI) satisfaction, the relevant and environmental impacts and risks of the proposed project (which may include, if relevant, the illustrative list of issues as found in Exhibit II of the EP). The Assessment should also propose mitigation and management measures relevant and appropriate to the nature and scale of the proposed project. These Principles are intended to serve as a common baseline and framework for the implementation by each EPFI of its own internal social and environmental policies, procedures, and standards related to its project financing activities. EPFI will not provide loans to projects where the borrower will not or is unable to comply with her respective social and environmental policies and procedures that implement the Equator Principles.

Environmental and Social Safeguards policies (African Development Bank)

The African Development Bank issued its Environmental Assessment Guidelines (EAG) in 1992, but since then, many changes have occurred in the Bank' structure and operations. The revised Environmental and Social Assessment Procedures (ESAP) have therefore been updated to reflect the more integrated approach addressing all crosscutting themes as well as the new organizational structure. The main purpose of the Environmental and Social Assessment Procedures (ESAP) is to improve decision-making and project results in order to ensure that Bank-financed projects, plans, and programs are environmentally and socially sustainable as well as in line with Bank's policies and guidelines. Other relevant AfDB policies are: AfDB Policy on the Environment (2004), AfDB Environmental Review Procedures for Private Sector Operations (2000), AfDB Gender Policy (2001), AfDB Policy on Poverty Reduction (2004) and AfDB Policy on Involuntary Resettlement (2003).

Convention Concerning the Protection of the World Cultural and National Heritage (World Heritage Convention), 1972

The World Heritage Convention (1972), seeks to set aside areas of cultural and natural heritage, the latter defined as areas with the outstanding universal value from the aesthetic scientific and conservation points of view.

United Nations Guiding Principles on the Human Environment

The United Nations (UN), concerned about negative environmental trends since its formation, published two major concept documents: Guiding Principles on the Human Environment, 1972 and the Rio Declaration on Environment and Development. Ten of the Guiding Principles were defined as formal declarations that express the basis on which an environmental policy can be built and which provide a foundation for action. The principles most relevant to the proposed project are summarized below.

Principle Two

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

Principle Four

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

Principle Six

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

The Rio Declaration on Environment and Development

The UN Conference on Environment and Development (Rio de Janeiro, 1992), reaffirmed the 1972 declaration on the Human Environment and sought to build upon it. This is with the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people.

It is also to aid work towards international agreements, which respect the interests of all, protect the integrity of the global environmental developmental system, and recognize the integral and interdependent nature of the earth. The UN thus added additional principles to the originals, the more relevant being:

Principle One

Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle Ten

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle Seventeen

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

Convention on the Conservation of Migratory Species of Wild Animals or Bonn Convention (1979)

The Bonn Convention's mode of action is conservation and management of migratory species (including waterfowl and other wetland species) and promotion of measures for their conservation, including habitat conservation. Conservation of these habitats is one of the principal actions taken for endangered species or groups of species, which are subject of Agreements under the Bonn Convention. This was adopted in 1979.

Convention on Biological Diversity (1992)

The objectives of this Convention, which was opened for signature at the 1992 Rio Earth Summit, are 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,

including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and appropriate finding.

Pollution. The countries are also expected to prevent, reduce, combat and control coastal erosion, protect and preserve rate or fragile ecosystem; cooperate in dealing with pollution emergencies in the Convention area; establish rules and procedures for the determination of liability and the payment of adequate and prompt compensation for pollution damage of the area.

Vienna Convention for the Protection of the Ozone Layer, 1985 and the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987

The release of chlorofluorocarbons (CFCs) into the atmosphere acts to deplete ozone in the stratosphere, thus, increasing the amount of damaging ultraviolet radiation (DUV) reaching the ground from the sun The Convention and its Protocol made recommendations and programmes for the control of any substance, practice, process or activity which may affect the ozone layer in the stratosphere

United Nations Framework Convention on Climate Change (UNFCC), 1992 and Kyoto Protocol on Climate Change, 1997

Green House Gas (GHG) emissions, particularly of carbon dioxide (CO2) are implicated in global warming of the atmosphere causing global change/increase in the earth's atmospheric temperature and the latter is responsible for series of adverse climatic/meteorological changes such as sea level rise, excessive heat, flooding, desertification, reduced agricultural productivity, human ill health, and death of grazing mammals, among others. The Convention and its Protocol called for the protection of climate system for the benefit of present and future generations of humankind, reduction or prevention of anthropogenic emissions of GHG in energy, transport, industry, agriculture, forestry, and waste management sector.

Ramsar Convention on Wetlands, 2002

Wetlands are areas of submerged or water saturated or water dominated lands. The Treaty is for conservation and management of wetlands because they are important habitats for specialized plants and animals.

Other relevant regulations/conventions include:

Protocol Concerning Cooperation in Combating Pollution in Cases of Emergency in the West and Central African Region, 1981

The Abidjan Convention obligates the Contracting Parties to take all appropriate measures to prevent, reduce, combat, and control pollution and to ensure the sound environmental management of natural resources in the Convention area. To meet their obligations, the Contracting Parties are called upon to cooperate with relevant international, regional, and sub-regional organizations to establish and adopt recommended practices, procedures, and measures designed to fight pollution. These initiatives should be supported by the national laws.

The Abidjan Convention focuses on: pollution from normal or accidental discharge from ships: pollution caused by dumping from ships and aircraft: pollution caused by discharge from rivers, estuaries, coastal establishments, and outfalls, or emanating from any other sources on the Contracting Parties' territories: pollution from activities relating to the exploration and exploitation of the sea-bed: pollution from or through the atmosphere; and coastal erosion caused by human activity, such as land reclamation and coastal engineering.

In addition, the Contracting Parties are called upon to work towards establishing protected areas for fragile ecosystems and endangered species and controlling activities likely to have adverse effects on endangered species, ecosystems, or biological processes.

Table 1- 3: Summary of Key International Agreements

Environment –Resource Protection Regulation	**Year Adopted**
World Bank Environmental Assessment Source Books	1998
United Nations (UN) Convention on Biological Diversity	1994
Basel Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal	1989
UN Convention on the Law of the Sea	1982
Protocol Relating to the International Convention for the Safety of Life at Sea (SOLAS PROT)	1978
Convention on the Conservation of Migratory Species (CMS)	1987
African Convention on Conservation of Nature and Natural Resources	1968
UN Framework Convention on Climate Change	1992

Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel Convention)	1990
Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (including the Protocol Concerning Cooperation in Combating Pollution in Cases of Emergency)	1981
Convention on the Prevention of Marine Pollution By Dumping of Wastes and Other Matter (London Convention)	1976
Convention on the Territorial sea and Contiguous Zone	1958

1.9 Report Structure

This report begins with a table of contents, a list of tables figures plates and relevant abbreviations. The details of the Environmental and Social Impact intending TGNL pipeline project are reported as follows:

Executive Summary

It contains a non-technical summary (executive summary) of the content of the chapters in the report.

Chapter One: Introduction

This is an introduction comprising basic information about the proponent, the methodology and a review of the legal and administrative framework as applicable to the proposed- TGNL Sagamu LDZ Natural Gas Pipeline Network Construction Project.

Chapter Two: Project Justification

It looks at the project justification, the need/value and the envisaged sustainability of the project.

Chapter Three: Project and Process Description

The technical details of the proposed project are thoroughly discussed.

Chapter Four: Description of the Existing Environment

This chapter describes the ecological and socio-economic baseline condition of the project area.

Chapter Five: Socio-Economic Impact Assessment

This chapter discusses the Socio Economic impact assessment and presents the associated and potential impacts of the proposed TGNL Sagamu LDZ Natural Gas Pipeline Network Construction Project.

Chapter Six: Potential and Associated Impacts

It offers mitigation measures for the important impacts of the proposed project.

Chapter Seven: Mitigation Measures

It offers mitigation measures for the important impacts of the proposed project.

Chapter Eight: Environmental and Social Management Plan (ESMP)

This chapter presents ESMP as a tool for proper management of the environmental concerns identified in the ESIA; by facilitating its integration into ESIA, ensuring future compliance with legislation and good environmental performance, and integrating the environmental concerns into the decision making.

Chapter Nine: Decommissioning

This chapter discusses some notices regarding decommissioning and abandonment of the projected sequel to the fact that the proposed project is a component of Sagamu LDZ Natural Gas Pipeline Network Construction Project, an industrial/commercial site that will be developed for the future centuries with persistent maintenance and as such demolition and recovery of the land in the original state is exclusive of this project.

Chapter Ten: Conclusions

The salient findings of the ESIA are pinpointed in this chapter.

References and Appendices

This report is closed with cited and relevant references appendices. The appendices include:

1. Terms of References (ToR)
2. TGNL Corporate HSE Policy
3. Waste Management Plan (WMP)
4. Environmental Baseline Data
5. Field Sampling Methods and Map
6. Photo Album
7. Project uncertainties
8. Notification for a change in the pipeline route
9. ESIA Questionnaire

1.10 Declaration

In compliance with all relevant National, State, Local Governments laws and regulation including International Agreements Conventions, Rite Foods Nigeria Limited Ososa, Ogun State and Transit Gas Nigeria Limited declare that this Environmental and Social Impact Assessment (ESIA) is prepared using the best available expertise in personnel equipment, and university acceptable methods.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Introduction

The proposed 135km Gas pipeline project (design, construction, operation and decommissioning) will start at tie-in point KP312 on the Escravos-Lagos Pipeline System (ELPS) at Ibefun Sagamu LDZ Natural Gas Pipeline Network Project. The ESIA analysis of project alternatives provides a clear and objective basis for the identification of best means for project implementation that complies with regulators', stakeholders', proponent's and sponsors' requirements applying best practicable environmental options (BPEO) and incorporating best available technique (BAT).

The process provides consideration to technical, economic, environmental, safety, health, security, and social components. Early identification and due consideration of these components, along with the other key components of the proposed project, enable the project proponent to carry out proper planning and effective implementation targeted towards accomplishing the project objectives.

This chapter, therefore, presents the project's needs and benefits, and methodology for selecting the optimal alternative that will meet the project objectives and other statutory local, national and international requirements.

2.2 Need for the Project

The industrial users of gas on the Sagamu LDZ including Rite Foods Nigeria Limited require the supply of gas to support their production activities. The Sagamu LDZ natural Gas Pipeline Network requires 150 mmscfd of natural gas for entire complex. The Rite Foods Nigeria Limited (RFNL) consulted with the Transit Gas Nigeria Limited (TGNL) to provide the gas required pending the completion and commissioning of the East-West Offshore Gas Gathering System which will ultimately provide gas to support the complex in the long term.

The TGNL agreed and decided to lay a 135km x 12'' pipeline from its tie-in point KP312 on the Escravos-Lagos Pipeline System (ELPS) at Ibefun to the Rite Foods Nigeria Limited in Ososa. To fast track the process and ensure that the production schedule is met, Axxel Nigeria Limited, the parent company of Transit Gas Nigeria Limited agreed to fund the gas pipeline project. It is feared that if an alternative gas source is not made, which the proposed project seeks to do, there will be a major slip in project delivery schedule with significant impact on project objectives and cost.

Therefore, adoption of the proposed 135km gas pipeline project will ensure timely project delivery and commencement of production while reducing cost.

2.3 Benefit of the project

The proposed TGNL gas pipeline project is expected to have many economic, social and environmental benefits which include the following amongst others:

- Natural gas is a very attractive feedstock in the world today and offers itself as a cheaper, cleaner and safer alternative when compared to other sources of feed. It is also a feedstock whose usage is increasing because of its unique qualities in terms of safety, reliability, cost and environment friendliness.
- Gas flaring is a waste of natural resource with resultant adverse environmental implications, the chief one being the emission of greenhouse gases (GHGs) causing global warming. Therefore, consumption of natural gas by the RFL will help the nation reduce the amount of gas routinely flared and foster national economic growth in line with the National Gas Policy (2017) and Gas Master Plan (GMP) of 2008.
- The construction and operation of the gas pipeline will increase revenue for Ogun State and Federal Governments via taxes, tariffs and other dues that will be paid by RFL and contractors throughout the life span of the project. In light of the recent state of the agricultural sector, supplying gas for generation will help in improving the agricultural sector and the nation in general through the increased supply. Through the sales and utilization of more gas for generation, it will contribute to Nigeria's ability to sustain its growing food needs and increase national gross domestic product (GDP) and Income.
- The gas pipeline will promote lateral and vertical growth of gas utilizing project around the project area especially around the Sagamu LDZ Ogun State axis. The project will enhance the national economy by stimulating industrialization through increased and cheap access to gas as process feedstock and power generation in Ogun State.
- Locally, the project will create skilled and unskilled job opportunities that will improve the living standards of rural communities.

2.4 Value of the project

The estimated value of the project is about $1,000,000,000.00 (One Billion Dollars only). Moreover, the project offers a number of opportunities in a national context.

- Improves the gas availability to the Rite Foods and potential customers in the region for the produced Rite Foods industries thereby enhancing national economic growth.

- Is consistent with the Nation's priority for the rapid growth of the agricultural sector.
- Satisfies drivers to achieve diversification of the nation's economy.

2.5 Envisaged Sustainability

Natural gas that traditionally in Nigeria was flared at oil extraction sites for years, (as of mid-2002, gas flared was 21.56bcm while gas utilized was 20.76bcm), has increasingly been recognized as an enormous income-generating resource for Nigeria and now being captured for processing and sale both regionally and overseas. Nigerian National Petroleum Corporation (NNPC) estimates that Nigeria flared natural gas accounts for approximately 12% of the world total. Within the last four decades, about 23Tcf of gas has been produced, with activity in the sector expanding each year.

The project's sustainability is addressed under its economic, technical, social and environmental sustainability potentials as discussed below.

2.5.1 Technical sustainability

The agricultural sector currently consumes minimal percent of Nigeria's natural gas. Nigeria's Agricultural Development Strategies requires diversification into the use of cleaner and more available source of feed for the production of edible foods as a measure of sustainability in development. On the supply, the proven and probable natural gas reserves will ensure supply for at least another 20years. The designed life for pipelines is generally about 30 years, which is primarily determined by the life expectancy of the cathodic protection (anti-corrosion) system. With proper corrosion inspection and remedy of the corroded pipes, this life expectancy can be achieved.

The gas pipeline construction project is technically sustainable because T G N L / NGMC will strictly adhere to internationally and nationally acceptable engineering design, construction and operation standards. Best Available Technology (BAT) in the oil and gas industry shall be adopted. TGNL/NGMC throughout the life cycle of the project (Design, Construction, Operation, and Decommissioning) shall strictly comply with applicable national and international engineering design codes, guidelines and standards.

2.5.2 Environmental Sustainability

Innovative technologies that are economically viable and having minimal environmental, social and health impacts shall be utilized in the execution of the proposed project. Pipeline and facilities construction techniques vary according to the environmental considerations and are guided by Regulatory and Engineering Design standards. Pipelines in marshy/swampy areas and water crossings would have an applied concrete coating over the external, anti-corrosion coating. To ensure that environmental sustainability is maintained, the pipeline will be laid without excavating more than required and the excavated material will be used to backfill. The stream/river crossings of the rivers will be by Horizontal Directional Drilling (HDD), this pipe laying technique cross the rivers will help to minimize the environmental impact of the project to the aquatic ecosystem and adverse socio-economic impacts to people.

Furthermore, waste materials will be collected and disposed of in an approved manner by an accredited waste vendor(s). Meanwhile, the right-of-way (ROW) will be done only to the extent of what is required to execute the project. The regulatory supervision and requirements involving DPR, Federal, State, and Local Government Council environmental laws, regulations, guidelines, standards and edicts, and the ratified international conventions, as well as TGNL HSE Policies, shall be adopted and implemented to sustain the project environmentally throughout its lifespan. Good housekeeping and waste management practices shall be adopted. There shall be continuous consultations with all stakeholders and a good working relationship with the host communities, including the provision of mutually agreed infrastructural and social services by Transit Gas Nigeria Limited (TGNL). The incorporation of the findings and recommendations of this ESIA at the various stages of the project development and strict adherence to the Environmental and Social Management Plan (ESMP) will ensure Environmental sustainability.

2.5.3 Economic Sustainability

The Project will boost the economic activities within Sagamu and its environs. Income will be generated by the gas supplier from the sales of gas which would have been otherwise flared. Uninterruptedly, it will be generating revenue for the government as foreign exchange. Economy diversification will be achieved as well. There will be food security as both local and mechanized farmers will have access to at an affordable price and any available period of time.

2.5.4 Social Sustainability

The Project will offer gainful employment to the members of the host communities and the wider Nigeria community that have the specialist skill required for pipeline construction. Several welders (both from and outside the host community) will be trained and some up skilled, these skills will help the beneficiaries to be gainfully employed even after the project must have been concluded. Food and Agriculture supply program which includes training and provision of inputs will be provided to support the local communities. The stakeholder workshop organized by TGNL as part of the ESIA process to explain the objectives of the project has contributed to the acceptability of the project by the communities' members. Continuous consultation with stakeholders will further promote the social sustainability of the project.

2.6 Project Alternative Analysis

The purpose of the Environmental and Social Impact Assessment (ESIA) project alternatives analysis is to provide a transparent and objective basis for identifying optimal project alternatives consistent with stakeholder, sponsor and regulatory goals. The alternatives analysis is structured to accord a high priority to environmental and social concerns in the selection process, in addition to considering technical and economic criteria. By explicitly incorporating environmental and social impacts into a high-level, early-stage evaluation of the proposed project, this analysis is expected to assist in identifying the approach to meeting project objectives that offers the best combination (i.e. the minimum) of cost and negative environmental/social impacts (World Bank, 1996).

Alternatives may include but are not limited to, location or site alternatives, process or technology alternatives, the no-action alternative, etc. The "No Development" alternative provides the baseline against which the impacts of the other alternatives are compared. The alternatives analyzed for this project are as follows:

- Analysis of Alternative Right of Way route (Concept)
- Analysis of Alternative Technology (Compressed Natural Gas CNG) in bottles vs. pipeline gas
- Analysis of "No development" alternative.

2.6.1 No-Project Option

Taking no action would, naturally, be a feasible option. Under the No-Project Option, gas would not be transported to the Rite Foods Nigeria Limited plant. No action on any alternative would mean a lack of a viable feed solution in the Rite Foods Nigeria Limited plant, limiting productivity.

Advantages

- Land that would otherwise be occupied by the pipeline (or other project alternatives) would continue to remain available; in some instances, the population employs this land for income-earning activities (e.g., agriculture).
- With the reduced need for land acquisition and development, the likelihood of people being displaced would be reduced.
- No increase in the likelihood of environmental impacts. Potential impacts that may be avoided if the No-Project Alternative were implemented include:
  - ✓ Habitat disruption;
  - ✓ Contamination associated with construction; and
  - ✓ Re-suspension of sediments (of water bodies) – some sediments could be contaminated.

Disadvantages

- Lack of feed solution for the Rite Food plant (feed alternatives, such as the proposed pipeline, are required for continued production and economic growth).
- No reduction in existing environmental impacts would occur. Existing gas resources are being flared, and ongoing flaring from Nigerian oil production would continue to contribute to the production of greenhouse gases.

While this No-Project Alternative does avoid the negative environmental and socioeconomic impacts associated with the other alternatives (which in the case of the Proposed Project Alternative are limited and tolerable), this does not justify foregoing the socioeconomic and environmental benefits associated with the project's primary objectives achieved by Rite Food Nigeria Limited.

Decision: Rejected

2.6.2 Sources of Gas

(A) Trucking through tankers:

Advantages

- Operations of Rite Foods Nigeria Limited (RFNL) will commence as scheduled.
- Land that would otherwise be occupied by the pipeline (or other project alternatives) would continue to remain available; in some instances, the population employs this land for income-earning activities (e.g., agriculture).

- With the reduced need for land acquisition and development, the likelihood of people being displaced would be reduced

Disadvantages

- Transportation and traffic impact
- Safety and environmental consequences leading to explosion, fire, emission, and pollution of the environment
- Challenges of gas supply reliability
- Increase in production with consequences of an increase in Snacks and Beverages price
- Impact on food production and a possible increase in the cost of food items

Decision: Rejected

(B) Pipeline

Advantages

- Low-cost feed solution for the Rite Foods Plant *(Economic Implications of the TGNL gas pipeline).*
- Reduction of associated gas flaring in Nigeria and the reduction of greenhouse gas emissions.
- Cleaner feed matrix in the country.
- Potential to spur industrial development, employment opportunities, and foreign investment *(Economic Implications of the TGNL gas pipeline).*
- Pipeline reinstatement criteria will consider multiple uses of the pipeline Right of Way (ROW).

Disadvantages

- The land would be acquired for the pipeline ROW, and therefore the likelihood of people being displaced increased. The potential loss of income-earning activities on land developed for the pipeline.
- "Boomtown" socioeconomic effects (pollution, disease, inflation) associated with construction workers.
- The potential for water quality, ecological, and fisheries impacts, in particular:

- Habitat disruption;
- Contamination associated with construction;
- Re-suspension of sediments– some sediment could be contaminated.
- Would require construction in sensitive habitat and ecosystems (across water body)
- Potential safety/security hazards associated with pipeline

Chapters 5 and 6 of this ESIA report also provide more detail on potential positive and negative impacts and the project sponsor's commitment to reducing negative impacts. The need for this project is based on the following:

- Potential demand for natural gas as feed in the Rite Foods Plant.
- Technical feasibility to implement the project;
- No major legal nor commercial aspects have been identified that could obstruct project implementation; and
- Feasibility to implement the project in a cost-effective, efficient, and timely manner.

Rite Food Nigeria Limited will meet the project objective to commence production early enough providing a more reliable supply of energy and feedstock for the variety of industrial processes while stimulating foreign investment. At the same time, natural gas currently being flared in Nigeria will be used (with a subsequent reduction of greenhouse gas emissions and reduced dependence on less environmentally desirable sources) to provide a market and financial return. This alternative will include the following scope of work:

- Build a 12" x 135km gas pipeline from tie-in point KP312 on the Escravos-Lagos Pipeline System (ELPS) at Ibefun Ogun State to supply of 45mmscf/d to Rite Foods Nigeria Limited Ososa, Ogun State and other industries and to enable the supply of 150mmscf/d of gas to the entire LDZ Natural Gas Pipeline Supply System.
- The Right of Way survey
- The Right of Way acquisition
- Digging, trenching and drilling hole across the river using HDD equipment
- Hauling and Stringing the Pipe(s)
- Welding of line pipelines and coating
- Lowering of pipe(s)
- Back-Filling the Trench
- Integrity test of the pipes welds including Hydro-test and
- Clean-up, reinstatement, and Commissioning

This alternative will accommodate the maximum delivery of the 150mmscf/d to the entire LDZ Natural Gas Pipeline Supply System.

Decision: Accepted

2.6.3 Concept Alternatives

The Project concept alternatives considered were based on pipe size design specifications to deliver the required volume of gas and the pipeline route alternative. The concepts were analyzed based on several key factors including Project cost, Environmental and Socio-Economic Impacts, construct ability rating, measured by the degree to which the alternatives would minimize impacts to existing infrastructure and minimize disruption to existing services. The concept alternatives are as follows:

2.6.3.1 Pipeline Size alternatives: The following pipe size options were considered for the delivering of the required volume of gas to the power plant:

- 6" pipeline to deliver 150mmscf/d (Rejected)
- 8" pipeline to deliver 150mmscf/d (Rejected)
- 12'' pipeline to deliver 150mmscf/d (Accepted)

In the options above, external coatings, operating environmental data e.g. water depth, tidal range data, soil/water parameters, geotechnical and geophysical characteristics, load combinations and allowable stresses, pipeline design methodology, cathodic protection, pipeline stabilization, riser design (if applicable), pipeline laying, provisions for pigging are the same except for the internal diameter that varies between 6", 8" and 12". The processed gas leaves the tie in point at KP312 at 19 Bar (after the R&M station) and it is expected to be delivered at 2.5 Barg at the Rite Foods plant.

The 12" line pipe was accepted for the following reasons:

1. Loss of pressure during transportation will be minimal in comparison to the two other pipe size options;
2. Liquid dropout/condensation inside pipeline will be minimal relative to 8" and 6" pipeline;
3. Provide redundancy (allowance) for future gas requirement/demands within the Sagamu LDZ Natural Gas Network complex area;
4. Availability of 12" line pipes in the country.

2.6.3.2 Pipeline Route Alternatives

Transit Gas Nigeria Limited investigated overall pipeline routing options for feasibility. The main objective of the initial route selection process was to identify the lowest-cost option that meets the safety requirements of both the general public and pipeline workers while minimizing impacts on the environment and surrounding communities.

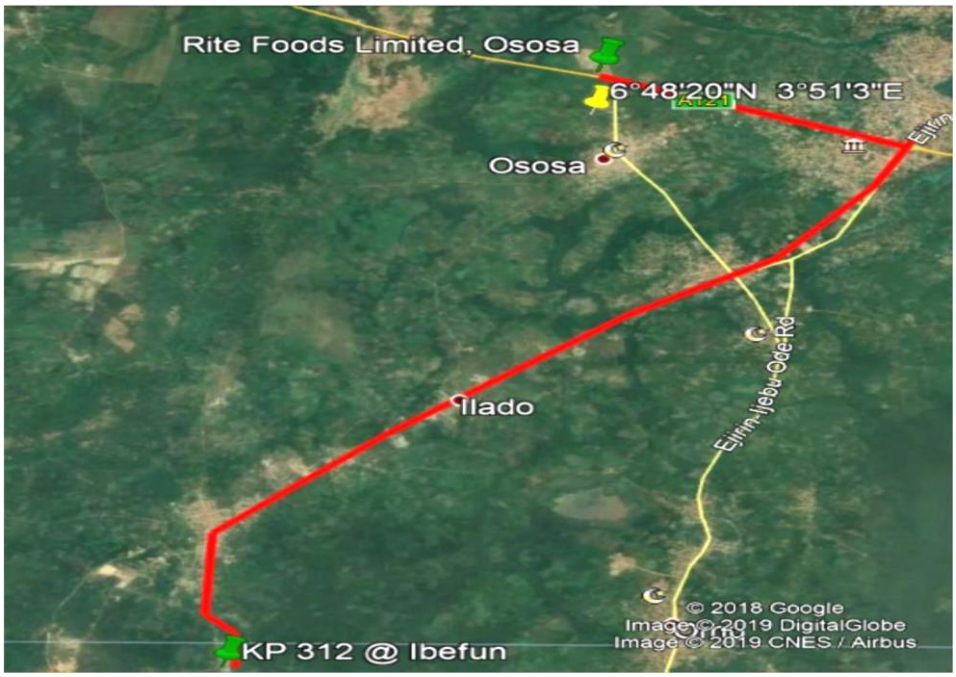


Figure 2 1: The existing Nigeria Gas Market company (NGMC) pipeline would supply the proposed Sagamu LDZ Natural Gas pipeline Network Project to the connection at KP312 tie-in point. On the northern side, the pipeline sidetracks the Ibefun and Ososa communities.

Description: Option 1 - KP312 to R.F through Ijebu- Ode Junction. Distance: Circa 24km. Location Class: 3 and 4.

Conclusion: Acceptable not approved for Sagamu LDZ Natural Gas Pipeline Network Project

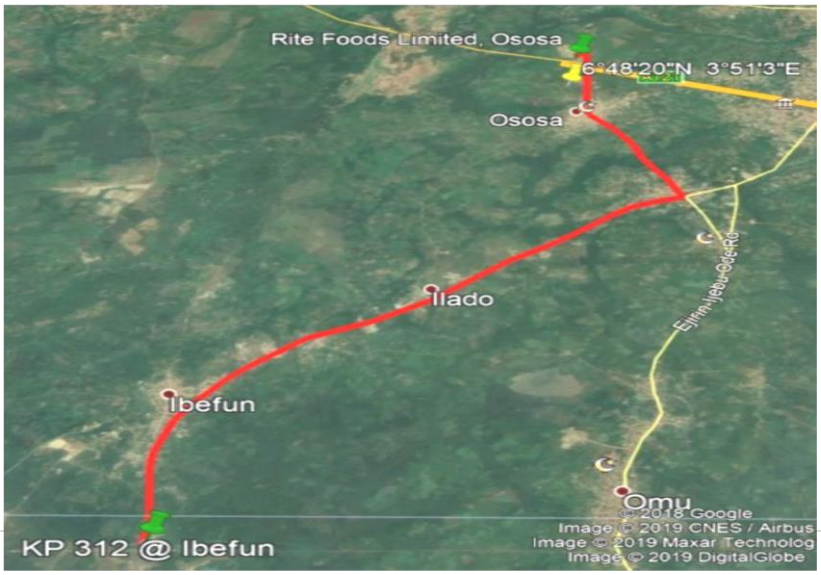


Figure 2.2

The existing Transit Gas Nigeria Limited (TGNL) pipeline would supply the proposed natural gas pipeline to the connection at KP312 tie-in point. On the northern side, the pipeline sidetracks the Ibefun and Ososa communities.

Description: Option 2 - KP312 to R.F through Idowa road. Distance: Circa 20km. Location Class: 3 and 4. CAPEX : 10% CAPEX reduction. Rank 2

Conclusion: Acceptable not approved

Figure 2.3

The existing Nigeria Gas Marketing Company (NGMC) pipeline would supply the proposed natural gas pipeline to the connection at KP312 tie-in point. On the northern side, the pipeline sidetracks the Ibefun and Ososa communities.

Description: Option 3 - KP312 to R.F through Imodi-Ijasin road. Distance: Circa 18km. Location Class: 3 and 4. CAPEX: 20% CAPEX reduction. Ranking: 1- Preferred Concept for R&M development. Rank 3

The considerations for the changes include:

- The proposed choice of the pipeline route (Option 3) falls within KP312 to Rite Foods Nigeria Limited factory through Imodi-Ijasin Road a distance 18km which is shorter than the pipeline route option 1 and 2 which are about 24km and 20km respectively.

Additionally the CAPEX reduction of about 20% is better than the CAPEX reduction for the two other option (1 & 2).

Conclusion: Option 3 is **Accepted and approved by TGNL and Ogun State Government**

The map of the final approved pipeline route is as indicated in Figure 2.4 below.

Table 2.1: The consideration and comparison of options for the Best Practicable Environmental Option (BPEO)

Consideration	Option 1 (24Km). See Figure 2.1	Option 2 (20km). See Figure 2.1	Option 3 (18km). See Figure 2.1
Environment issues (E)	Highest Impact (4)	High Impact (2)	Lowest Impact (1)
Installation Cost (I)	High Cost (2)	Medium Cost (3)	Low Cost (4)
Community issues (C)	Highest Impact (1)	High Impact (2)	Lowest Impact (4)
Resettlement issues (R)	Highest Impact (1)	High Impact (2)	Lowest Impact (4)
Decommissioning	High Impact (2)	Medium Impact (3)	Low Impact (4)

(D)			
Security and Safety (S)	Highest Impact (1)	Medium Impact (3)	High Impact (2)
Regulatory Compliance (Rc)	Compliance (1)	Compliance (1)	Compliance (1)
***Cumulative Rating**	**11**	**15**	**19**

*Cumulative Impact = (E+I+C+R+D+S) x Rc
The consideration for the impact of each element includes:

1. Area extent
2. Duration
3. Frequency
4. Reversibility

Impact significance	Consideration
Low	3 parameters low
Medium	2 parameters low, 1 parameter medium and 1 parameter high OR 2 parameters medium and 2 parameters high
High	1 parameter medium and 3 parameters high OR All parameters high

2.6.4 Pipeline Installation Alternatives

The following pipeline installation technologies were considered.

Option 1: Directional Boring (HDD/Thrust boring)

Option 2: Trenching

Option 3: Above Ground Installation

Option 4: Diverse Methods (i.e. HDD for surface water crossings, Thrust Boring for major road crossings, Trenching for swamp crossings, etc.) – accepted based on the varied terrain on the project route.

OPTION 1: Directional Boring (HDD/Thrust boring)

Directional boring, commonly called Horizontal Directional Drilling (HDD), is a steerable trenches method of installing underground pipe, conduit or cable in a shallow arc along a prescribed path using a surface-launched drilling rig with minimal impact on the surrounding area. Directional drilling is used when trenching or excavation is not practical. It is suitable for a variety of soil conditions. This method was chosen over other options as the preferred option for the river crossing due to its lowest environmental impact if properly designed and implemented. See Figure 2.4 below.

Conclusion: **Accepted**

Figure 2.5: Horizontal Directional Drilling process

Option 2: Trenching

For this method, 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 putting soft material (medium sand bed) to obtain a soft surrounding for the installed pipeline.

The material shall be free of stones, rocks, timber, roots, debris and any other materials, which may damage the pipe coating. This method was chosen over other options as the preferred option for the land areas due to its lower cost compared to HDD technology, ease of installation and maintenance and ease of decommissioning. A schematic of the buried installation method is as shown in Figure 2.5.

Conclusion: Accepted

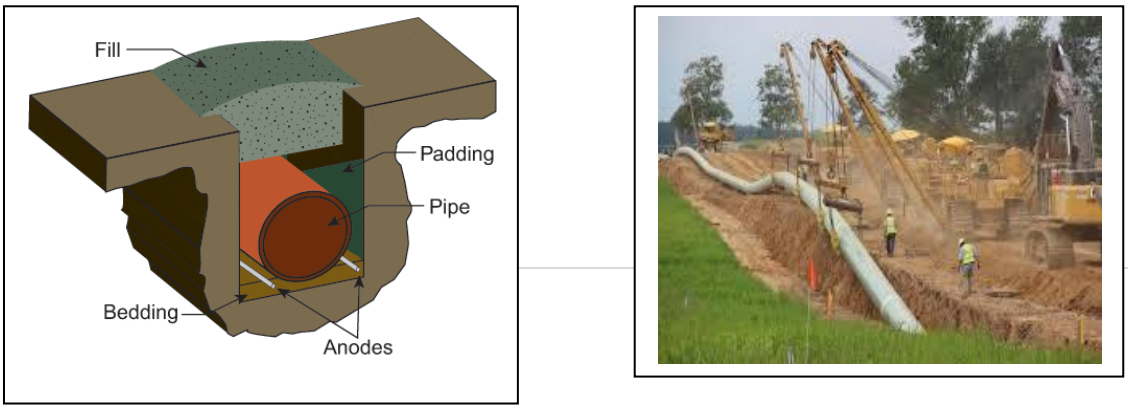


Figure 2.6: Buried Installation process

Option 3: Above Ground Installation

Though this option is the easiest to install and decommission (Figure 2.6), it will raise more community issues which can lead to vandalization. It also has high environmental impacts due to the clearing. This installation method will also expose the pipeline to corrosion. Hence this option was ruled out.

Conclusion: Rejected

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

Based on the expression of interest of supply of Natural Gas to Rite Food Nigeria Limited by Transit Gas Nigeria Limited which requires 150mmscfd of Natural Gas as its feedstock and fuel and considering future potential customers in entire Network, Transit Gas Nigeria Ltd, decided to build a 12" X 135km gas pipeline from KP312 Tie-in point on ELPS to Rite Food Nigeria Ltd. A map of the pipeline route is attached in Figure 3-1.

The entire pipeline network is about 19km long and required land for the project was acquired from the Federal Ministry of Environment and the Ogun State Ministry of Environment.

The estimated lifespan is between 25 years and 30 years.

3.2 Project Scope

The project scope includes:

- Survey of Pipe Route and selection of an optimum route for laying pipeline
- Acquisition of 25 meters wide Right of Way (ROW)
- Procurement of Pipeline, PRMS and other necessary items
- Construction and installation of pipeline, PRMS and other gas infrastructure
- Commissioning
- Operation and Maintenance

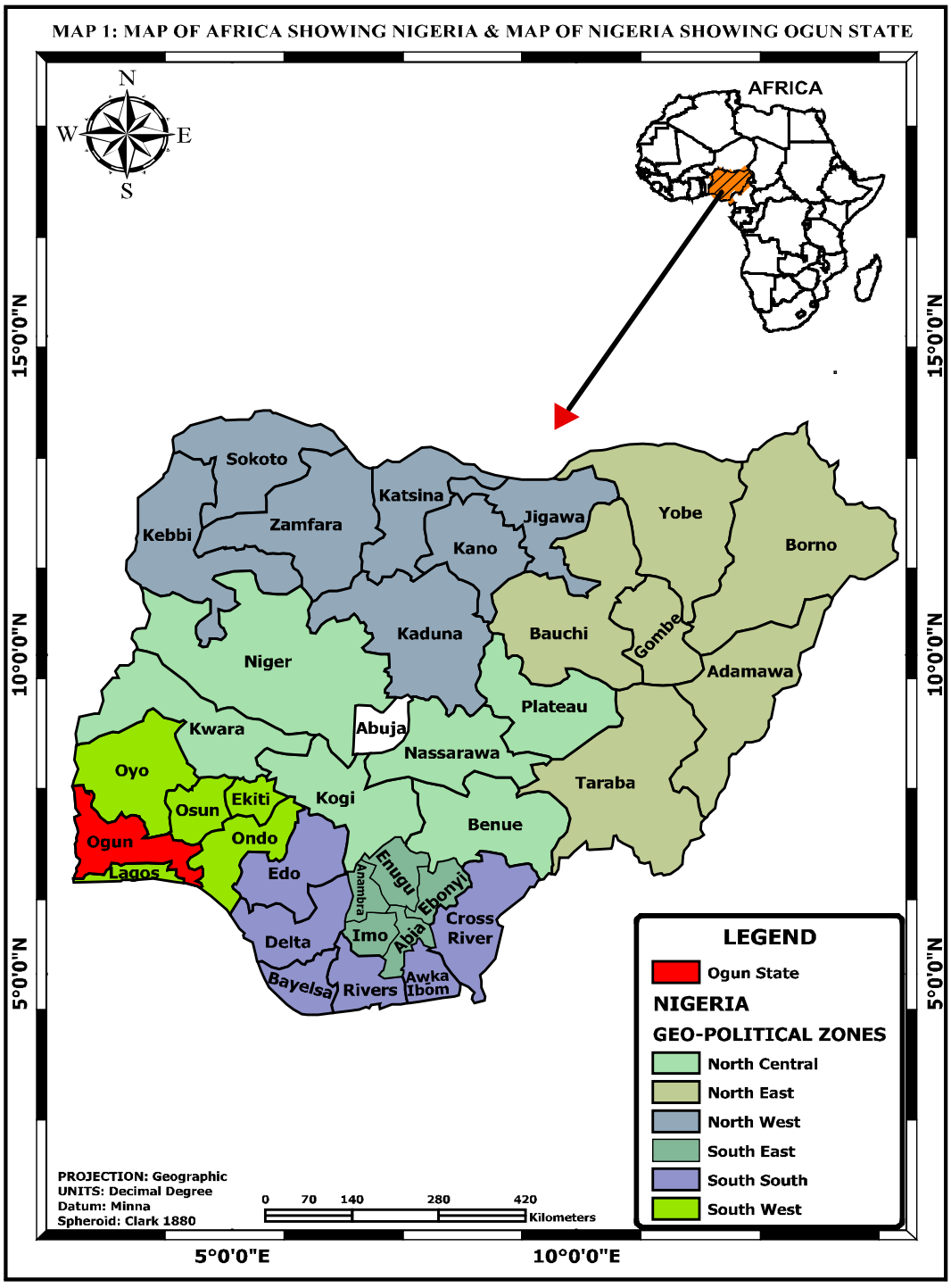
The project is designed to comply with Recognized and Globally Accepted Good Engineering Practices (RAGAGEP), all applicable International, and Nigerian Regulations and Standards; including the existing legislation of Ministry of Environment of Ogun State. The 70% of the workforce are unskilled workers who are basically excavators while the 30% of the labour force are made up of welder, hydro-text, xray machine operators.

It is not expected that any work will be carried out at night for security reasons throughout the construction period.

3.3 Geographical Location of the Project

The proposed Sagamu LDZ Natural Gas Pipeline project is beginning from a section of the pipeline at Ibefun to Rite Foods Nigeria Limited, Ososa, Sagamu Local Government Areas of

Ogun State in Nigeria. This section is to serve as a backbone for Natural Gas supply from KP312 of Escravos Lagos Pipeline System (tie-in point) to J4 Ogun State, Sagamu Benin Express Junction Ogun State. The geographical coordinates are as shown in Figure 3-4 and 3-5.



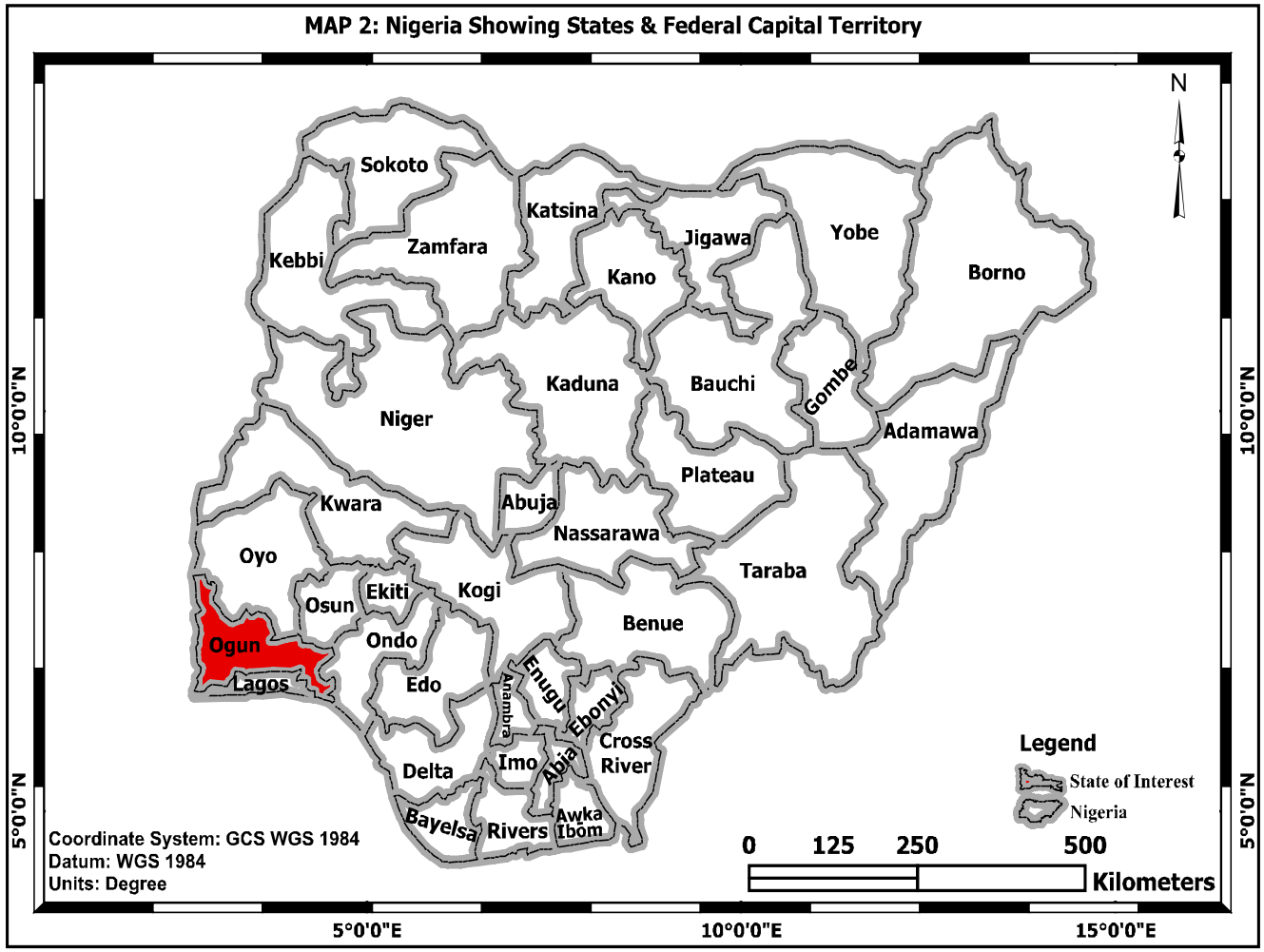
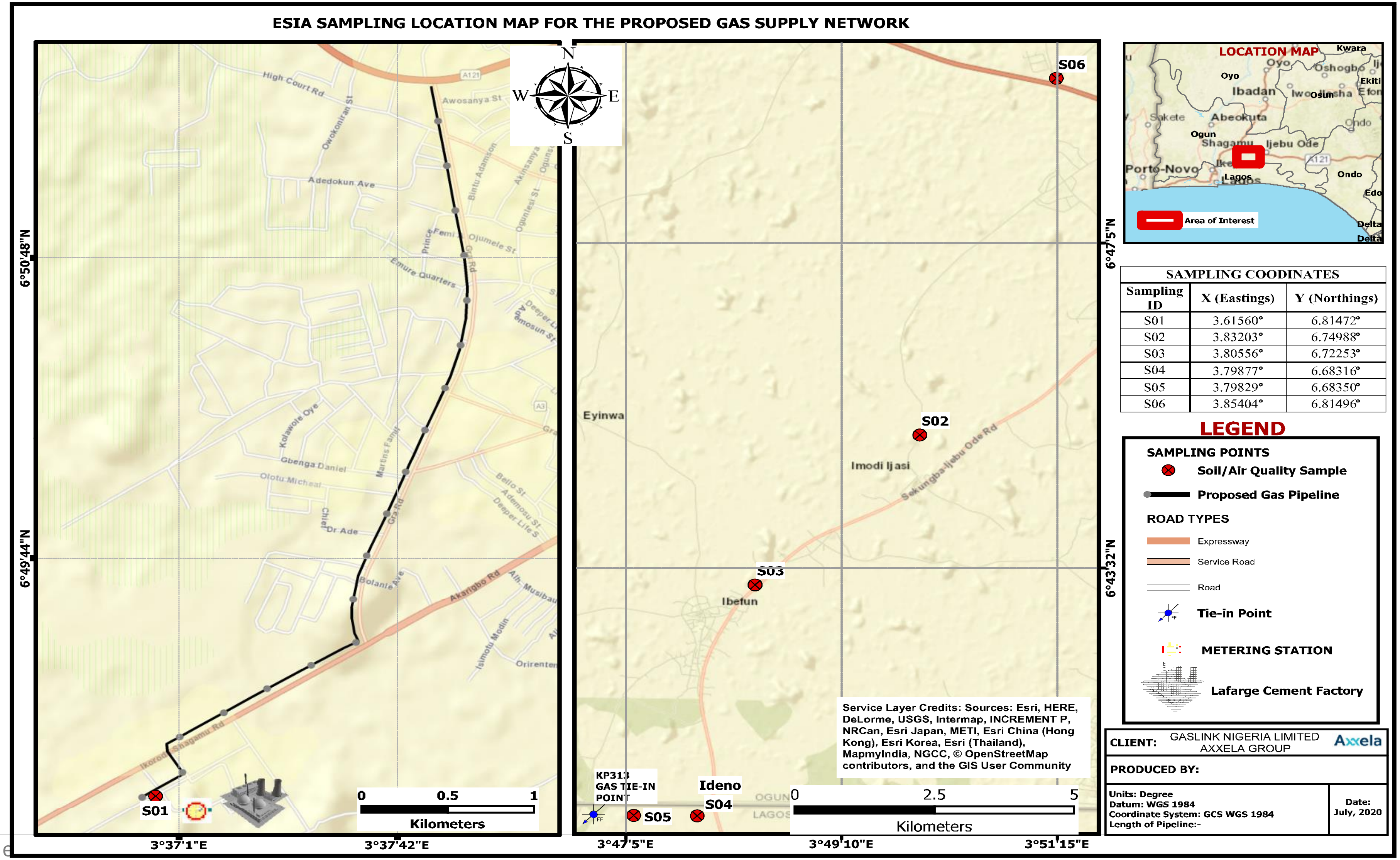


Figure 3-1: Map of the 135km Sagamu LDZ Gas Pipeline Route

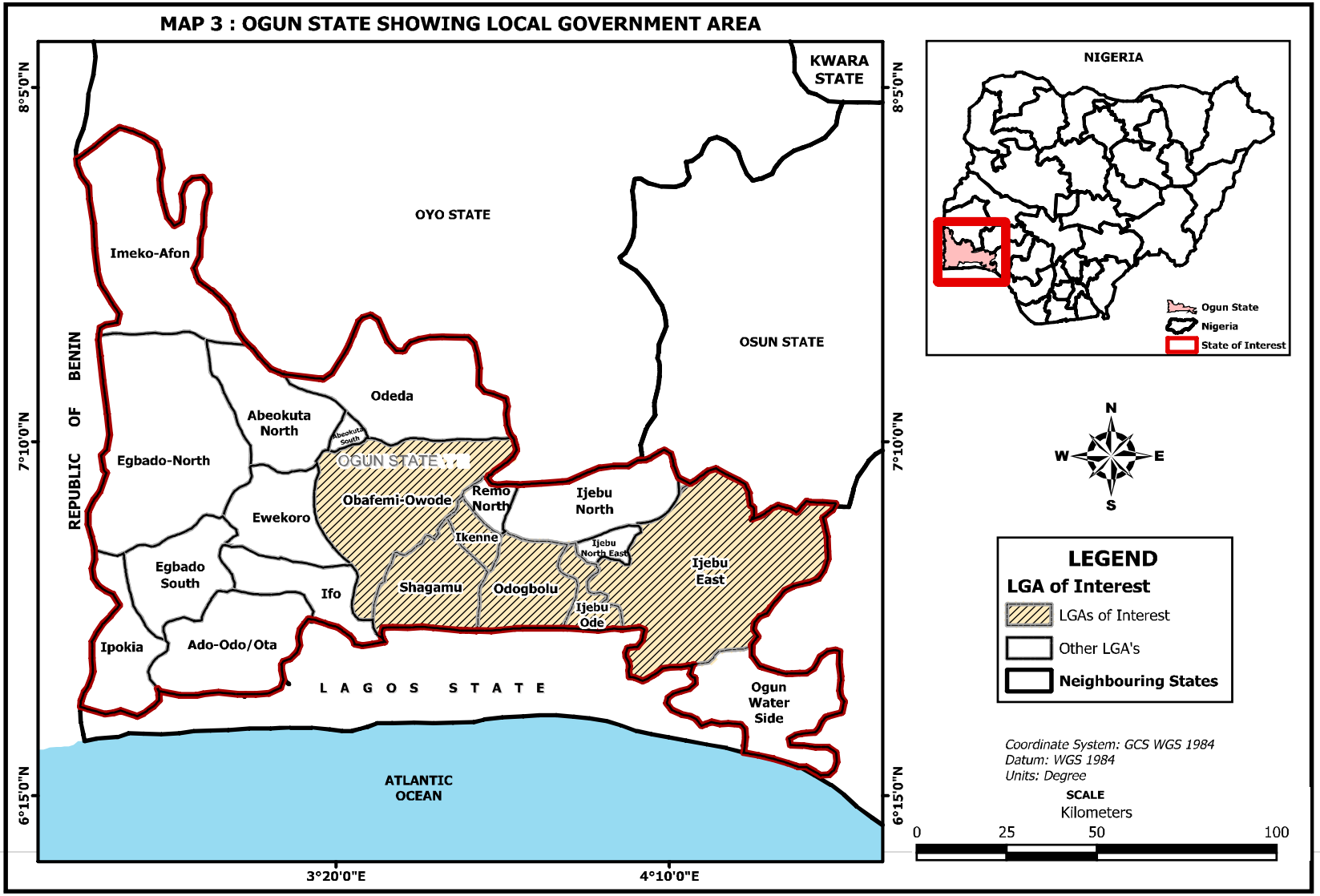
Figure 3-2



SAMPLING COODINATES

Sampling ID	X (Eastings)	Y (Northings)
S01	3.61560°	6.81472°
S02	3.83203°	6.74988°
S03	3.80556°	6.72253°
S04	3.79877°	6.68316°
S05	3.79829°	6.68350°
S06	3.85404°	6.81496°

FIGURE 3-3 MAP OF OGUN STATE SHOWING LOCAL GOVENMENT AREA



PIPELINE ROW HORIZONTAL ALIGNMENT BEARINGS AND DISTANCE RIGHT HAND SIDE

STATION FROM	BEARING	DISTANCE	EASTINGS	NORTHINGS	STATION TO
			568043.979	753172.360	TGNL/SAG/001R
TGNL/SAG/001R	5.024	58d53'55"	568048.281	753174.955	TGNL/SAG/001AR
TGNL/SAG/001AR	108.418	57d20'5"	568139.552	753233.472	TGNL/SAG/002R
TGNL/SAG/002R	173.443	57d44'37"	568286.226	753326.040	TGNL/SAG/003R
TGNL/SAG/003R	172.806	327d49'37"	568194.211	753472.310	TGNL/SAG/004R
TGNL/SAG/004R	38.418	10d58'53"	568201.529	753510.025	TGNL/SAG/005R
TGNL/SAG/005R	116.529	57d47'25"	568300.125	753572.137	TGNL/SAG/006R
TGNL/SAG/006R	54.226	57d47'25"	568346.005	753601.041	TGNL/SAG/007R
TGNL/SAG/007R	209.738	57d31'22"	568522.941	753713.663	TGNL/SAG/008R
TGNL/SAG/008R	205.279	57d58'45"	568696.989	753822.507	TGNL/SAG/009R
TGNL/SAG/009R	195.167	58d29'44"	568863.388	753924.494	TGNL/SAG/010R
TGNL/SAG/010R	195.942	58d29'21"	569030.436	754026.905	TGNL/SAG/011R
TGNL/SAG/011R	219.165	58d1'33"	569216.351	754142.962	TGNL/SAG/012R
TGNL/SAG/012R	122.963	52d56'50"	569314.485	754217.053	TGNL/SAG/013R
TGNL/SAG/013R	210.885	347d30'0"	569268.841	754422.939	TGNL/SAG/014R
TGNL/SAG/014R	207.000	5d40'6"	569289.286	754628.927	TGNL/SAG/015R
TGNL/SAG/015R	196.829	20d35'26"	569358.509	754813.182	TGNL/SAG/016R
TGNL/SAG/016R	198.316	23d8'58"	569436.473	754995.529	TGNL/SAG/017R
TGNL/SAG/017R	216.884	21d49'9"	569517.084	755196.876	TGNL/SAG/018R
TGNL/SAG/018R	190.249	21d27'32"	569586.684	755373.937	TGNL/SAG/019R
TGNL/SAG/019R	198.141	21d46'5"	569660.164	755557.949	TGNL/SAG/020R
TGNL/SAG/020R	218.878	22d21'54"	569743.449	755760.363	TGNL/SAG/021R
TGNL/SAG/021R	193.624	22d1'17"	569816.048	755939.861	TGNL/SAG/022R
TGNL/SAG/022R	185.506	17d0'28"	569870.309	756117.254	TGNL/SAG/023R
TGNL/SAG/023R	207.544	9d35'17"	569904.879	756321.899	TGNL/SAG/024R
TGNL/SAG/024R	203.535	2d44'25"	569914.610	756525.201	TGNL/SAG/025R
TGNL/SAG/025R	197.503	354d57'50"	569897.272	756721.942	TGNL/SAG/026R
TGNL/SAG/026R	179.040	350d27'36"	569867.599	756898.506	TGNL/SAG/027R
TGNL/SAG/027R	194.415	349d43'50"	569832.939	757089.806	TGNL/SAG/028R
TGNL/SAG/028R	206.315	350d50'3"	569800.075	757293.486	TGNL/SAG/029R
TGNL/SAG/029R	192.896	350d1'34"	569766.665	757483.466	TGNL/SAG/030R
TGNL/SAG/030R	167.391	350d13'39"	569738.252	757648.428	TGNL/SAG/031R
TGNL/SAG/031R	203.884	350d13'39"	569703.646	757849.353	TGNL/SAG/032R

Figure 3-4

PIPELINE ROW HORIZONTAL ALIGNMENT BEARINGS AND DISTANCE LEFT HAND SIDE

STATION FROM	DISTANCE	BEARING	EASTINGS	NORTHINGS	STATION TO
			568040.904	753176.074	TGNL/SAG/001L
TGNL/SAG/001L	112.873	56d50'44"	568135.401	753237.804	TGNL/SAG/002L
TGNL/SAG/002L	169.649	57d42'1"	568278.799	753328.456	TGNL/SAG/003L
TGNL/SAG/003L	167.931	327d49'37"	568189.381	753470.598	TGNL/SAG/004L
TGNL/SAG/004L	45.793	10d56'25"	568198.072	753515.559	TGNL/SAG/005L
TGNL/SAG/005L	116.528	58d0'19"	568296.899	753577.300	TGNL/SAG/006L
TGNL/SAG/006L	52.707	58d0'19"	568341.600	753605.226	TGNL/SAG/007L
TGNL/SAG/007L	211.255	57d46'33"	568520.316	753717.874	TGNL/SAG/008L
TGNL/SAG/008L	205.268	57d56'40"	568694.288	753826.819	TGNL/SAG/009L
TGNL/SAG/009L	195.498	58d32'33"	568861.053	753928.843	TGNL/SAG/010L
TGNL/SAG/010L	195.640	58d28'4"	569027.806	754031.158	TGNL/SAG/011L
TGNL/SAG/011L	215.467	58d0'8"	569210.537	754145.331	TGNL/SAG/012L
TGNL/SAG/012L	122.963	52d56'50"	569308.671	754219.422	TGNL/SAG/013L
TGNL/SAG/013L	207.947	347d40'8"	569264.261	754422.572	TGNL/SAG/014L
TGNL/SAG/014L	209.104	5d34'35"	569284.580	754630.687	TGNL/SAG/015L
TGNL/SAG/015L	197.774	20d59'4"	569355.406	754815.344	TGNL/SAG/016L
TGNL/SAG/016L	196.237	21d51'56"	569428.491	754997.464	TGNL/SAG/017L
TGNL/SAG/017L	218.422	22d45'58"	569513.014	755198.869	TGNL/SAG/018L
TGNL/SAG/018L	190.440	21d16'2"	569582.090	755376.339	TGNL/SAG/019L
TGNL/SAG/019L	197.906	22d1'16"	569656.294	755559.807	TGNL/SAG/020L
TGNL/SAG/020L	218.051	21d49'45"	569737.374	755762.224	TGNL/SAG/021L
TGNL/SAG/021L	194.337	22d27'8"	569811.594	755941.830	TGNL/SAG/022L
TGNL/SAG/022L	184.409	16d58'47"	569865.448	756118.200	TGNL/SAG/023L
TGNL/SAG/023L	207.389	9d36'11"	569900.046	756322.683	TGNL/SAG/024L
TGNL/SAG/024L	203.053	2d42'25"	569909.635	756525.509	TGNL/SAG/025L
TGNL/SAG/025L	196.885	354d52'1"	569892.020	756721.605	TGNL/SAG/026L
TGNL/SAG/026L	178.659	350d37'12"	569862.903	756897.875	TGNL/SAG/027L
TGNL/SAG/027L	194.268	349d37'52"	569827.937	757088.970	TGNL/SAG/028L
TGNL/SAG/028L	206.615	350d48'6"	569794.910	757292.928	TGNL/SAG/029L
TGNL/SAG/029L	192.882	349d58'42"	569761.344	757482.867	TGNL/SAG/030L
TGNL/SAG/030L	167.443	350d28'57"	569733.657	757648.005	TGNL/SAG/031L
TGNL/SAG/031L	203.136	350d28'57"	569700.069	757848.344	TGNL/SAG/032L

Figure 3-5

3.3.1 Design and Engineering

3.3.2 Design Philosophy

The engineering design philosophy is to ensure conformity to regulations and achieve uniformity and standardization of facilities and procedures.

The pipeline design pressure will be 19barg and the material is carbon steel, API 5L Glade B (12.7mm wall thickness for land and swamp; 15.8mm at river crossing). The increased pipeline wall thickness at the river crossings is due to inaccessibility and need to provide for extra corrosion allowance.

3.3.3 Design Intent/Technical Specification

The engineering design, procurement, and installation would be in accordance with the best engineering practices. Statutory Codes, and Standards. The system shall be designed to the requirements of ASME B 31.8. In addition, the following codes and standards shall be appropriately followed for design.

Pipeline

American Petroleum Institute (API)

Steel Pipelines Crossing Railroads and Highways	API RP 1102
Line pipe Specification	API 5L
Welding of Pipelines and Related Facilities	API STD 1104
Recommendation Practice for Railroad Transportation of Line Pipe	API RP 5L1
Recommended Practice for Marine Transportation of Line Pipe	API RP 5L5

Tanks, Vessels, and Packaged Equipment

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code

Pressure Vessels	ASME Section VIII-Div. 1
Welding and Brazing Qualifications	Section IX

American Petroleum Institute (API)

Guide for Pressure Reliving and Depressurizing Systems	API RP 521

Instrumentation

American Petroleum Institute

Manual on Installation of Refinery Instruments & Control Systems	API RP 550

International Society of Automation (ISA)

Instrument Symbols and Identification	ISA S5.1
Instrument Loop Diagrams	ISA S5.4
Control Valve Capacity Test Procedure	ISA 75.02

American Gas Association (AGA)

API Manual of Petroleum Measurement Standards	Report 3

Electrical

Institute of Petroleum

Model Code of Safe Practice in the Petroleum Industry

Electrical Safety Code	Part 1
Area Classification Code	Part 15

Coating System

Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures) ASTM E 337

Standard Test methods for Cathodic Disbonding of Pipeline Coatings
ASTM G8

High Voltage Electrical inspection of Pipeline Coatings Prior to Installation	NACE RP-02-74
Discontinuity (Holiday) Testing of Protective Coatings	NACE RP-01-88
Measurement of Dry Paint Thickness with Magnetic Gauges.	SSPC-PA-2
Solvent Cleaning	SSPC-SP-1

Mechanical Cleaning	SSPC-SP-10
Polyethylene Coatings for Steel Pipes	DIN 30670

Civil

British Standards Institution (BSI)

Structural Use of Concrete (Parts 1 to 3)	BS 8 110
Code of Practice for Foundations	BS 12
Specification for Aggregates from Natural Resources for Concrete	BS 882
Specification for Carbon Steel Bars for the Reinforcement of Concrete	BS 4449
Methods for Test for Soils for Civil Engineering Purpose	BS 1377
Chapter V – Wind Loads (Part 2)	BS CP 3
Structural Steel Sections Part 1 –Specification for Hot-Rolled Sections	BS 4
Specifications for the use of Structural Steel in Buildings (Part 2)	BS 449
Specifications for Hot Dip galvanized Coating on Iron & Steel	BS 729
Hot rolled products of structural steels. Technical delivery conditions for non-alloy structural steels	BS EN 10025-2:2019
Fences – Specification for Anti-Intruder Fences In chain and Welded Mesh (Part 10).	BS 1722
Code of Practice for Earth Works	BS 6031

Piping

American Petroleum Institute

Specification for Line Pipe	API 5L
Specification for Pipeline Valves	API 6D
Specification for Fire Test of Valves	API 6FA

Steel Gate Valves – Flanged and Butt-Welding Ends.	API 600
American Society of Mechanical Engineers (ASME)	
United Inch Screw Threads	ASME B1.1
Pipe Flanges and Flanged Fittings	ASME B16.5
Factory made Wrought Steel welding Fittings	ASME B 16.9
Face-to-Face & End-to-End Dimensions of Valves	ASME B 16.10
Forged Steel Fittings, Socket Welding and Threaded	ANSI B 16.11
Metallic Gaskets for Pipe Flanges-Ring-Joints Spiral Wound	ASME B 16.20
Non-Metallic Flat Gaskets for Pipe Flanges	ASME B 16.21
Butt Welding Ends	ASME B 16.25
Valves-Flanged, Welding End & Threaded	ASME B 16.34
Chemical Plant & Petroleum Refinery Piping	ASME B 31.3
Non-Destructive Examination	ASME B&PV Sec.V Gas
Transmission and Distribution Piping System	ASME B 31.8
Large Diameter Steel Flanges	ASME B16.47
American Society for Testing and Materials	
Pipe, Steel, Black & Hot-Dipped, Zinc-Coated, Welded	
& Seamless	ASTM A53
Forging, Carbon Steel, for Piping Components	ASTM A 105
Alloy Steel and Stainless Bolting Material	ASTM A193/A194
Wrought and drawn Carbon Steel Fittings	ASTM A234
Cast Steel Valves	ASTM A216
Butt Fusion PE Pipes and Fittings	ASTM D3350

3.4 Process Description

The proposed transmission line will take-off from existing 36" Escravos Lagos Pipeline at KP312 by means of hot tapping, to be performed by a prequalified specialist company. The split tee size for tie-in shall be 36"x 12". The total pipeline length from tie-in to Rite Food Nigeria Limited Plant is approximately 18k m. The pipeline and instrumentation (P&ID) diagram of the process is attached as Figure 3-2 and 3-3.

3.4.1 Pipeline System

3.4.1.1 Design Data for Pipeline System

The Design Data for Gas Pipeline from tie-in point at KP312 to Proposed Rite Foods as presented in Table 3.1

Table 3.1: Design Data for the proposed pipeline system

S. #	Description	Unit	Value	Remark
1.	Design Code	ANSI B31.8		
2.	Pipeline Diameter Steel Grade API 5L-X-70	Inches (")	36	
3.	Design Pressure	Barg Psig	100 1450	
4.	Maximum Allowable Operating Pressure	Barg	100	
5.	Wall Thickness X-70	Mm	22.225	For location class 3
6.	Wall Thickness X-70	Mm	19.05	For location class 2
7.	Temperatures: Design Operating	^{o}C (^{o}F) ^{o}C (^{o}F)	50 (122) 32 (90)	
8.	Tie-In Pressures	Barg	60/30	
9.	Flow rate when Tie-in Pressure 60 Barg	MMSCFD	600	Limiting case
10.	Flow rate when Tie-in Pressure 30 Barg(At Fertilizer)	MMSCFD	210	Limiting case
11.	Design Gas Composition	Mole %		See Section 2
12.	Length of Pipeline (approx.)	Km	18	
13.	3 Layer Polyethylene Coating			On Buried sections of the Pipeline
14.	Corrosion Protection Impressed current			Recommended

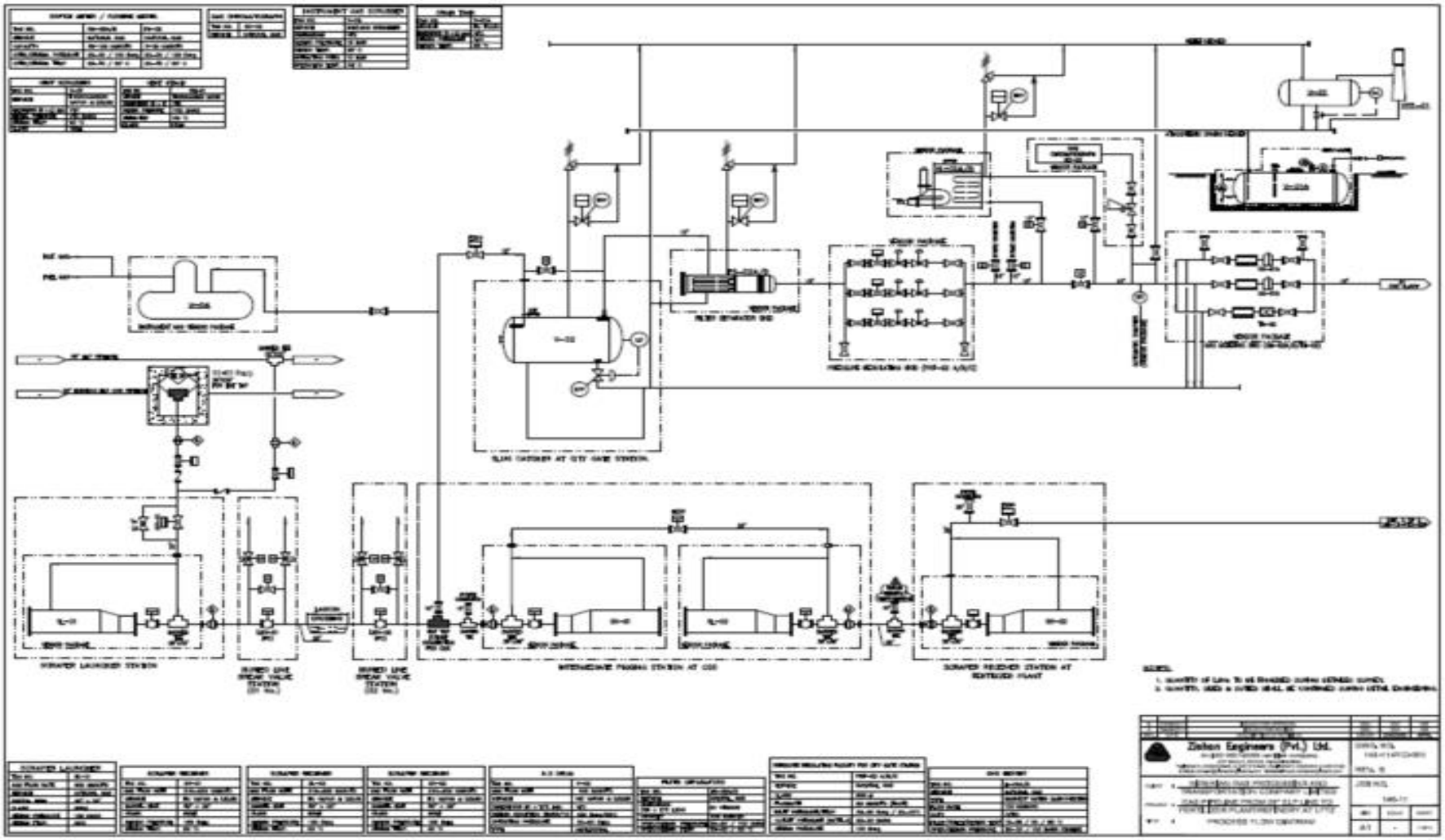


Figure 3.6: Piping and Instrumentation Diagram for the NGC Gas Pipeline

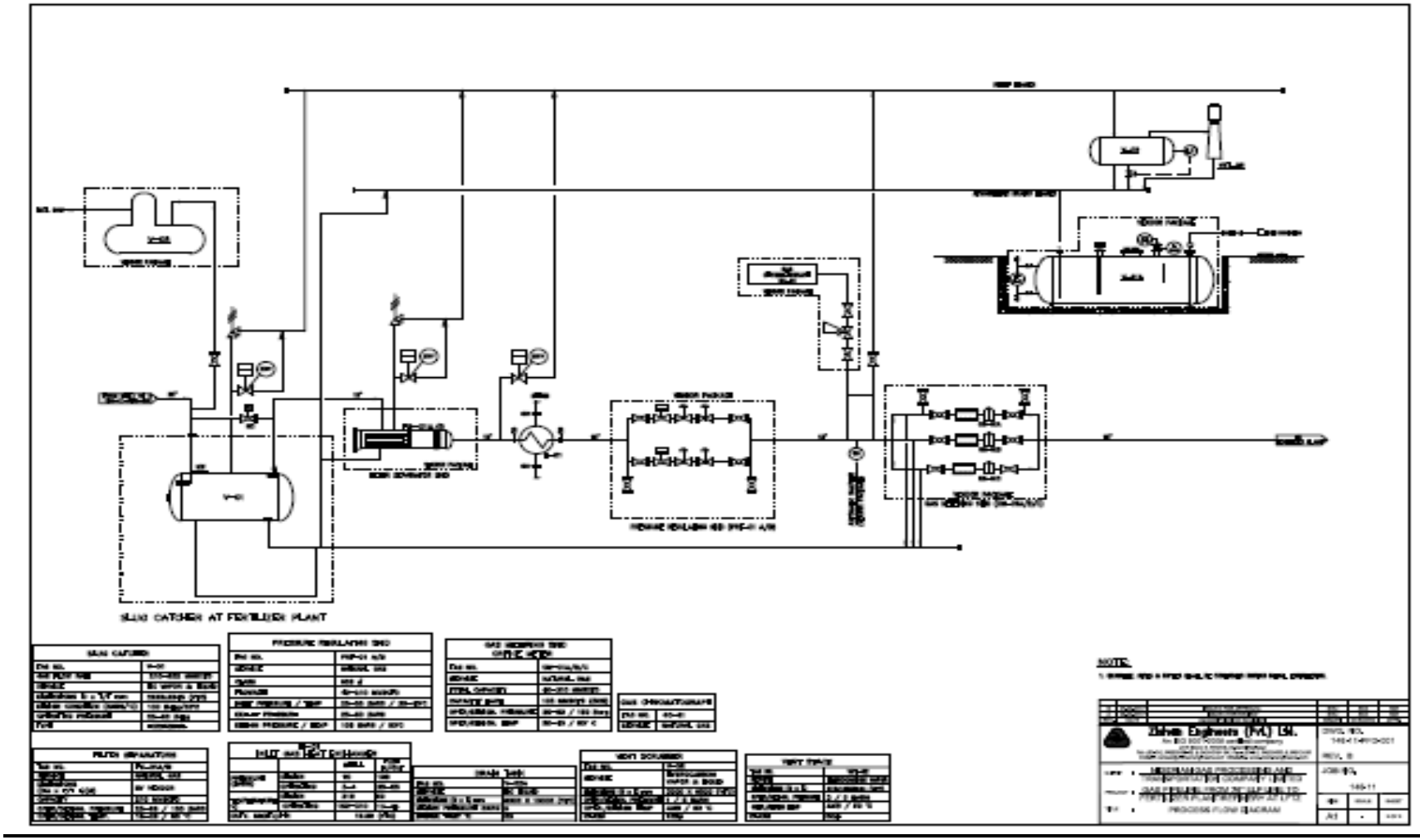


Figure 3.7: Piping and Instrumentation Diagram for the NGC Gas Pipeline

3.4.1.2 Pipeline System Components

The pipeline system comprises of the following:

- A tie-in to NGC's 36" Escravos-Lagos Gas Pipeline. The tie-in will be effected through hot-tap connection using split tee 36"x12".
- Scraper Launcher station near tie-in point at KP312.
- 12" NPS x 135km approximate pipeline system.
- The lagoon crossing approximate by means of Horizontal Directional Drilling (HDD).
- River (Bridge) Crossing approximate also by means of HDD
- Line Break valve stations.
- Scraper Receiver station at City Gate Station.
- Future option for 36" x 12" for City Gate Station at a specified location on mainline.
- Scraper Launcher station at City Gate Station online to Rite Foods Plant.
- Pig Launcher/Receiving Facility
- Future valve-tee connections for prospective customers
- The Scraper Receiver is proposed to be installed within the Rite Foods PRMF station. From Scraper Receiver, a line will be routed to Gas/Liquid Separator Vessel (Slug Catcher) for Rite Food PRMF Station.
- The City Gate Station will include a PRMF Station to meet their individual gas requirement. Each PRMF Station shall include Filter Separator skids, online gas analysis system, Metering assemblies, Gas heater/Heat Exchanger, Pressure Reducing facilities (PRF), Vent and drain systems.

3.4.1.3 Coating System

A 3-layer polyethylene (3 LPE) corrosion protection coating is proposed for the steel pipeline system. The minimum coating thickness shall not be less than 3200microns (3.2mm) consisting of:

- 300microns Fusion Bonded Epoxy (FBE)
- 300microns Copolymer Adhesive
- 2600microns High-Density Polyethylene (HDPE)

3LPE combines the pipe adhesion, chemical resistance and cathodic dis-bonding characteristics of FBE and the higher impact resistance, abrasion resistance and moisture impermeability of polyethylene. 3LPE provides the relative advantage of higher toughness which is primarily relevant to line pipe transportation and construction when pipe can be subjected to impact loads during handling.

3.4.2 Rite Foods and City Gate Station Pressure Regulating and Metering Facility

The present gas demand for the Rite Food Nigeria Limited is 45mmscfd while the demand in the entire Sagamu LDZ Natural Gas Pipeline Network is estimated at 150mmscfd to be distributed through City Gate future Natural Gas within the complex.

Since both CGS and Rite Foods stations have a typical configuration, therefore, an outline of the proposed configuration of PRMF station is given below which applies to both PRMF Station unless otherwise specified.

There is only one above ground installation which contain pigging station, substation facilities metering stations, valve station.

The hydro-test water which is fresh water will be obtained from a borehole. It will be laboratory tested before and after the hydro-test is carried out to attain the chemical composition water before and after the hydro-test exercise.

3.4.2.1 Pressure Regulating and Metering Facility (PRMF) Configuration

A modular Pressure Regulating and Metering Facility is planned for both the CGS and the Rite Foods. The facility comprises of skid-mounted, shop fabricated/assembled vendor package modules, which are shipped to the site and installed. The skid-mounted design results in a very compact unit, thereby economizing space. Further, it greatly reduces the normal site time for erection, welding and project management, thereby reducing cost from the traditional onsite, build-in-place method historically employed in the industry.

All off-skid valves within PRMF Station shall be Gas-over-Oil Actuator for local, manual and remote electronic (PLC Based Control).

The gas-over-oil actuator is fed by pressurized gas which, after being filtered, flows through the control valves into the tank relevant to the operation (opening or closing) to be performed The hydraulic oil contained in the tank is pressurized by the gas and flows into the relevant cylinder

chamber, while the oil contained in the other chamber flows into the second tank. The cylinder piston stroke causes the actuator operation.

The oil flow from the cylinder into the tanks is adjusted by means of two flow control valves. In this way, it is possible to adjust the stroking time of the actuator. Emergency manual override can be performed by selecting the opening and closing operation by means of the hand-actuated directional control valve and then actuating the hand pump.

The Pressure Regulating and Metering Facility (PRMF), serve the following purposes:

- To receive the intelligent and another type of pigs in case of pigging operations.
- To remove solid particles (dust, debris, and other impurities) and any liquid droplets.
- Measure the quantity of gas consumed by CGS and Rite Foods consumers for the purpose of billing and counter-checking with the sum of the individual customer's consumption.
- To determine the gas composition and calorific value.
- To regulate the gas pressure from the mains pressure down to the pressure required by each consumer.
- To protect the downstream facilities from overpressure.

3.4.2.2 Major Design Modules of PRMF

These typically include:

- Gas/ Liquid Separator (For Rite Foods Only)

  The proposed 12" pipeline has been simulated to ascertain the build-up of any hydrocarbon liquid within the pipeline and any possible liquid flow along with the gas stream at the discharge end. However, since strict control on the composition of the incoming gas cannot be exercised, provision for the handling of liquid receipt with gas stream has been considered in the design for separator and drain vessel. The disposal of liquids is assumed to be through road tankers.

- Filter Separators Skids

  The pressure (25-60 barge) gas stream received through Barred Tee to be taken to filter separator to remove any liquids or other solid particles that may have been picked up

during transmission. Two filter separator in parallel (one operating and one as standby) each of equal capacity shall include:

- Isolation Valves & Spectacle Blind: At inlet and outlet of skid for safety and maintenance.
- Filter Separator Vessel: Two 100% capacity vessels (one on each stream) suitable for effective removal of solid particles and liquid droplets. Arrangement for safe vessel drains to be provided with proper valves on the vessel.
- Pressure Relief Valves: Pressure relief valves at each filter separator vessel.
- A safe vent system to manually blow down pipeline inventory shall be provided, connected to each filter separator vessel.
- Electronic Instrumentations provided on skid are to be connected to control panel for activation of alarm/indication.

- Online Gas Analysis System

  The on-line gas analysis system shall be separate and dedicated for each of the PRMF stations and each shall consist of the following:

  - Gas Chromatograph (GC) System
  - Automatic Gas Sampler.

  GC shall have a high-speed factory engineered system to meet specific field application requirements based on typical natural gas stream composition and the anticipated concentration of the components of interest like gas calorific value etc. The GC system shall consist of three major components, sample conditioning system, the Analyser Assembly and the GC Controller.

The output from the GC Controller shall be communicated via a serial link interface to respective PRMF Station's main PLC and displayed on the main HMI. In addition to the above, the basic operation may also be performed from a keyboard and LCD display mounted on controller panel.

Automatic Sampler (QS) point shall be mounted on the piping as near as practical to the gas metering skid. The gas sampler consists of a probe, a bypass loop, two sample collection pumps, a pneumatic supply system, a timing system and two sample collection cylinders for sample collection and transportation.

The automatic gas sampler shall be controlled either by a dedicated controller or from the main PLC. Use of PLC is recommended for the project. There shall be continuous monitoring in the controller of the sample volume collected. There shall be an indication in the PC when the sampling cylinder has reached its capacity.

The automatic gas samplers shall be online and shall provide the following functions:

a) The gas sampler shall be at pre-determined intervals, collect and store a representative gas sample at line conditions, allowing it to be transported to an off-site laboratory for repeatable analysis.

b) It shall be possible to isolate the gas sampler from the main process.

c) The gas sampler shall be able to communicate with the main plant PLC by a serial data link interface (preferably Modbus RS-232/485).

d) The gas sampler shall provide easy access to all main components and valves.

- Gas Metering Skid

  To measure the Gas flow consumed by CGS and Rite Foods and other consumers, two Orifice Metering streams (operating and standby) and a low flow capture turbine meter stream shall be provided. Each stream shall include:

  DBB Isolation Valves:

  At inlet & outlet DBB for safety and maintenance.

  Gas Flow Computer & Chart Recorders:

  Two 100% duty orifice type flow meters and one low flow capture turbine meter stream (flow computer & chart recorder) designed to achieve the full flow range required for start-up and final design condition with necessary straight lengths of piping upstream and downstream of each meter. Gas flow computers are to be installed alongside chart recorders on orifice metering assembly. However, if placed in the control room, field mounted display units should be provided alongside chart recorder for local indication of instantaneous and total flow. These display units shall be connected to the flow computer or main PLC Station. The flow computer unit shall include multivariable sensors (DP, Pressure, and Temperature) and shall give a local indication of

instantaneous & total flow. Furthermore, the unit shall be able to communicate the calculated flow data to stations main PLC through serial communication and software interface. The meters shall have good accuracy and rangeability. The measurements shall be temperature and pressure compensated. The capability of the meters shall be optimized to allow metering minimum and maximum gas flows.

- Gas Heaters (For CGS) & Heat Exchanger (For Rite Foods)

  Gas heater and a Heat exchanger provided in CGS and Rite Foods respectively shall be capable of handling 100% of the maximum flow of the facility which will pass through the Pressure Regulating and Metering skid to pre-heat the gas in order to increase the temperature up to a pre-determined level so that process gas stream can remain well above the hydrocarbon dew-point and hydrate formation temperatures before the pressure reduction in Pressure Regulating Facility (PRF).

  Heaters shall be indirect fired heater type and their controls shall be designed for On-Off operations to facilitate turndown to zero flow. All indirect heater vessels and components shall be designed, furnished, fabricated, inspected, tested, and stamped in accordance with API 12K, and as specified herein. Coils shall be designed, fabricated, inspected, tested, and stamped in accordance with ASME Section VIII, Division 1.

  However, the Heat exchanger selection for Rite Food and their controlling units shall be designed to achieve the desired temperature of the downstream facility and avoid the hydrate formation before the regulating facility. Heat exchanger type shall be confirmed by the vendor but the design shall comply with TEMA and ASME section VIII.

  Burners: Burners shall be capable of modulating operation from 0 to 125% of the designed heat rate. Bidders shall provide the turndown capability of the heater. A manually adjustable air damper shall be provided for each burner. The pilot light ignition system shall be an electric spark gap type. Manual pilot light ignition ports shall be included. The burner shall be a low nitrous oxide (NOx) type design. The burner air intake shall include a flame arrestor. The forced draft system has been proposed for the Gas Heater Skids.

  Gas Coil: The gas coil design and fabrication shall be in accordance with ANSI B31.3, using seamless pipe in accordance with the applicable ASTM material specification.

The coil inlet and outlet connections shall be flanged and located at the end opposite the burner. The gas-heating coil shall be removable for maintenance. The maximum velocity for gases in the coil shall be 30.5 m/sec (100ft/sec). The gas coils shall be designed for the maximum gas inlet pressures as specified in process datasheet.

Fire Tube: The fire tube shall be of the "U"- tube design with a maximum design heat flux of 25.2kW hr/m^2 (8,000 Btu/Ft^2) of surface area and overall efficiency of 75 - 85%. Higher flux rates may be considered if no significant degradation of the heat transfer media in a sixty-day period of full use can be guaranteed. The fire tube shall be removable for maintenance. The minimum wall thickness of fire tubes shall be 6.35 mm (1/4").

Water Bath: Water bath fluid for the heater will be a clean fresh solution.

Stack: The stack shall be designed to provide a satisfactory natural draft at 125% of the design heat rate. The stack shall be self-supporting with a minimum wall thickness of 3.17 mm (1/8") and equipped with a downdraft prevention device, spark arrestor, and a weather cap with a bird screen.

Heater Shell: The heater shell shall be designed for an internal pressure of 0.69 barges (10psig) without distortion of the shell or end plates. The ends of the shell shall be designed to facilitate the removal of both the gas coil and fire tube for repair or replacement. The shell shall be equipped with a combination fill-vent connection as described in API-12K, Section 2.6. A coil inspection opening shall be provided. An expansion tank and water top up facility shall be provided. The shell shall be protected against overpressure and vacuum conditions with a relief device. One drain connection with a valve shall be provided. Drain nozzles shall be ground flush with the inside wall of the shell. External nozzle projections shall be a minimum of 7.6cm (3 inches) beyond insulation. Nozzle reinforcement design shall be per ASME code.

Burner Management System: by which, equipment is purged and a burner is started, ignited and stopped automatically shall be provided to control and monitor the heater operations. The equipment shall include an electronic PLC controlled panel, fail-safe, first-out type panel with manual restart, test, and reset and one spare annunciator. The equipment's control panel shall be designed to interface all alarms, operational status,

process variables and set points with stations main programmable logic controller (PLC) via serial link (RS-232/RS-485 Modbus Protocol). The Station PLC shall also be able to monitor, operate, startup, and shut down the equipment. The local control panel shall be designed to operate under fully automated local PLC control or local manual operator control.

BMS shall include following control/monitoring features:

- Flame Status Monitoring / Safe Guarding
- Quick Fuel Isolation
- Fuel Gas Pressure Regulation & Monitoring
- Remote Ignition of Pilots
- Remote Operation of Pilots and Main Burners
- Temperature Control arrangement
- Firebox Purging

Pressure Regulating Facilities

The pressure regulation facilities shall serve to regulate the gas pressure and also protect consumer's downstream facilities from overpressure. The system shall include two (2) normally operated pressure regulating streams (one as standby) at Rite Foods.

Four CGS facility system shall include three (3) normally operated Pressure regulating streams (two working & one standby). However, Vendor shall comply with the minimum flow criteria due to change in load within the city.

There shall be two PRF as follows:

- Pressure regulating facility for Rite Foods (PRF-01 A/B) supplying 150MMSCFD at 25-60 barge.
- Pressure regulating facility for CGS (PRF-02 A/B) supplying 3-100 MMSCFD gas at 20-25 barge to downstream consumers.

The PRF shall consist of two normally operated streams, with one as standby. Each stream shall include:

- Isolation valves: At inlet & outlet (DBB) of skid for safety and maintenance.
- Pressure Reduction: the set pressure of the regulators shall be staggered such that failure of the selected online stream will allow the backup stream to take over the pressure control, thus maximizing system reliability.

The PRF relief system consists of:

Creep relief valves downstream of each pressure regulator shall provide pressure relief for leakage across regulator seat during closure of user connection. Pressure relief rates shall be minimized and consistent with an overall safe design.

Slam-shut valves: These shall be installed on the inlet line of each pressure regulator stream to provide automatic isolation in the event of any malfunction on the stream. Valves shall be arranged to close automatically if the pressure in outlet line to consumer rises above, or falls below the preset level. The pressure settings for the slam shut valves shall have an adequate margin over the regulator monitor and relief valve settings to ensure that normal operational pressure surges do not initiate a shutdown. The parallel stream arrangement ensures that the consumer is still receiving suitable supply from the other stream even when one stream is shut down. Each valve is to be provided with an open/ close limit switches for alarm/annunciation on the control panel and future SCADA system to draw attention as soon as the valve is closed. Restart of the station shall be manual and ESD reset procedures shall be followed:

A safe vent system to manually blow down station inventory, vent and purge each stream separately. Adequate protection shall be provided against overpressure of the consumer side piping system by providing relief valves for regulator creep. These valves shall be sized to minimize the volume of gas released.

Redundancy of key components has been provided for reliable operation and fail-safe shutdown in situations of system failure or equipment malfunction.

All process design of the PRF equipment and packages shall be tailored to meet the particular process and system requirement of the consumer's facilities.

Pressure relief rates and blow-down rates shall be minimized to rate consistent with an overall safe design. ESD initiation shall result in lock-in. De-pressurization of the

system through operator intervention shall be done to achieve a positive pressure of 0.5barg in less than 15 minutes.

The basis of PSV sizing shall be established and data sheets prepared accordingly. Where applicable, any installation work within the new consumer's factory/plant shall be subject to the safety rules and practices of the consumer.

- Emergency Vent System

  A vent system shall be provided for the collection of potential discharges from all relief valves in over-pressure protection service and all facility blow-down valves. The vent stack will be used for emergency venting and depressurizing operations. In addition, this will also be used for venting during the intelligent pig run.

  The Vent System shall consist of a relief header, a vent scrubber skid, and a vent stack, each designed together and dispose of hydrocarbons released. The primary source of blow down/vent gas will be from relief valves located on the piping and process equipment.

  All relief valves shall discharge into the relief header and routed to the vent scrubber. Since only trace amounts of liquids are predicted during steady state flow, all pressurized liquid drain streams shall be routed to the vent gas system, where liquids shall be separated from vent gas in the vent scrubber and sent to the drain system.

  Process liquids from the process drain system shall be routed to the vent collection scrubber via an independent header, the Pressurized Drains Header, and a separate vent scrubber inlet connection. This liquids header and vessel connection shall be separate from the relief header and vessel nozzle.

  A small amount of purge gas shall be continuously injected into the vent header piping at the extremities to ensure that the header system remains free of oxygen and mitigate the air ingress. Vent stack shell equipped with a mechanical seal to prevent the air infiltration in the flare header & vent stack.

  Carryover and flashed liquids collected in the vent scrubber shall by gravity flow to the non-pressurized Slop Tank and be commingled with the liquids from the atmospheric drains system.

Vent Stack (VST-01/ 02) shall be provided with elevated gas entry nozzle to facilitate self-draining of condensed liquids back to the scrubber.

The size of a vent stack is determined by the available pressure drop and by any minimum velocity required to prevent hazardous conditions due to combustible or toxic material at grade or working levels. Vent stack diameter shell is based on maximum velocity criteria of 500ft/s for good dispersion.

Gas dispersion calculation shall be carried out based on API 931. The dispersion results shall be based on the treated gas composition (CH_4) and results shall be within the allowable range of industrial practices.

- Liquid Handling Facilities

  The function of liquid handling facilities is to collect, store, treat and dispose of all liquid streams collected from the process and utility systems, including any rainwater or wash water that may contain spillage from equipment.

  The system shall be segregated into pressurized and atmospheric drains for safety, and to prevent the contamination of clean water.

  Pressurized Drains System

  - The pressurized drains system shall collect liquids from equipment and liquids from process instruments and instrument bridles.
  - Collection points for the pressurized drains header shall be hard-piped from the vessels and instruments directly to the pressurized drains header.

  Vent Scrubber Skid (V-01 & 02)

  Liquids in the pressurized vent header shall be routed to the Vent Scrubber. Gas flashed in the Vent Scrubber shall be vented to the station Vent Stack (VST-01 &02). Liquids collected in the Vent Scrubber shall flow via process pressure (with gravity assistance) to an atmospheric drain Tank (V-02A & V-02B) and be commingled with the liquids from the atmospheric drain system. The Vent Scrubber shall contain high and low liquid level switches which shall be connected to the control panel for alarm/indication.

Atmospheric Drains System

The atmospheric drains system shall collect spillage from drip pans underneath equipment and low point maintenance drains. Collection points for the atmospheric drains header shall be hard-piped directly to the atmospheric drains header.

Drain Tank (V-02A & V-02B)

Liquids in the atmospheric drains header shall be routed to the drain tank, installed below grade to allow the drain headers to empty under gravity conditions.

Gas flashed in the drain tank shall be vented to atmosphere at a safe location. Liquids collected in the drain tank shall hold until they are emptied to a waste removal truck. The atmospheric drain tank shall contain a liquid level gauge for operator information. In addition, atmospheric drain tank shall have a high liquid level switch which shall be connected to control panel for alarm/indication. For design basis of the drain, tank refer Datasheet 146-11-DSM-015.

- Instrument Gas/Air System

  Instrument Gas package is provided to meet the instrument gas requirement of a new facility of City Gate Station. Processed gas will be used to operate the pneumatic instruments. Instrument gas header of 2" size being proposed to provide instrument gas to consume in the City Gate Station. Instrument gas header will have 2 spare connections for future expansion. However, Instrument Air for the new facility in the plant will be provided by the existing instrument air system of the complex. Instrument gas system shall be provided only for CGS and include:

  Inlet Emergency-shutdown Valve shall be provided with isolation valve for safety and maintenance. Open/close limit switches shall be provided on the valve and connected to the control panel for status indication.

  Pressure Control Valve shall be provided to let-down the gas inlet pressure (25-60 barge) up to 10.3 barg.

  Instrument Gas Scrubber (V-04) Instrument gas scrubber shall remove entrained liquid from the natural gas stream prior to the gas being sent to instrument gas consumers. The

horizontal scrubber is proposed to be installed. Manual by-pass with normally closed isolation valve shall also be provided to isolate the scrubber in case of any maintenance.

ESD Panel Instrument gas scrubber skid shall be furnished with ESD panel and fusible loop system. ESD panel shall consist of IG Supply Unit, Filter, Pressure Control Valve set and ESD Push Button. During cold start-up of PRMF, the natural gas stream will be passing through by-pass valve across the isolation valve (upstream of ESV-02). ESD panel shall be used to automatically cut-off the gas supply and simultaneous depressurizing of instrument gas scrubber system by activating (ESV) & BDV respectively in case of an emergency condition e.g. fire etc. The ESD could also be activated manually by pressing the push button. A PSL shall be installed on pneumatic ESD loop to give ESD indication on the control panel in case of any manual or fire activated ESD.

Instrument Gas Dryer The dryer package shall be capable of drying the gas meeting below mention outlet spec. There must be two dryer vessels filled with suitable desiccants like Silica gel, activated alumina or mol sieve. Each dryer shall be capable of handling 100% capacity. One dryer will be performing dehydration operation and the other will be on regeneration. Adsorption time during drying operation will be minimum 06 hours. For dryers, adsorbent media service life shall be at least three to five years. Dryer package shall be fully equip with all supporting engineering auxiliaries like 2 x 100% pre-filters for the inlet (one operating and one on standby) and 2 x 100% after filters for the outlet (one operating and one on standby). The proposed type of dryer is pressure swing adsorption.

Outlet Specification of Dryer

Outlet Dry Instrument Gas

Pressure Required	174 - 101.5 Psig
Moisture Content	60-80 ppm
Oil Content	< .01 ppm (Wt) Dew Point -40 °F

3.4.3 System Monitoring and Safety Management

3.4.3.1 Basic Process Safety Management

The overall objectives of the Safety system are:

1. Prevent undesirable events that could lead to a release of hydrocarbons (HC).
2. Shut-in the process or affected part of the process to stop the flow of hydrocarbon to a leak or overflow if it occurs.
3. Accumulate and recover HC liquids and disperse gases that escape from the process.
4. Prevent ignition of released HC.
5. Shut in the process in the event of a fire
6. Prevent undesirable events that could cause the release of HC from equipment other than in which the event occurs.

Operating Modes of Safety Systems

The operating modes of the Safety system would be:

1. Automatic monitoring of the process to detect abnormal condition or an undesirable event through a sensor on a processing unit. This operating mode is applicable through the provision of instrument switches (Pressure, Level, etc.) activation of which will generate alarm signals.
2. Automatic shutdown of the process on detection of an abnormal condition or an undesirable event to prevent the system by following the defined shutdown logic.

   This operating mode is applicable through activation of Emergency Shutdown valve and Slam shut valves which act on signals from internal pressure sensing mechanism.
3. Automatic protective action if manually actuated by personnel who observe or are alerted to an unsafe condition by an alarm.

   This operating mode is applicable through the manual generation of shutdown signals in case abnormal conditions are witnessed by operators or maintenance personnel.

4. Continuous protection by support systems that minimize the effects of escaping hydrocarbons.

   The support system includes, in this case, a fusible loop provided on the locations containing ignition sources. This fusible loop provides instant indication of any fire and generates a facility shut down signal to halt the operation and simultaneously de-pressurizes the system.

3.4.3.2 Monitoring & Control System at PRMFs

For control, indications, alarms, and shutdown, separate and dedicated control and monitoring system shall be provided for each PRMF station.

For each PRMF Station, the Monitoring/Control system shall be based on a PLC-based central control panel (referred to as main station PLC for respective PRMF stations in this document).

There shall be separate Local Control Rooms for each PRMF Station and shall house station's main PLC (complete with marshaling JB / Panel) as well as other control panels (such as but not limited to GC Controller, etc.)

The PLC shall receive signals from the field instruments installed in respective PRMF and shall be responsible for complete control, monitoring, alarm, and shutdown of the PRMF.

Control System of each PRMF Station shall also incorporate 1 Engineering Workstation and 1 Operator Workstation complete with HMI graphic display and remote control/ alarm/indication features.

Following are the main features of the monitoring system:

- Station's main PLC shall be installed in an office building/control room to give indications/annunciation from instruments installed at PRMF to operators. Such indications/annunciations shall include but not limited to.
  - Activation of all process switches.
  - Open/close status of shutdown valves.
  - Open/close status of all blow-down valves.
  - Pig status indication.

- Flow metering status of turbine flow meters

1. The main PLC shall also be responsible for safe shutdown and blowdown of the system on any processor fire-related upsets as defined on C&E.
2. All limit switches provided at PRMF shall be connected to main PLC for activation of alarm/indication.
3. All limit switches provided at Tie-in point, Scraper Launchers & LBVs shall be connected to the future SCADA system for activation of alarm/indication.
4. All pressure & level switches provided at PRMF are to be connected to main PLC for indication. The main PLC shall have the option of connecting to a future SCADA system.
5. All scraper passage signals provided at Scraper Receiver shall be electric/ flag type giving local flag indication as well as electrical signal to control panel for pig status indication.
6. All scraper passage signals provided at Scraper Launcher shall be electric/ flag type giving local flag indication as well as electrical signal to the future SCADA system.
7. Gas flow computers are to be installed in addition to chart recorders on orifice metering assembly. The flow computer unit shall include multivariable sensors (DP, Pressure and Temperature) and shall give a local indication of instantaneous & total flow. Furthermore, the unit shall be able to communicate the calculated flow data to the main PLC through serial communication and software interface.
8. Turbine flow meters should give a local indication of instantaneous and total flow both locally and on the control panel. Additionally, it shall have provision to give 4-20 mA. analog signal for connection to the future SCADA system.
9. A PSL shall be installed on pneumatic ESD loop of instrument gas system to give ESD indication on the control panel in case of any manual or fusible loop activated ESD.
10. A PSL shall be installed on each fusible link to be provided at filter separator skids, gas metering skid & pressure regulating facilities to give an indication on the control panel in case of fire.

In addition following electronic sub-systems which are part of the skids/units shall also be interfaced with this new PLC through RS-485 serial interface:

- BMS PLC of heater skid
- Flow Computers
- Instrument Gas Dryer Controller (PLC)
- Gas Chromatographs / Analyzers

– F&G detection System Controller (as described in subsequent Section 3.5.6

Provision for future SCADA System

For remote monitoring of pipelines and associated equipment, a SCADA system is proposed to be installed in future to operate in parallel with the above-mentioned control panel. Hence, the field instruments installed at Tie-in, scraper launchers, LBVs & PRMF shall have provision for hook up with the future SCADA system.

3.4.3.3 Emergency Relief & Blowdown System

The blowdown systems have been incorporated in the system which will safely collect and dispose of hydrocarbon releases due to pressure relief as a result of an accidental overpressure of equipment or piping, equipment malfunction and process upset conditions, blowdown of equipment/piping in the event of fire or gas detection, equipment start-up and shut-down. BDVs will be installed to blow down the system in case of fire or gas detection on Filter separators, heaters, instrument gas system, PRF skids. In case of fire or gas detection, all the SSVs & ESDVs will be closed automatically. Simultaneously all the BDVs will be opened automatically.

The relief rate from each BDV is calculated as per the calculation basis defined in API RP 521 for vapor depressurizing during fire case. The design of vent system includes provision for simultaneous relief flow rates from all BDVs during fire case. Whereas all other possible scenarios have to be discussed during the detailed design to determine the governing loads for the sizing of the vent and blowdown system.

All the relief and blowdown connections are connected to vent header. The vent header is connected to Vent Scrubbers vessels to remove entrained liquids, which are dispatched to drain tanks where the vapors are piped to the vent stack.

Both knock out drum & vent stack are sized per API-521 recommendations.

3.4.4 Safety Considerations

The safety considerations proposed to be built into the system fall under three broad categories, namely design, construction, and operational safety. Each is discussed separately, below:

3.4.4.1 Safety in Design

- The design of the pipeline system shall, as a minimum, meet the safety requirements of ASME B31.8.
- The maximum allowable pressure of the steel main distribution system shall be 100barges. The line pipe and fittings to be used shall be suitable for safe operation up to 100barges.
- Two levels of safety are provided at the consumer PRFs (slam shut valve and PSV) to avoid overpressure.
- Pipelines shall be laid maintaining the minimum spacing from other underground utilities as required by ASME B 31.8.
- The depth of cover and road crossings for the network has been specifically designed to prevent any accidental damage to the pipeline. A minimum depth cover of 1.2m has been maintained as per API 1102,
- It is generally recommended to carry out maintenance work only on equipment, units or systems that have been totally shut down, isolated, depressurized to atmospheric pressure, drained and free of flammable and toxic gas.
- Especially for maintenance of such systems or equipment, where a total shutdown is not practicable, facilities shall be provided to ensure adequate isolation of units or systems from live plant parts to provide safety against any accident.
- A philosophy in isolation for maintenance has been formulated and is consistently applied throughout the project. The philosophy is described below:
- For minor maintenance work, a single leak-tight closed valve shall be provided at the inlet and outlet of the "block". The "block" may be the plant itself, units, trains, or single components. Minor work is defined as a job of a routine nature e.g. pig trap opening or control valve opening.
- For major maintenance work, a single leak-tight valve plus a spade/blind, or a double block and bleed arrangement shall be provided at the inlet of the "block".
- Inert gas injection and downstream blowdown points have been provided in the pipeline for each section, to be used during start-up to avoid the formation of combustible mixtures of gases.
- A small amount of purge gas shall be continuously injected into the vent header piping at the extremities to ensure that the vent header, vent scrubber, and vent stack remain free of oxygen.

- A slam shut valve has been provided at the inlet of the pipeline system, which will automatically shut down the pipeline in case of line rupture or overpressure.
- LBV stations containing Line Break Valve (LBV) are being provided, which will automatically shut down the section of pipeline in case of line rupture or overpressure.
- For cold start-up of the pressure regulating & metering facility, instrument gas scrubber have been provided with ESD panel which shall be used to automatically cut off the gas supply and simultaneous de-pressurizing of instrument gas scrubber in case of an emergency condition e.g. fire etc.
- The LBV station is equipped with blow down facilities to depressurize the relevant pipeline section.
- Each consumer PRF facility shall be provided with inlet and outlet valves to be closed in the event there is an emergency downstream of the valve so that the affected consumers can be isolated and the gas supply to the consumer shut-off.
- Blowdown connections at pipeline and process equipment have been sized so that the system shall be depressurized to 7barges within 15 minutes. This criteria is as per the requirements mentioned in API 521 and is intended to protect the equipment and pipeline against overpressure while losing strength due to heat input and to reduce the escaped inventory in case of a leak.
- LBV station and PRMF at Complex is proposed to be fenced with warning signs posted to inform the passers-by of possible hazards.
- Suitable fire extinguishers and NFPA-10 shall be kept in readiness to be used in the event of an emergency.
- Monitors for smoke/flame detection, minimum two for each PRF are proposed to be installed. These shall initiate an alarm/hooter in the event of a fire. Fusible links shall be provided which will close the slam shut valves in case of fire and initiate the alarm/hooter.
- A safety assessment of the Pipeline System has been undertaken covering the following aspects:
- The safe operating pressure of the pipeline considering the location class as per requirements of ANSI B 31.8.
- Safe venting height and distance for the vent at 2 PRMF, as per the requirements of API RP 521.
- Proper access arrangements shall be provided at all above ground facilities.

- Operating and inspection points shall be accessible and visible from operating aisles, preferably without the help of auxiliary platforms and ladders. Equipment parts, instruments, valve hand wheels, and piping shall not protrude into access aisles.
- Pig Receivers and Launchers shall be oriented towards the least vulnerable area outside the installation. Proper access to insert/remove pigs shall be provided.
- Pressure Reducing and Metering Facilities shall be laid out in a manner that it shall meet requirements for normal vehicle and personnel traffic, security, emergency evacuation, firefighting and accessibility for maintenance and workovers. Furthermore, it shall include proper positioning of depressurizing valves, ventilation inlets, and outlets & vents.
- The recommended minimum distances, which shall be followed in facility layout, are given below:
  - Roads which may be used by the public shall be located at least 30 m from process plant equipment.
  - Roads within a fenced site shall be at least 15m from process plant equipment.
  - Service buildings shall be at least 15m from process plant equipment.
  - Vent stack shall be located at least 15m horizontally from any structures or equipment at a higher elevation from the discharge point.
  - For good operational access and for safe egress a minimum of 1m shall be left free between lined-up equipment (piping and instrumentation installed).

3.4.4.2 Safety in Construction

Since work has to be carried out and the pipeline is to be laid in a row parallel to the highway, possible hazards to the general public and traffic are to be included in the safety consideration during the construction stage. These will include:

- Marking of the trenches with fluorescent or reflective markings to notify the public of the trench hazard.
- Trenches shall be properly prepared and free of all stones, debris and other materials, which can cause damage to the pipeline coating.
- Following the safety practices, recommended clothing and gear be used by the workers.
- Pipelines shall be laid following good construction practices so as to avoid overstressing the line pipe and other piping components.

- Proper welding procedures to be followed for safe distances from possible flammable sources to be implemented. Proper precautions such as availability of extinguishers at hand are also proposed to be taken.
- In the event, gas is to be vented, as for instance during commissioning of the pipeline, mobile temporary vent stacks shall be used, of sufficient height so as to disperse the gas evenly before a combustible mixture can be formed. Snifter gadgets to detect the hydrocarbon content will be utilized during such start-ups to ensure safe start-up of the gas pipeline. All activities, which cause spark and fire, shall be completely stopped.
- An earthing cable shall be installed prior to every depressurization, gassing-up to prevent static charging of the pipeline.

3.4.4.3 Safety in Operation

Operational safety is built into the system through the following:

- It is proposed that snifter equipment shall be kept so that leakage within CGS and Rite Foods premises may be detected.
- The PRF skid comprises four regulators, each of which can independently regulate the gas for the 100% requirement. These are arranged in two independent trains each with a slam shut valve to doubly ensure safety during equipment malfunction. The slam shut valves are proposed to initiate an alarm in the event of the shutdown while the consumer is still supplied through the other train, and emergency procedures executed.
- Break valve stations shall be installed underground in the pit with fence and lock and key arrangement to facilitate optional blow down of any pipeline section and easy access for operational and maintenance activities.

3.5 Utilities

3.5.1 Electrical Power Distribution System

Electrical System for Rite Foods and City Gate Station's PRMF

Electrical System for each PRMF station shall be separate and dedicated. All requirements mentioned as follows shall be applicable to each PRMF station

For each PRMF Station, Electrical Power shall be supplied from two independent feeders of 400/230V, 50Hz from Power Plant. This power shall be distributed through respective Main Distribution Board (MDB) located at each PRMF to the following main load consumers:

- Area Lighting.
- 16A/32A Power socket outlets installed in the field.
- UPS for instrumentation systems.
- Control Room/Control Panel Equipment.
- Control Room/Office Building Lighting, Air Conditioning, and Utilities.
- Guard Room Lighting, Air Conditioning, and Utilities.
- Cathodic Protection System.

Power Distribution to these above-mentioned loads shall be established through Sub Distribution Boards.

Auto Transfer Switch (ATS) shall be provided for automatic switching between the two incoming power sources. Additionally, a tie-in point for a backup generator shall be provided in the Main Distribution Board along with a manual change over switching mechanism to ensure redundancy in power supply to essential loads.

3.5.2 Earthing

Earthing System shall be constructed as required by project specifications and in conformity with BS7430 and other relevant codes and standards. The system shall consist of a network of copper earth rods and copper earth conductors along with relevant accessories. The equipment to be earthed includes but is not limited to the following:

- All electrical loads/equipment.
- All vessels/skids. (To be provided with double earth connections)
- All light poles.
- Mounting channels for field installed socket outlets.

3.5.3 Lightning Protection

Lightning Protection System shall be constructed as required by project specifications and in conformity with BS6651 and other relevant codes and standards.

Lightning protection of the facility shall be achieved by installation of air terminals either as lightning rods or horizontal strips mounted on equipment/building tops or connected to dedicated earth rods through suitable down conductors. Earthing system for lightning protection shall be connected to the main earthing system through Transient Earth Clamps (TEC).

3.5.4 Area Lighting System

Area lighting at each PRMF shall be achieved through 400W/250W pole mounted light fixtures. Floodlights shall be used for general area lighting while Street lights shall be used to light up roads/ pathways. These light fixtures shall be non-explosion proof as they shall be mounted at heights in access of 8meters. Light fixtures used shall be suitable for 230V, 50 Hz single phase supply and shall be installed complete with ballast, igniter and P.F improvement capacitors.

3.5.5. Uninterruptible Power Supply (UPS) System

A UPS system shall be provided at each PRMF to provide uninterruptible supply to sensitive instrumentation systems including field mounted instrumentation and the monitoring equipment/panels located in the control room. Emergency exit lighting of control room shall also be provided through this UPS. This UPS shall provide both 230V AC and 24V DC supplies for a total of 10kVA load. UPS shall include:

- 24V lead- acid battery bank, sealed type contained in a closed cabinet, to supply normal load for 12 hours.
- Battery Rectifiers.
- DC-AC Inverters.

3.5.6 Fire & Gas Detection/Fire Suppression System

F & G Detection on each PRMF's Outdoor Locations

The Fire and Gas (F&G) system shall consist of fire detectors monitoring any combustible gas leakage, the presence of flame through radiation, and presence of excessive heat due to any

abnormality. The different detector would be considered based on the potential of abnormal circumstances (flame and gas), the requirement of response time and degree of protection required due to hazards associated with equipment and process. Combustible gas detectors would also be installed where flammable or toxic gas could accidentally accumulate. Furthermore, Manual Alarm Call points and audible/visual alarm devices shall also be provided at strategic locations throughout the station.

For each PRMF station, separate and dedicated F&G detection System Controller/Panel shall be provided. All field devices shall be individually wired back to respective F&G System Panel of each PRMF station. The system shall provide continuous and effective monitoring of fire and combustible gas on each PRMF Station.

This F&G Panel shall be interfaced with the respective main Station PLC to communicate signals related to gas release and fire. These signals shall be used by the main Station PLC for activation of ESD through predefined Cause & Effect Logic.

The F&G Panel shall also provide an operator interface in the form of integral touch screen MMI or a combination of LCD display/keypads. The screen display pages used in conjunction with the operator keyboard controls shall provide the necessary animated displays and controls.

Typical alarm displays shall typically include, but not limited to:

– Fire alarm/trip indications

– Gas alarm/trip indications

– Fault indications

– Gas level display

– Gas over range indication

– Operator keyboard inhibits etc.

– Equipment failure

These displays may be configured as:

– Alarm/text pages

– Zonal displays

– Historical/trend displays

– Operator help pages

– Animated process displays

Furthermore, the above information shall also be communicated to the station's main PLC through the above mentioned serial link for critical indications on PLC HMI and also for data logging, storage and printing.

3.5.7 Administrative/Control Building for PRMF Station

In addition to the above, adequate type and quantity of fire detectors shall be installed within various rooms of Admin/Control building and connected to a separate multi-zone addressable Fire Alarm & Suppression Panel.

This Fire Alarm and Suppression Panel shall be equipped with adequate battery backup for emergency supply in case of loss of power. The Panel shall also be responsible to accommodate and control the FM-200 Suppression System for the Control room, UPS room, telecom rooms, etc. in the main Admin Building.

The Admin Building Fire Alarm and FM-200 Suppression System shall preferably be provided as an integrated package including all mechanical and electrical installations, all detection and control equipment, agent storage cylinders with agent, system actuation equipment, discharge nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, functional checkouts, diagnosis and all other operations necessary for a functional UL Listed and/or FM approved Fire Suppression System.

The Panel shall be capable to provide an alarm signal (with address) to station's main PLC in case of fire. Such a signal shall be used by PLC to provide an alarm on the HMI as well as to audible/visual alarm devices installed in the outdoor locations.

3.5.8 Fire Water System for PRMF Station

Firewater shall be stored in a dedicated above ground storage tank and supplied to firewater users via a dedicated diesel engine driven firewater pump (1 operating +1 standby) and a ring main network. The firewater tank shall be supplied directly from the borehole.

The storage capacity of the tank shall be sufficient for up to 4 hours of continuous demand of the largest user.

The firewater ring main shall be routed through Heaters, Metering Skid, Filter Separator, K.O Drum, Slop tank and other areas of city gate station where future expansion is expected, to ensure firewater is supplied to all firewater users.

The system shall consist of a total of two firewater pumps comprising one 100% duty, diesel engine drove fire pump together with one 100% stand-by diesel driven fire pump. The firewater pumps shall provide sufficient firewater to satisfy the flow and pressure requirements of the largest firewater demand.

Fire hydrants have to be provided and distributed throughout the facility so that firewater supplied from these hydrants can be used to overcome fire on any part of the facility. The distance between any two hydrants on the fire water ring shall not exceed 30meters. The firewater ring-main shall be routed underground.

The hydrant supply for Fire water system of Rite Foods PRMF shall be provided from Rite Foods complex network.

3.6 Project Activities

The following are proposed project activities by phases is a below

Pre-Construction:

a. Land Acquisition of 25m by 135km Right of Way
b. ROW Clearing and Preparation
c. Survey of 25m by 135km Right of Way and lay down area for line pipes and construction
d. Equipment Mobilisation
e. Workforce Mobilisation

Construction

f. Line pipes laydown and fabrication areas
g. Clearing
h. Landscaping and grading
i. Trenching
j. Pipe Stringing
k. Bending and Welding

l. Lowering and Laying
m. Backfilling
n. Construction and installation of the pipeline, PRMF, and other gas infrastructures including civil, mechanical and structural works

Pre-Commissioning

o. Hydrostatic Testing
p. Final Tie-in
q. Clean Up and Restoration
r. Commissioning

Operations

s. Operations and Maintenance

3.6.1 Survey of the Right of Way (25m X 135Km)

The survey involved field reconnaissance visits, coordinates gathering, cutting of the Right of Way boundary and center line. Others were monument implantation by the in-situ casting of the monument pillars on a 0.5" pipe driven into the firm ground. This was followed by field observations of coordinates relative to established Global Position System coordinates and finally data processing and draughting of the Topographic map, Right of Way alignment sheets and bathymetric alignment of the water body.

3.6.2 Land Acquisition of Right of Way (25m X 135Km)

Land acquisition of the Right of Way (ROW) will be carried out in accordance TGNL's policy and in conformance to the International Finance Corporation (IFC) Performance Standard (PS 5): Land Acquisition & Involuntary Resettlement. See Appendix.

The Land for the pipeline ROW has been acquired by TGNL. The ROW was chosen due to the following considerations:

- Minimal or no displacement of people living along the route (ROW avoided communities and settlements)
- Environmental issues especially biodiversity
- Installation cost
- Security and safety especially from sabotage and vandalisation
- Regulatory Compliance

- Less impact to economic livelihoods

Generally, construction easement widths would normally be a strip of land 25m in width for a single pipeline. The proposal for this project is to minimize land use.

Where necessary, a Livelihood Restoration Plan (LRP) or Resettlement Action Plan (RAP) inclusive of an entitlement matrix will be compiled by the proponent (TGNL). The LRP/RAP shall outline with compensation measures for all projects affected communities including means of implementation and timeframe. The land acquisition process will be completed with the completion of easement agreements with the project affected persons/communities and handover of ROW to the project construction team.

The land acquisition (LRP/RAP) will be carried out in accordance with applicable National and Lagos States laws and regulations, and with the **IFC Performance Standard (PS) 5: Land Acquisition and Involuntary Resettlement (2012).**

The following underlying principles will guide the planning and implementation of the project land acquisition and associated activities:

a. The land acquisition process will comply with the **Land Use Act (1978)** and the **Oil Pipeline Act (1990)** and all other applicable Nigerian laws and regulations.

b. The acquisition will compensate affected persons for loss of assets at full replacement cost.

c. The acquisition will treat occupancy rights as ownership rights for the purposes of compensation and will compensate accordingly.

d. The project will compensate persons affected by the acquisition of permanent land at full replacement cost

e. The project will pay compensation in full prior to the occupation of land or removal of assets.

f. The project will implement livelihood restoration measures in order to assist Persons Affected by the Project (PAPs) land acquisition to restore incomes to pre-displacement levels by the provision of gainful employment positions during the pre-construction and construction phase Vulnerable groups will be identified, registered and their livelihood

monitored. Specific measures for compensation and livelihood assistance will be developed and funded by the project.

g. A Grievance Arbitration procedure will be made accessible to all those affected by the project.

After the pipeline construction is completed, the need for wide construction corridors is replaced by a lower requirement to gain access for maintenance and repair. In open swamp terrain, this permanent ROW can be reduced to a 10m strip centered on the pipeline centerline (i.e. 5.0m either side). Any conditions or restrictions contained in the ROW was incorporated in the design and will be implemented during the construction phase of the project.

3.6.3 Construction and Installation of the pipeline, PRMF, and Other gas infrastructure

3.6.3.1 Construction Management

Construction of the gas pipeline will be executed in accordance with a standard planning framework that will be reviewed as it becomes expedient by the project team to ensure:

- Maximum efficiency in construction
- Minimum adverse environmental and health impacts
- Earliest completion time
- Compliance with the laws of the land and all regulatory requirements

Logistics Arrangements

In consideration of the massive movement of construction equipment, materials, and resources during the construction phase of the project, the construction work itself will need proper logistics arrangement. The operational focus of the project will be along the pipeline route. The equipment will be supplied via Lagos port. Other miscellaneous logistics arrangement shall be in the scope of Contractor.

Main Construction Team Work

The majority of pipeline length will be constructed in several stages, each by the main construction team. The activities of this team result in sections of fully welded pipe being laid in the trench and roughly backfilled. In addition, special crews for such operations as field bending of pipes, installation of manifold/valve stations and major water crossings also operate as necessary.

3.6.3.2 Right of Way Preparation

The pipeline Right of Way preparation will involve the following:

- Vegetation clearing
- Land ditching/excavation using heavy equipment
- Sweeping of ditch to appropriate depth prior to lowering of pipeline

Prior to commencement of any construction works, TGNL shall re-establish the ROW corridor already surveyed across the lands, swamps, creeks, and river to ensure that lands not compensated for are not encroached upon. The surveyors shall set-out boundaries along the ROW and will be clearly marked. The ROW will be cleared of all vegetation and stripped within the width/boundary of the acquired area. The width of the RoW is 25m to accommodate the pipeline and equipment during construction. The depth of the pipeline trenches on land and in the swamp will be 1.5 and 5.0 meters respectively

Trench dimensions shall be in accordance with approved design specifications for the pipeline trench. Where required, the excavated trench will be secured against collapse by suitable means, e.g. timber, sheet piles etc.

3.6.3.3 Materials for Pipeline Construction

3.6.3.3.1 Material Specification

Material for construction of the pipeline shall be Carbon steel, API 5L Glade B. A corrosion allowance of 3mm has been prescribed in accordance with the project Basis for Design for Gas Flow.

3.6.3.3.2 Pipeline Design Requirements

The pipeline design is in accordance with ASME B31.8. Evaluation of combined stresses on the pipeline shall be carried out for the assurance of the mechanical strength in conformance with the relevant code. In addition, detailed stress analysis shall be carried out during the detailed design phase.

3.6.3.3.3 Pipeline Loading Cases

To analyze the pipeline systems, the following loads will be taken into consideration as a minimum:

- Internal pressure loads (hoop stress).
- Sustained Loads (soil loads, soil frictional force, self-weight)
- Live Loads (vehicle traffic)
- Thermal Loads (changes in operating/installations temperatures)
- Test Loads (hydrostatic testing)

3.6.3.3.4 Stress Conditions

The following stress conditions have been considered for the design of the pipelines:

- Circumferential stresses due to internal pressure and external sustained and live loads
- Expansion stresses for restrained and unrestrained portions of the system due to internal pressure and thermal loads.
- Longitudinal stresses for unrestrained pipeline sections, due to pressure, weight and other sustained loadings.
- Longitudinal stresses for restrained pipeline sections, due to pressure, weight and other sustained loadings, considering the frictional restraint of the soil.
- Longitudinal stresses produced by internal pressure, live and dead loads.
- Circumferential and longitudinal stresses induced during hydrostatic testing.

3.6.3.3.5 Combined Loads

For combined loading cases on the pipelines, ASME B31.8 shall be used as guidelines.

3.6.3.3.6 Hydrotest Loads

Calculations of any hydrotest induced loads and the proposed method to cater for them shall be developed in accordance with ASME B31.8.

3.6.3.3.7 Pipeline Expansion and Flexibility

The length of welded sections of pipeline prior to ditching shall be restricted to 2km and the temperatures at which the buried pipelines are tied-in shall be maintained within 10^0C of the normal ambient temperatures in order to maintain pipeline stability.

Pipeline expansion before ditching will be analyzed to ensure that unacceptable stresses are avoided during construction. Anchor blocks may be installed at the ends of the buried pipeline in order to limit expansion and prevent the pipe being overstressed at the end or branch connections to piping, cause any external soil disturbance and prevent pipeline coating damage. In

calculating maximum allowable thermal stress, both the short-term expansion, immediately after start-up and the long-term friction relaxation shall be considered.

The buried sections of the pipeline system covered by this specification shall be designed to be fully restrained by soil friction, as defined by ASME B31.8. During detailed design, the minimum depth of cover will be assessed to determine if it is sufficient to prevent the pipeline from suffering upheaval buckling due to expansion forces which shall meet applicable TGNL approved standards. All buried connections shall be located within the restrained region of each pipeline. Where the connections are not in the restrained regions they shall be relocated or have above ground expansion legs incorporated. Anchor blocks may be avoided if the stress analysis simulation shows the pipeline is operating in stable conditions. Should the pipeline operating conditions change in the future and show significant fluctuation in operating temperature conditions, the decision will need to be revisited and the requirement for anchor blocks evaluated.

3.6.3.4 Laying of Pipeline

The activities associated with the pipeline laying consist of:

- Stringing
- Bending and Welding
- Field Joint Coating
- Lowering
- Installation of saddlebags to control weight and prevent buoyancy of the pipeline
- Directional Drilling for River Crossing sections
- Hydrostatic testing
- Backfilling

3.6.3.4.1 Stringing

TGNL shall string the line pipes along the ROW beside the open ditch with suitable equipment and handling tools where possible. Stringing of the pipes will be interrupted to allow for passage of community pedestrians. Coated pipes shall rest in padded supports or timbers to avoid damage to the coating. Strung pipes shall be capped at both ends to keep the pipe 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.

3.6.3.4.2 Bending, Beveling, Welding, and Non-destructive Weld Inspection

TGNL pre-inspected and approved pipe cutter or thermal cutting and beveling machine shall be used to perform joint beveling. Manual cutting shall not be permitted. Bevels shall conform to the requirements of welding specification. Pups required for tie-ins shall be cut from undamaged pipes. One hundred percent radiography of all welds joints shall be employed. All radiography films will be processed and interpreted on site to facilitate quick repairs of defective welds.

3.6.3.4.3 Pipeline Coating

Anti-corrosion coating for field joint protection will be polyethylene-coating with shrinkable sleeves. Heat shrinkable sleeves or repair patches shall be used for repairs of defective field joint coatings taking into account the extent of the portion to be repaired. Holiday test shall be conducted on all field joint coatings. TGNL QA/QC representative on site must certify this okay before lowering can commence. Defective coatings shall be clearly marked. All repairs shall be inspected visually and with a holiday detector to confirm that they are acceptable.

3.6.3.4.4 Lowering and Backfilling

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 putting soft material (medium sand bed) to obtain a soft surrounding for the installed pipeline. The material shall be free of stones, rocks, timber, roots, debris and any other materials, which may damage the pipe coating. During lowering in the dry land, special care shall be taken to ensure the pipe coating is not damaged. Initial backfilling will be carried out by the installation of soft material. Backfilling material shall be free of rocks, timber, roots, debris which may damage the coating on the pipeline.

3.6.3.4.5 Cathodic Protection

The Cathodic Protection will be installed in accordance with the Cathodic Protection design for both pipelines and other interconnecting pipelines and associated facilities

3.6.3.4.6 Pipeline Laying

The pipeline will be buried with a minimum soil cover of 1meter, with the pipe laying process depending on the particular environment.

- Normal Ground

In the Normal ground, the ditch would be excavated such that the sides are 200mm clear from the pipe and backfilled with selected a mix of concrete mix of cement and fine aggregate sand.

- Horizontal Directional Drilling (HDD) for Lagoon and Bridge crossing

The HDD technology will be employed at two crossings, namely:

a. <u>Lagoon Crossing:</u>

The pipe shall be laid through horizontal directional drilling (HDD) across lagoon.

b. <u>Bridge Crossing:</u>

The pipe shall be laid through horizontal directional drilling (HDD) across bridge.

The HDD method for River Crossing was preferred and chosen over the conventional method of Open Cut (Trench Construction Methodology) due to the fact that method:

- is environmentally friendlier (minimal disturbance to wetland and wildlife habitat, minimal pollution to water, sediment and cultural sites)
- feasible proven option for a challenging terrain/environment such as rivers, swamps, and wetland crossings

- Huge time savings for HDD method relative to the open cut method. The HDD installation involves five main steps:
  i. Pre-site planning (Site survey and Bore Planning)
  ii. Site Preparation and HDD setup
  iii. Drilling of pilot hole
  iv. Expanding the pilot hole by reaming and
  v. Pull back of the pre-fabricated pipe

A schematic of a typical HDD is as shown in Figure 3-4 while a schematic of typical water crossing in as shown in Figure 3-5.

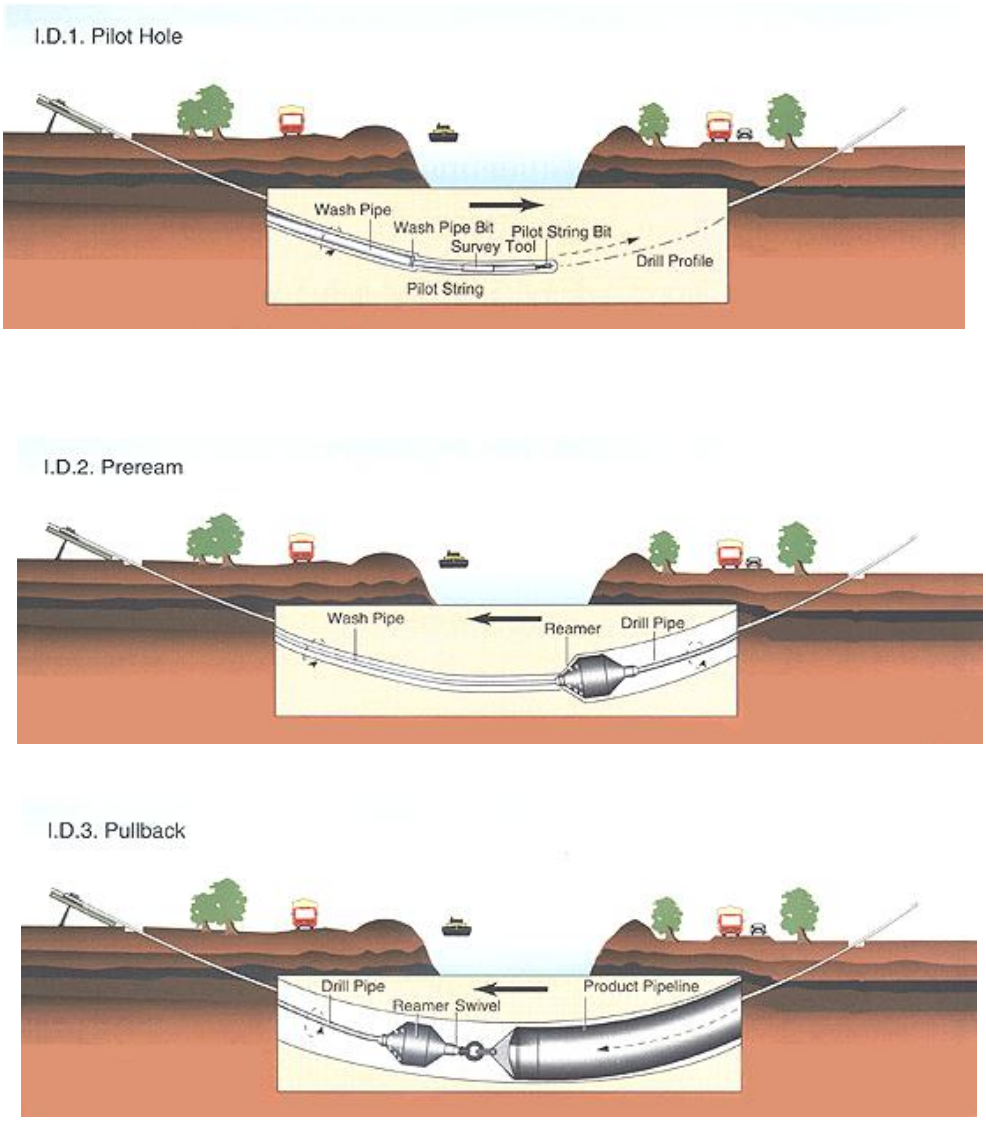


Figure 3.8: **Typical HDD operation**

Pre-site Planning (Site Survey Bore Planning)

A confirmatory Bathymetry survey will be carried out to establish the Riverbed profile. A survey team will map out the bore paths. The purpose of this is to provide an accurate plan and elevation of the area that the pipeline will go through. The survey team will also locate, identify and mark any buried services that run close to the path of the bore. In addition, during the survey stage, the exit point, entry point and azimuth for the drilling will be established for the river crossings.

Survey data obtained from this phase will be used to develop a bore plan and profile using bore planning computer software. The bore plan will establish the entrance and exit angles and the radius of the pipe curvature, to achieve the depth and length of the drill. The bore plan will also

show any utilities that will be found by the survey team and will allow for the necessary deviation of the pipeline to avoid contact with the utility.

Site Preparation, HDD Setup and Calibration of Survey Device (Para track II)

The drilling rigs will be set up and anchored at the planned drilling locations. The drilling rig will also be aligned with the projected centerline and rotated to the requisite entry angle. Secure anchorage will be achieved by driving pipes into the ground with the aid of a swamp buggy in front of the rig. In the swamp areas, the ground shall be stabilized with the use of mud mats to allow for rig access and positioning.

After the rig setup, it will be closely followed by the synchronization of the rig setup stage on site. The downhole survey instruments which will be utilized for monitoring the pilot-hole position will be calibrated at the drilling location. Each instrument unit will be separately aligned along the project pipeline center line at the location free from magnetic influence. During the calibration, the instrument will be physically positioned relative to the pre-surveyed control points and the instrument readings shall be measured and stored in the "uphole computer unit". On completion of the alignment, the recorded readings as stored in the computer will be correlated with the survey readings of the control points.

An additional component of the directional measurement system is known as the Tru Tracker will also be used. This system is not susceptible to magnetic interference and will be used to verify the steering instrument readings, thereby assuring accuracy at the exit location. The Paratrack II utilizes a single wire grid located on the ground surface and will be established everywhere the surface is accessible. The accuracy of this system is indicated with approx. 0.5% of the actual depth.

Pilot Hole Drilling

The pilot hole will be drilled along a predetermined alignment in which the entry and exit points are located using traditional survey methods.

The pilot hole will be drilled using a drill pipe attached to non-magnetic housing and a jet bit assembly. Drilling fluid will be pumped through the annulus of the drill pipe aiding the jetting assembly in cutting the soil. The drilling fluid (a mixture of bentonite and water) which is environmentally friendly also helps lubricate the drill stem, suspend and carry the drilled

cuttings to the surface, and form a wall cake to keep the hole open and minimize the potential for a drilling fluid seepage to the surface.

Non-magnetic housings will also be fitted with a steering toolkit which will allow the drilling along the entire borehole length to be monitored and recorded and the profile subsequently plotted. To get the best result on sections of the drill path, an additional independent "TruTracker" or Paratrack II system will be used to verify the survey records. With the conventional single drill approach, the pilot borehole drilling will be completed when the bottom hole assembly appears at the exit point location.
For longer drills, the intersect method would be applied. In this case, two rigs would drill from either end of the profile or bore plan and intersect at a predetermined point. The drilling of the Pilot hole and pipe string pull back are illustrated in Figure 3.2

Pre-Ream/Reaming Hole – Opening Process (Reaming)

The purpose of pre-ream is to enlarge the pilot hole to the desired diameter about 30% above the diameter of the proposed pipeline and ultimately ensure the safe passage of the line pipe during pullback. When the pilot drilling is finished, a reamer for hole enlargement will be connected to the drill string on pipe side at the site. The reaming process starts by pulling/pushing and rotating the drill string towards the preferred direction as determined by the design.

During the reaming operations, drilling mud (bentonite) is pumped through the drill string and out through the nozzles of the reamer to clean cuttings from the hole and to lubricate the drill string. The drilling mud used in the HDD works from the pilot drill to the pullback of the product pipe will be recycled using the HDD recycling units. However, after the project, the leftover environmentally friendly drilling mud will be brought to contractor base yard in the recycle unit.

During the reaming operation the final decision will be made regarding the number of ream steps and the final borehole diameter based on the proposed pipeline configuration, soil information and experiences gathered during the ongoing operation. Usually, a borehole diameter is selected, which is about 30% of the diameter of the pipeline to be installed which in this case is 31.2".

Pipe String Pull Back

The last step to complete a successful installation is the pullback of the prefabricated pipeline into the enlarged hole. The pullback process is the most critical step of the HDD process. A reinforced pull head is attached to the leading end of the pipe(s) and to a swivel that is connected to the drill pipe. The swivel is placed between the drill rig and the pipe to keep any rotation and minimize torsion from being passed through to the pipeline. When a pipeline has minimal positive buoyancy even with the lightest possible drilling fluid densities, it may, therefore, require the addition of a calculated amount of water to achieve neutral buoyancy. The pulling processes are as follows:

1. Pipe string will be welded to a drag section of pull head that is slightly longer than the length of the drill, on the exit side of the borehole
2. The pipe is typically coated with a corrosion and abrasion resistant covering and will be hydro statically pretested to ensure pipeline integrity
3. The pipe string will be pulled over rollers into the exit hole and the pull-back will continue until the entire pipe string have been pulled into the borehole
4. The external coating of the pipe string visible at the entry point is inspected for damage upon completion of the pullback
5. An internal inspection of the pipe string is performed to identify any damage done to the pipeline during the pullback.

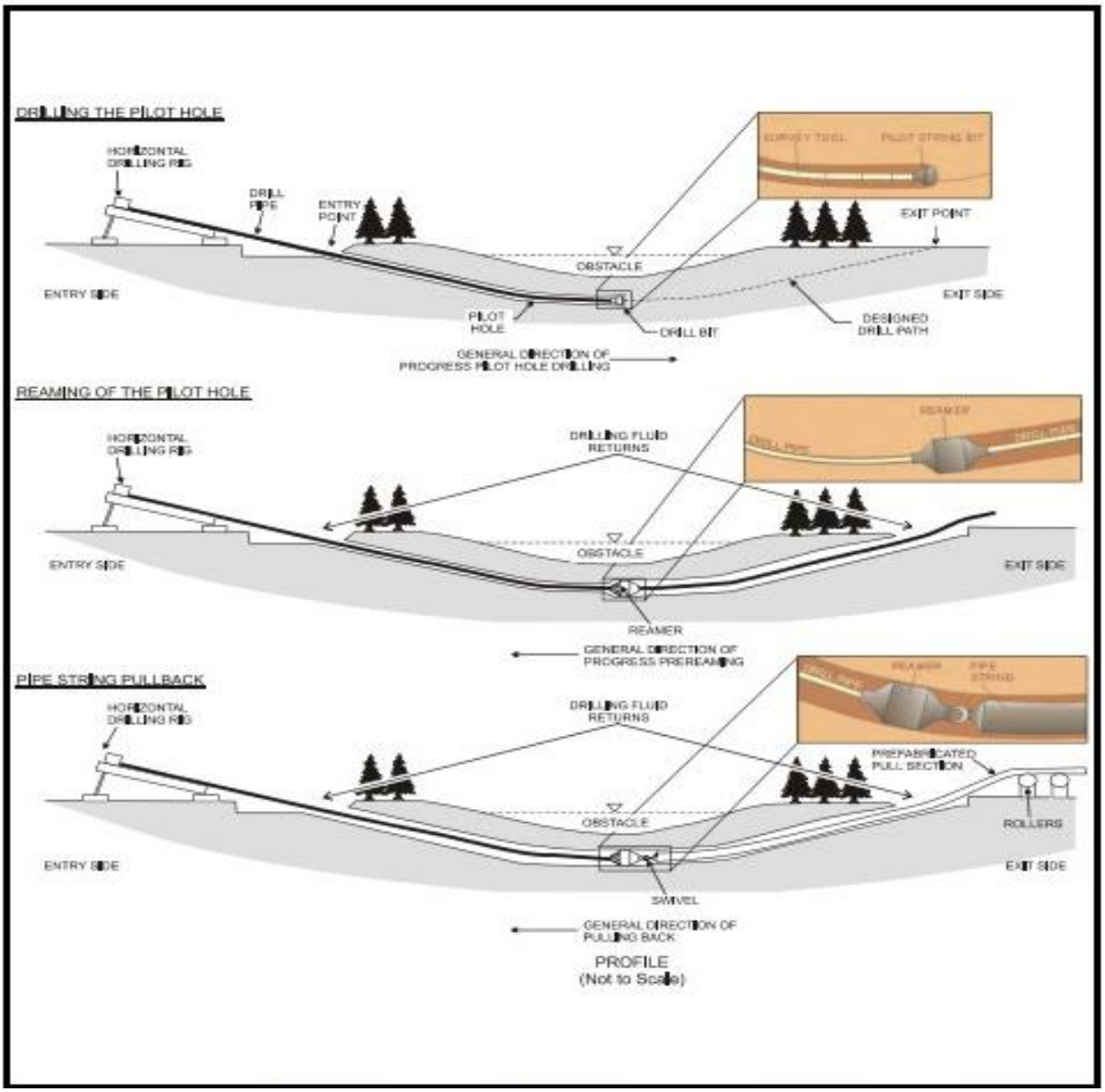


Figure 3.9: Water Course Crossing – Horizontal Directional Drill (Canadian Association of Petroleum Producers Publication September 2004)

Tie-in

After completion of the pullback and the removal of the pulling head, the product pipe will be tied to the parent adjoining conventionally laid section of the pipeline making a complete string of pipeline.

HDD Demobilization and Site Reinstatement

Upon successful pullback of the pipe string and tie-in as described above, the drilling equipment will be dismantled; demobilized and work areas will be reinstated with the rest of the pipeline right-of-way.

- Swamp/Wetland Crossings

In swamps susceptible to water level fluctuation, the effects shall be considered by calculating potential pipeline buoyancy and the resulting induced loading. Pipeline shall be restrained against flotation by the use of saddle bags weight. During construction, sandbags may be required to provide some additional stability to the pipe in an open trench.

The ditch would be excavated with side sloping at 2:1 to minimize side slippage. The pipe would be laid with a continuous 2.5ton saddle bags laid at calculated distances to prevent floatation from buoyancy effects. The width and depth of the ditch shall be sufficient to accommodate all floatation equipment and to provide the minimum distance from swamp level to top of the 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.

The depth of the pipeline at river crossings as per design specification shall not be less than 5m from the deepest point of the river bed, while the depth for swamp location is a minimum of 1.5m cover from the top of the pipe.

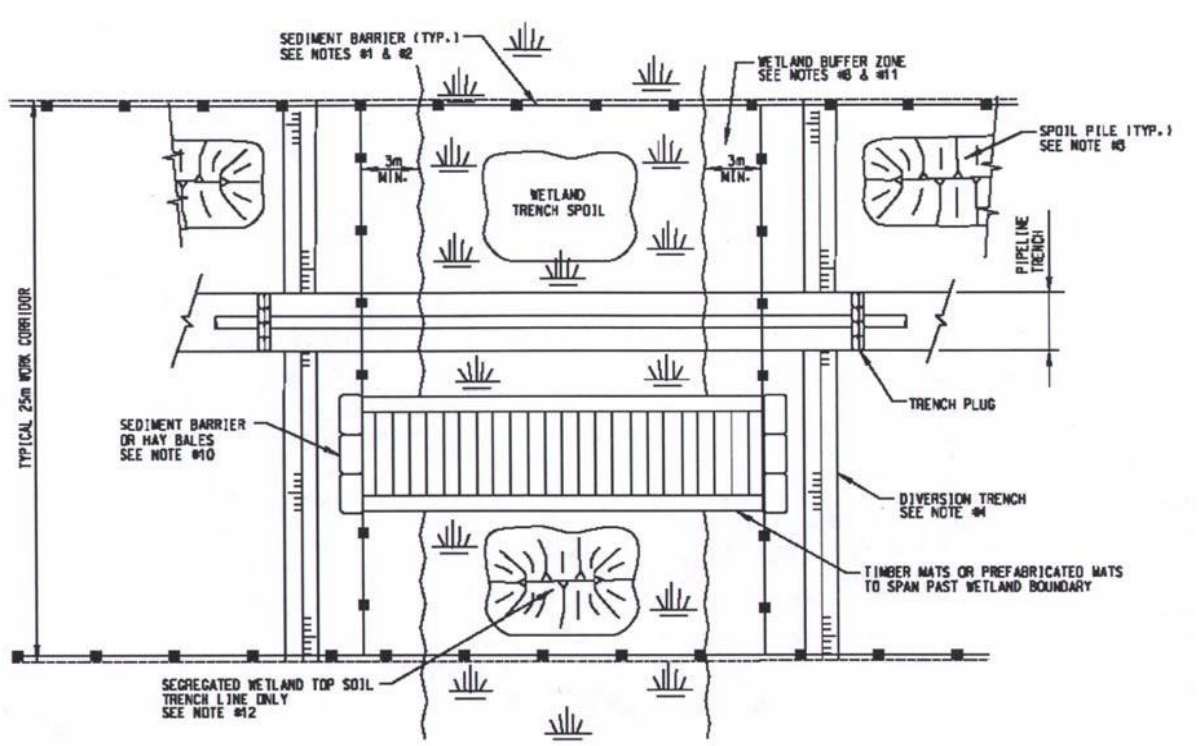


Figure 3.10: Typical trenching operation in wetlands

- **Road crossings**:

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 1.5 meters to the top of the pipe. The extra cover would be extended 5 meters from the center line of track, measured perpendicular to the track.

- **Existing / Foreign service (Telephone cables and water pipes):**

Precast reinforced concrete slabs shall be installed above existing service where required by the owning authority. A 150mm thick precast reinforced concrete slabs would be laid on all Telephone cables and water pipes.

3.6.4 Commissioning

3.6.4.1 Cleaning, Gauging, Pressure Testing, and Dewatering

The newly constructed pipeline shall be cleaned using brush-cleaning pigs. The line shall also be gauged using Aluminum gauging plates. The pipeline will be subsequently flushed clean and pressure tested to 1.5 times the design pressure or that which impose a stress level equal to 90% SMYS in the pipeline for 24hours. Fresh borehole water from drilled boreholes

will be used to carry out the hydro-test. The water quality shall conform to the World Health Organization (WHO) potable water quality criteria. The time the hydro-test water remains in the newly constructed pipeline will be kept to a minimum so as to eliminate the use of inhibitors. TGNL and Regulating Agencies representatives shall supervise the hydro-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 pigs.

3.6.4.2 **Corrosion Protection**

i. Internal Corrosion

To minimize the threat of internal pipeline corrosion, an inhibitor may be injected into the pipeline. Furthermore, pigging of the line will prevent the accumulation of debris which is a known contributor to internal corrosion. The low concentration of sulfate in the pipeline will minimize the activity of sulfate-reducing bacteria and consequently eliminate the risk of corrosion and hydrogen induced cracking from this source.

ii. Cathodic Protection

Cathodic Protection is based on galvanic and impressed current. The efficiency of the cathodic protection will be greatly improved through the use of impressed electric current. The design of the cathodic protection scheme would be determined by the findings of the corrosion survey, the pipeline diameter, wall thickness and coating material, and application quality.

The long-term cathodic protection system would be designed to provide an adequate pipe-to-pipe negative potential for the expected operational life of the pipeline. Direct current electricity supply will be obtained by conversion from the main electricity. The effectiveness of the cathodic protection system will be monitored throughout the life of the pipeline. To facilitate monitoring, a number of above-ground test points will be installed along the pipeline route.

3.6.5. Operations

3.6.5.1 Operation Control/Monitoring of Gas Pipeline

The risk of pollution is small as the pipeline system will be buried within a ROW, there shall be negligible nuisance associated with its operation. Pipeline integrity is vital for operational

reasons and management of the operational phase. To achieve effective operations, it is wise to look into the:

- Operational Management
- Effects of Pipeline temperature
- Gas Leak

Pipeline pressure will be monitored at the pipeline manifold end at KP312 and flow will be measured at the terminal points at or other terminals in future. These measurements will act as additional indicators that the pipeline integrity is being maintained.

3.6.5.2. Intelligent Pigging

The 12" TGNL Gas pipeline will be designed as fully piggable with permanent pigging facilities.

At the KP312, Ibefun and the Rite Foods complex end of the pipeline; provision will be made for pig launcher and pig receiver respectively. These shall enable routine maintenance, periodic intelligent and utility pigging program ensuring pipeline integrity for continuous service.

Pigging of the 135km TGNL pipeline shall be carried out to achieve the followings;

- Remove accumulated condensate and any free water that may have been deposited in the pipeline.
- Clean the internal wall of the pipeline.
- Conduct internal condition monitoring of the pipeline.

Pigging operation shall be conducted as per established pigging philosophy and approved by TGNL. Different types of pigs shall be utilized depending on the application i.e. Utility pigs (Cleaning, condensate removal etc.) and Intelligent pigs (wall thickness, corrosion, profile, and general internal conditions monitoring).

Routine pigging of the pipeline should have no effect on the operation of the pipeline as far as pressure is concerned, however, the flow rate during intelligent pigging activity may need to be adjusted through existing means at the tie-in point KP312 at Ibefun Ogun State.

Magnetic Flux Leakage (MFL) type intelligent pigging system is proposed for the project. Pig Launcher and Receiver sizes for plants Pipeline shall be adequately sized to accommodate intelligent pig tool.

The MFL surveys are more reliable than they used to be earlier because of the following reasons:

- Constant Recording of Magnetic Level
- Bi-directional MFL Measurement
- Constant Speed Measurement
- Constant Wall Thickness Measurement
- Constant Sufficient Magnetization Level

Confidence in the reliability of intelligent pig services can be established by checking whether the following points can be proven:

- Repeatable results of the measurement method
- Tracing the conditions of measurement
- Qualifying the inspection data
- Optimized use of recorded data
- The possibility of further analyzing any point of the pipe wall

Frequency of Pigging

Primarily, pigging shall be carried out as per DPR requirements as stipulated in the Mineral Oil Safety Regulations (MOSR 1997) "pipelines equipped with pig traps shall be pigged at intervals not exceeding 5years" and thereafter consideration shall be given as the need arises. Following the initial operation of the pipeline, the operating experience will show the effective pipeline hold-up and pigging frequency could be established accordingly.

The pigging frequency is a function of the water dryness level of the gas to be transported. In situations where the pipeline is operated at 25% less of nominal flow, the build-up of liquid in the pipeline is expected to increase hence pigging activity shall be required. When

low flow periods extend for longer than planned, the frequency of pipeline pigging shall be increased. This shall ensure that unacceptable liquid hold-up in the pipeline is avoided.

The frequency shall be determined based on simulated liquid hold up carried out when the pipeline becomes operational.

3.6.5.3. Venting

The system will incorporate the installation of Blowdown assemblies to allow for the evacuation of gas from the pipeline under emergency conditions or for scheduled maintenance operations. The blowdown assembly shall be sized to ensure minimum blowdown (venting) time and quantity of vented gas. The blowdown assembly will be part of the pig launcher skid.

3.6.5.4. Maintenance, Inspection and Shut down Activities

The gas pipeline will be operated in accordance with operational procedures developed by TGNL. The project will be managed by fully trained and qualified personnel who are conversant with TGNL's HSE policy guidelines.

3.6.5.4.1 Maintenance Philosophy

- **Upkeep of Structures**

Maintenance and inspection activities, based on periodic inspection to determine the condition of structures and performance of their protection system include refurbishment activity to restore the integrity of structures, replacement of and coating system applied to structures based on the time maintenance schedule.

- **Containment of Hydrocarbons**

Periodic (monthly) inspections will be carried out to determine the condition of all elements of the process fluid containment envelope, as well as any protective coatings, applied thereon. Inspection programs for certifiable pressure vessels, pressure/vacuum-relieving devices will be carried out to meet the requirements of the Minerals Oils (Safety) regulations of Nigeria. Refurbishment activity to restore the integrity of the envelope will be based on their condition. Where appropriate, economic systems to mitigate the effects of corrosion shall be put in place and their effectiveness routinely monitored.

- **Control and Protection**

Control and protection system will be based on periodic inspections /calibration/testing both their input and output functions as detailed in the Routines Job Maintenance. Non-availability of hydrocarbon production caused by such inspection/calibrations/test will be accounted for in the Production Plan. Change of set points will be controlled by the plant change procedure.

- **Shutdown system**

Maintenance of shut down system, involving both initiation and activation devices, will be based on periodic full function testing of both their input and output functions to ensure operation in accordance with TGNL guidelines. Non-availability of hydrocarbon production caused by such inspection/calibrations/test will be accounted for in the TGNL Gas plan. Where possible, for maintenance or construction activity that requires the facility to be shut down, such function tests will be used to shut down and check the isolation of the facility. The testing schedule will be adjusted to reflect the unscheduled test.

3.6.5.4.2 Maintenance and Inspection

- **Gas Pipeline**

Regular surveillance of the pipeline route and associated structures will form an integral element of the integrity monitoring system and will seek to:

- Detect and locate any activity which may interact with the pipeline including unauthorized third party activity.
- Locate any local changes or ground conditions which may threaten the pipeline including areas of ground erosion, movement or subsidence.
- Detect any leakage from the pipeline and its facilities.

To reduce the risk to the pipeline from third-party activities, most often due to unauthorized building and construction work, periodic physical inspection of route shall be carried out including community's surveillance via a contracted Team, the Team is tasked with the responsibilities of ensuring that the ROW is accessible, kept clear and clean. As part of the operational integrity monitoring, the following inspection procedures will be introduced:

- Initial inspection of the pipeline coating to cover routine surveillance aided by the presence of marker posts at all major crossings and field boundaries. The pipeline route will be inspected at monthly intervals.
- Close liaison with all communities along the route will be maintained.
- Induced current density readings will be recorded and analyzed to identify any areas where it is indicated that cathodic protection is not at the required level.

3.7 Manpower Requirement

The construction of the 135km 12" pipeline is expected to require averagely 150 and 200 personnels. The projected manpower requirement for each phase of the project is as below.

Table 3.2: Labour requirement for the project phases

Project Phases	Pre-Construction Phase	Construction Phase	Pre-Commissioning Phase	Operations Phase
Skilled	100 – 150	150 - 250	100 - 150	20 – 30
Unskilled	100 – 200	300 - 500	100 - 200	NA

3.8 Waste Management

Waste Generation

Any development project involving bush clearing and excavation in an environment such as the pipeline pipeline construction area is bound to encounter waste management problems which need to be handled in compliance with the Petroleum (Drilling & Productions) Regulations, 1969, Section 25, 36, 49 and (b), (c) and (d), which stipulate *inter alia:*

"The licensee or leasee shall adopt all practical precautions, including the provision of up-to-date equipment… to prevent the pollution of inland waters, rivers, creeks, water courses, the territorial waters of Nigeria or the high seas by oil, mud or other fluids or substances which might contaminate the water, banks or shoreline or which might cause harm or destruction to fresh water or marine life, and where any such pollution occurs or has occurred, shall take prompt steps to control end, if possible, end it"…… etc.

It is, therefore important that an effective waste management scheme or plan be in place to avoid contravening the above regulations and the AHL HSE policy.

Waste Management Strategies

Wastes anticipated from the project belong to the following broad categories:

Solid Wastes

Clean and dirty location run-off water

a. Domestic and sanitary waste
b. Gaseous Emission and discharges
c. Spent oily waste from plants and equipment maintenance
d. Spent bentonite from HDD operations

The following strategies of waste management will be adopted:

i. Reduce the volumes of wastes generated through appropriate technology
ii. Recycle and re-use wastes where feasible
iii. Treat hazardous wastes and make them inert before disposal
iv. Ensure safe and responsible collection, segregation, storage and disposal of all wastes.
v. Keep auditable records of all wastes streams
vi. Monitor wastes disposal activities in order to prevent future liabilities
vii. Reduce the negative impact of sites preparation and operations on the environment.

All chemicals used by AHL and their contractors would be handled and ultimately disposed of according to the requirements of Material Safety Data sheet or AHL Side Handling of Chemicals (SHOC) system. Records of all chemicals stored on site, shall be maintained identifying their Health, Safety and Environment implication.

Regular checks would be made by AHL staff to ensure that records are maintained and storage facilities are in good handling practices. Discarded consumables include spent lube oil for construction equipment and machineries, chemical/material bags, scrap metals used in constructions, pressure test fluid (inhibited fluid) etc. All these will be managed using AHL Wastes Management system/procedure and procedures/processes approved by FMEnv. Particular approaches to waste management of the broad categories identified previously include:

(a) Solid Wastes

Anticipated solid wastes include cleared vegetation, domestic refuse, unused pipes, pipe off cuts scrap metals, welding torches and spent welding electrodes, filters, hand gloves, pigging thrash, etc. Trees would be felled along the RoW and cut into useable lengths. All these shall be segregated at source and trucked back to wastes re-cycling depot at Contractor's yard or AHL's Facilities at Okwuiborne Gas Receiving Facility (OGRF) for subsequent trucking to recycling vendors. Identified accredited waste management contractors in the area will be identified and contracted to mange domestic waste.

(b) Liquid Waste

Hydrotest Water

Prior to operation, the pipeline will be pressure-tested fresh water from drilled boreholes. The borehole water is fresh, as a result 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. However, AHL would take the additional precaution by testing, treating and piping the water directly into a flowing water body at a controlled rate. The period for which the hydrotest would be undertaken is short (24 hours) and therefore does not require to use of an inhibitor. These source of water for the hydrotesting will be bore holes drilled for the purpose of the hydrotest in the study area. The nearby water bodies will serve as the recipient water bodies. The entire hydrotest process shall be witnessed by the FMEnv including the sale disposal of the effluent hydrotest water.

Spent Diesel/Oil/Condensate

These wastes would emanate from working equipment such as welding machines, excavator, bulldozers etc. These wastes shall be scooped, contained and disposed of in designated sites. Liquid condensate from pigging operations will be reclaimed and sent to fuel depots/refinery for recycling.

Spent Drilling Fluids (Bentonite)

The drilling fluid to be used for the HDD process and operation is a mixture of bentonite (naturally occurring day that is extremely hydrophilic with high swelling characteristics) and fresh water, The functions of the drilling fluid in the HDD process include:

- Cooling and lubricating the drilling stem and bit
- Carry cuttings out of the bore hole
- Stabilize the bore hole during the drilling process and
- Sealing fractures in the formation.

Unused drilling mud/fluid will be transported to HDD control yard for storage and future use. Spent bentonite and drill cuttings will be stored in sealed skips and transported to FMEnv approved drilling waste management contractor for treatment and disposal.

(c) Human Waste/Sewage

All sewage and grey water will be temporarily stored in septic tanks and will be managed to accordance with AHL Waste Management Procedure and FMEnv requirements. This involves liaison with the Delta State Waste Management accredited contractors to evacuate the waste matter after chlorination and storage in a septic tank.

(d) Gaseouse Emissions and Discharges

The atmospheric emissions principally associated with gaseous discharges during the construction activities are: Carbon dioxide (CO_2), Carbon monoxide (CO), Oxides of Nitrogen (NOx) and Sulphur dioxide (SO_2). The levels of these emissions shall be monitored during construction and operational phases of the project.

3.9 Project Schedule

The project Gannt Chart for the TGNL 135km Sagamu LDZ pipeline Project is presented in Figure 3.7 below.

Figure 3.11 Project Gannt Chart for NGC 135km Sagamu LDZ Gas Pipeline Project

S/No	**Milestones**	2017				2018				2019
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
1	ROW Survey									
2	Engineering Review									
3	Select Construction Contractor									
4	Award Construction Works									
5	Survey Confirmation									
6	Mobilization									
7	Complete Pipe Haulage									
8	Commence Construction									
9	Complete Pipe Stringing/ Welding									
10	Complete River Crossing Works									
11	Complete NDT / FJC									
12	Excavation / Lowering									
13	Tie-ins									
14	Mechanical Completion									
15	Hydro-testing / Purging									
16	Completion									

CHAPTER FOUR

ENVIRONMENTAL BASELINE DESCRIPTION

4.1 Introduction

This chapter presents the descriptions of the biophysical, socioeconomic and health conditions of the environment within the proposed 135km TGNL gas pipeline project area of influence including stakeholders' engagement activities by the proponent. The data, therefore, forms the basis for potential impact identification and appropriate mitigation measures associated with the development of the project.

4.2 The ESIA Study

4.2.1 Overview of the ESIA Process

The ESIA study for Sagamu LDZ Natural Gas Pipeline was concerned with identifying, predicting and evaluating foreseeable impacts, both beneficial and adverse, that are likely to emanate from all aspects of the project. Also inclusive were proffered mitigating measures to eliminate or minimize negative impacts while maximizing the positive impacts. This study is required purposely to provide information on the environmental, socio-economic and health effects of the NGMC pipeline project and to make sure that the proposed operations of the facilities are within acceptable limits set by the Federal Ministry of Environment and the Department of Petroleum Resources (DPR), the host State Ministry of Environment and the international limits set out by IFC and other international bodies.

4.2.2 Baseline Data Collection

The ESIA report provides a description of the existing environmental and socio-economic conditions as a basis against which the impacts of the project can be assessed. The baseline includes information on receptors and resources that were identified during scoping as having the potential to be significantly affected by the proposed project. The description of the baseline has the following main objectives:

- To identify the key environmental and socio-economic resources and conditions in areas potentially affected by the project (such as atmosphere, geology and soil, groundwater, surface water, fauna and flora, and the marine environment).
- To describe and where possible, quantify their characteristics i.e. their nature, condition, quality, and extent.
- To provide data to aid the prediction and evaluation of possible impacts.

- To inform judgments about the importance, value, and sensitivity or vulnerability of resources and receptors.

For this EIA, secondary data collection was obtained from existing sources including the following:

- Stakeholders including government agencies, community chiefs, elders, women, and youths in various communities and community-based organizations (cooperative societies, development committees, etc.);
- Local experts and research and academic organizations
- Existing and approved EIA reports, and other published sources.

Additional primary baseline data process involved sampling and data gathering for information on socio-economics, terrestrial soils, and geology, surface water, groundwater, air quality, noise, fauna and flora, traffic and waste surveys. The exercise also included water quality and sediment sampling and testing.

4.2.3 ESIA Terms of Reference

The ESIA Terms of Reference (ToR) was approved by the Federal Ministry of Environment. The FMEnv approved Terms of Reference (ToR) is attached as Appendix 1. This is in line with FMEnv standards. The ToR contained the following:

- The scope of work for the ESIA including the overall data requirements on the proposed project and affected environment;
- The environmental regulations guiding the project;
- The plans, procedures, and protocol for identification and assessment of associated and potential impacts and also for selecting mitigation (prevention, mitigation, control) measures for adverse impacts; and
- An effective Environmental Management Plan (EMP) for the project.

4.2.4 ESIA Scope of Work

The work scopes for this EIA were:

- Review of national and international environmental regulations, standards, codes and conventions relevant to the proposed project activities;
- Establish the baseline/status of the project area through literature research;
- Laboratory analysis of samples collected during the field survey;

- Impact identification, prediction, interpretation, and evaluation;
- Development of cost-effective mitigation measures, monitoring programmes and Environmental Management Plan (EMP) covering the project life cycle; and
- Preparation of detail draft report to meet FMEnv permitting requirements.

4.3 Study approach

The baseline status of the project area was obtained through consultations with the relevant stakeholders; review of relevant literature as well as from field studies. Summary of field sampling methods is provided below and details presented in Appendix 4.1.

4.3.1 Consultation

Prior to field sampling activities, meetings were held with the relevant stakeholders to intimate them of the project and seek their consent to carry out the field data gathering.

The key objectives of consultations on the ESIA for the proposed project are:

- To educate and enlighten the identified stakeholders (communities, Government agencies, Non-Governmental Organizations (NGOs), Community-Based Organizations (CBOs), on the need for their involvement in the conduct of the ESIA studies and to assist in articulating the concerns of the communities as well as those of their immediate environment;
- Building trust and confidence that would enhance the capacities of the identified stakeholders through participation in the project;
- Forming and promoting partnership with identified stakeholders through networking, information sharing and participation in consultation exercises;
- Provide a framework for improving the understanding of the potential impacts of the proposed project on the socioeconomic and biophysical environment and
- Including stakeholders' views and concerns about the potential impacts as part of the ESIA execution.

  The stakeholders consulted include;

- Federal Ministry of Environment (FMEnv)
- Department of Petroleum Resources (DPR)
- Ogun State Ministry of Environment
- Ibefun Local Government
- Ososa Local Government
- Communities in the Project Area

4.3.2 Literature review

Review of literature on International (especially those of the World Bank and IFC) and national regulations applicable to environmental safeguards conducted. A number of other relevant literature on to similar project and environment available in the public domain were also reviewed.

4.3.3 Field sampling

One season field studies was carried out on pipeline route of the proposed project area to capture the characteristics, including seasonal dynamics in the various environmental attributes. These initial field data for biophysical characteristics were collected for one season, 31st January, 2020. The field study for Vegetation, Wildlife, and Fisheries along Sagamu Axis of the Ososa was carried out 31st January, 2020 This was carried out alongside with the Socioeconomic Impact Assessment (SIA) study for the new communities as directed by the Federal Ministry of Environment.

Field studies involved quantitative sampling as well as a recording of observations of the environmental components of the study area within the project's area of influence. The environmental components investigated included; noise, air quality, surface and groundwater quality, soil, vegetation, land use, hydrobiology, fish and fisheries, and wildlife. All sampling locations were geo-referenced using a handheld Global Positioning System (GPS). In each case, data collection followed international standards and complied with the requirements of the Federal Ministry of Environment and other Regulatory Agencies. The sampling map, locations, and coordinates are presented in Table 4-1 and the methods used for the sample collection are presented in Table 4-2.

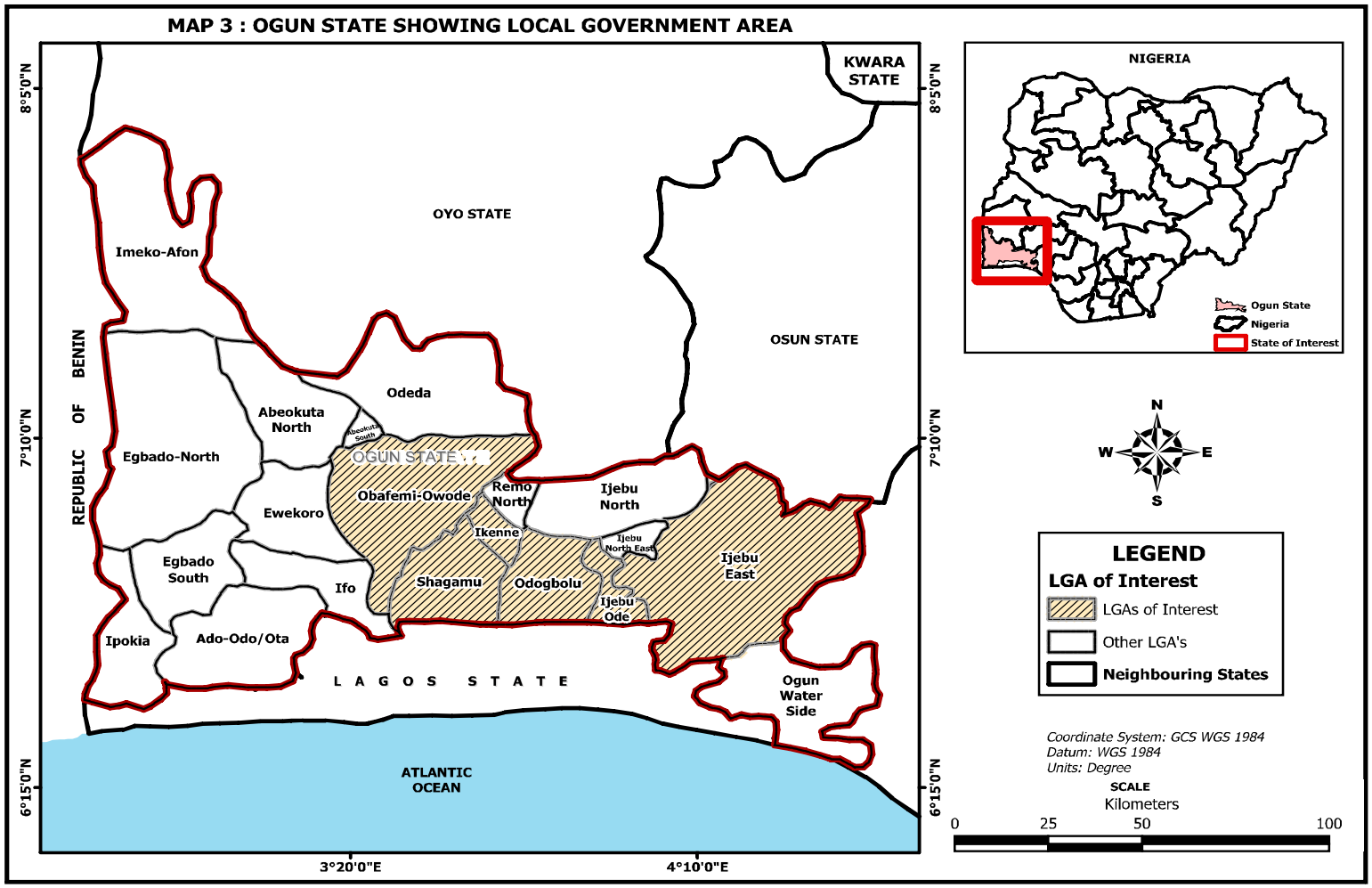


Figure 4-1: Sampling Map of the Initial 135km Sagamu LDZ Natural Gas Pipeline Route

S/N	Pipeline Section	Station ID	Environmental Component	Initial Pipeline Route – Rite Foods in Length		Communities	New Pipeline Route – from Rite Foods Nig. Ltd.		Communities
				Latitude (N)	Longitude (E)		Latitude (N)	Longitude (E)	
1	A	Sample 1	Soil (S), Air (A) and Noise	3..97400	6..68112	Sagamu, Ikene and Ilisan	3.97407	6.68125	Sagamu, Ikene and Ilisan
		Sample 2	Soil (S)	3..95304	6..66483		3.95314	6.66491	
		Sample 3	Soil (S), Air (A), Noise (N) and Groundwater (Gw)	3/.94202	6..63779		3.94425	6.63644	
		Sample 4	Soil (S)	3..92098	6..62777		3.92479	6.62656	
		Sample 24	Control, Soil (S), Groundwater (Gw)	4..02679	6..67172		4.02572	6.67891	
2	B	Sample 5	Soil (S), Air (A) and Noise (N)	3..92098	6..60974	Ososa	3.92246	6.60942	Ososa
		Sample 6	Soil (S), Air (A) and Noise (N)	3..90796	6..59972		3.90648	6.59809	
		Sample 19	Surface water (Sw), Sediment (Sd)	3..88275	6..60969		3.88456	6.60938	
		Sample 20	Surface water (Sw), Sediment (Sd)	3..91127	6..60542		3.91397	6.60497	
		Sample 21	Air (A), Noise (N), Surface water (Sw), Sediment (Sd)	3./92625	6..58973		3.92796	6.59241	
		Sample 22	Control, Air (A), Noise (N), Surface water (Sw), Sediment (Sd)	3..82284	6..60185		3.82910	6.60305	
		Sample 25	Control, Air (A),	3..71092	6..60826		3.72153	6.61574	

			Noise (N), Surface water (Sw), Sediment (Sd)						
3	C	Sample 7	Soil (S)	3..91326	6..54876	Ibefun Ilado Imodi-Ijasi	3.92450	6.58095	Ibefun Ilado Imodi-Ijasi
		Sample 8	Soil (S), Air (A) and Noise (N)	3..90295	6..54876		3.92591	6.53751	
4	D	Sample 9	Soil (S)	3..89708	6..51769	Kajola Bara Logbara Onile-Imo Siun	3.90320	6.52879	Kajola Bara Logbara Onile-Imo Siun
		Sample 10	Soil (S), Air (A), Noise (N) and Groundwater (Gw)	3..89497	6..49066		3.89498	6.49418	
		Sample 11	Soil (S)	3..92643	6..48535		3.91517	6.48190	
		Sample 12	Soil (S)	3..92341	6..46002		3.93525	6.47583	
		Sample 13	Soil (S), Air (A), and Noise (N)	3..93462	6..44275		3.95849	6.47879	
		Sample 14	Soil (S), Air (A) and Noise (N)	3..96178	6..43245		3.98890	6.47989	
		Sample 23	Control Soil (S), Air (A) and Noise (N)	3..82786	6..47207		3.83483	6.47360	
5	E	Sample 15	Soil (S)	3..98195	6..44031	Kajola Bara Logbara Onile-Imo Siun, Ideno	4.00468	6.47455	No community, pipeline within Rite Foods Nig. Ltd.
		Sample 16	Soil (S), Air, Noise (N) and Groundwater (Gw)	4..00441	6..43389		4.01728	6.46778	
		Sample 17	Soil (S)	4..02930	6..44447		4.03085	6.46215	
		Sample 18	Soil (S)	4..05546	6..43274		4.04172	6.45403	

Table 4-1: Sampling Locations and Coordinates

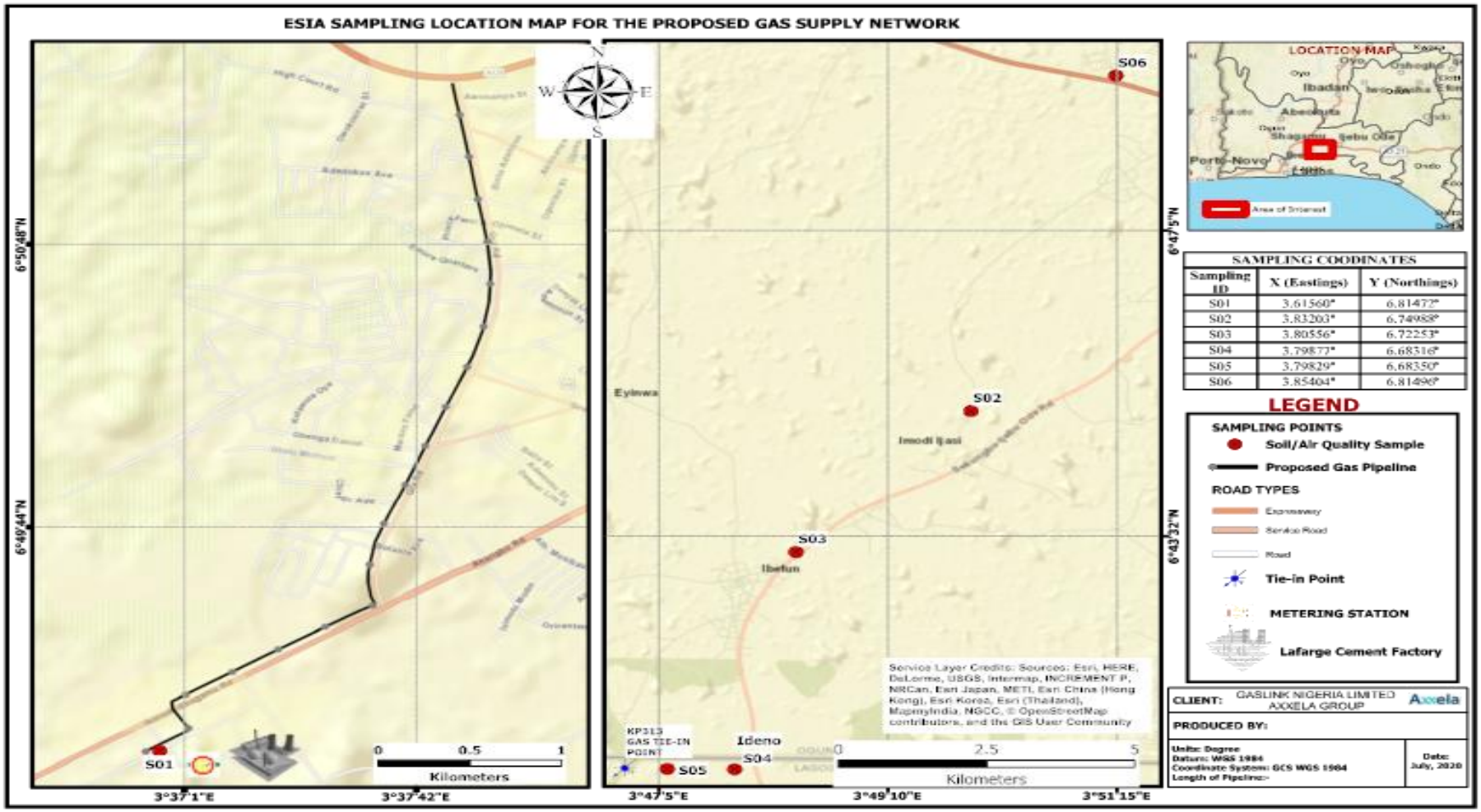


Figure 4-2: Sampling Map of the Initial 135km Sagamu LDZ Natural Gas Pipeline Route.

Source: Sagamu LDZ Natural Gas ESIA Field Study 2017-2018

4.3.4 Field Sampling Equipment and Materials

4.3.4.1 Air Quality/Meteorology

In-situ air quality was carried out using portable gas monitors; multi-RAE LITE and a particulate meter; Precision Gold Environmental meter. A total of eleven (11) stations including the controls were studied for air quality. The in-situ gases monitored include humidity, temperature, noise; oxides of nitrogen (NO_x), oxides of sulfur (SO_x), carbon monoxide (CO), volatile organic compounds (VOC) and hydrogen sulfide (H_2S). All equipment used is calibrated prior to usage.

4.3.4.2 Noise Level Measurement

The noise levels at the eleven sampling stations within the study area and control stations were determined using a pre-calibrated BK precision 732 Sound Level Meter. Table 4-2 summarizes field sampling equipment used for all the environmental components studied.

Table 4-2: Environmental Component and method of sample collection

Environmental Component	**Method of collection**
Air Quality and Noise	Electronic gas monitors, Particulate matter counter/ monitor. Telegan photoionisation Gas analyzer (Viper), Noise meter
Soil/Land use	Dutch stainless steel hand auger, digger, and spade for profile pit study, Core samplers, Interviews, and Direct observation
Surface Water	Water Samplers
Sediment	Sediment Grab sampler
Surface water Hydrobiology/ benthos	Collection with Grab, Collection with Plankton Net and sieves.
Fisheries	Direct observation and interview
Vegetation	Transects, Key Informant Interviews, Use of Binoculars, Direct Observation and sample collection
Wildlife	Direct Observation, Key Informant Interviews, and indirect count method
Socio-economics / health	Interviews, questionnaires, focus group discussions, publications

4.3.5 Sampling Methods

4.3.5.1 Soil Samples

Composite soil samples were collected at two depths: 0-15cm (topsoil) and 15-30cm (bottomsoil) with the aid of Dutch stainless steel hand auger from various at different location within the proposed project area and three control points outside the project area. Samples were collected for wet and dry seasons. The soil samples were collected in duplicate; those for physical and chemical analysis were packed in black polythene bags and those for microbial and oil and grease/hydrocarbon analysis wrapped in aluminum foil. The samples were neatly labeled, preserved and taken to the laboratory for analysis.

a. Chemistry: Total Nitrogen, Sulphates, Chlorides, Phosphates, Exchangeable cations (Ca^{++}, K^{+}, Mg^{++}, Mn^{++}). Heavy metals (Fe, Zn, Cr, Pb, Cu, Cd, Hg, V. Ni, Ba), etc

b. Physico - Chemistry: %clay, %silt, Electric Conductivity (EC), pH, Total Organic Content (TOC), Total Hydrocarbon Content (THC), % carbon, available P04, P, Total Nitrogen, NH4+, NO3, SO4, NO2, Na, K, Ca and Mg.

4.3.5.2 Surface Water, Sediment, and Hydrobiology

Sampling stations, including the controls along the course of the lagoon crossing (Ibefun-Ososa Axis) of the pipeline route, were sampled (Figure 4-1). A sampling of surface water, sediment and hydrobiology covered the following components:

- Physico-chemistry and microbiology of surface water
- Phytoplankton
- Zooplankton
- Benthos
- Fisheries

4.3.5.3 Surface Water

At each sampling station, grab samples of surface water were collected; top and bottom at three different time interval of 5 mins and mixed to form a composite sample.

Samples for laboratory analysis were taken and preserved as follows:

General physicochemical parameters: Samples were collected into 1-liter polyethylene bottles. The bottles were previously washed and rinsed with distilled water and with some portion of the surface water prior to sampling.

- Heavy metals- Samples were collected into 1 liter pre-cleaned polyethylene bottles and preserved by the addition of 2 ml Analar grade concentrated nitric acid.
- Oil and grease and THC- Samples were collected into 1 liter pre-cleaned glass bottles and preserved by the addition of 2 ml concentrated sulfuric acid.
- COD - Samples were collected into pre-cleaned 500 ml glass bottle and fixed with analar grade H_2SO_4
- Microbiology- Samples were collected into 25 ml sterilized glass bottles.
- BOD - Samples were collected into 300 ml amber-colored BOD bottles.

Samples collected were stored at 4°C±2 ice chest on the field before transportation to the laboratory for further storage at 4°C±2. Water temperature was measured *in situ* using a portable thermometer. Hydrogen-ion concentration (pH), electrical conductivity, total dissolved solids (TDS) and turbidity were measured *in situ* using Hanna portable digital meters. Samples for dissolved oxygen (DO) were determined on site by Hanna dissolved oxygen meter.

4.3.5.4 Sediment

Sediment samples were taken from the bottom of surface water using a $0.1m^2$ Van-veen grab. A total of five sediment samples were collected for physico-chemistry and kept in polythene bags; samples for hydrocarbon and microbiology analyses were kept separately in aluminum foil, preserved in an ice chest and transported to the laboratory for analysis.

4.3.5.5 Laboratory Analysis

After the fieldwork exercises, study samples were transported to Unlag Consult Laboratory, in Lagos State (accredited by DPR and FMENV) for analyses. Samples brought to the laboratory were analyzed using standard analytical methods. The synoptic description of the laboratory methods and procedures employed for the various physical, chemical, and biological parameters, as well as the detection limits of these parameters in seawater and sediment samples, is documented in Appendix 4-2. The summary of standard methods of environmental analysis is presented in Table 4-3.

Table 4-3: Summary of Laboratory analytical methods used for Water / Sediment Analysis

Parameters	Unit	Method
pH (H2O)		ASTM D 4972
Turbidity	(NTU)	APHA 214
Salinity	$^{0}/_{00}$	API-RP 45
Total Dissolved Solids	(mg/l)	APHA 209C
Total Solids	(mg/l)	APHA 209D
TSS	(mg/l)	APHA 209D
Electrical conductivity	(µS/cm)	APHA 209
Bicarbonate	(mg/l)	API-RP 45
Alkalinity	(mg/l)	APHA 2320-ALKALINITY-B
Acidity	(mg/L)	APHA 2310 B
Ammonia nitrogen	(mg/l)	EPA 350.2
THC	(mg/l)	APR – RP 45
Nitrite	(mg/l)	EPA 354.1
Chloride	(mg/l)	APHA 4500Cl- B
Sulphate	(mg/l)	EPA 375.4
Total Phosphorous	(mg/l) (mg/kg)	APHA 4500 P0 43-
Calcium	(mg/l) (mg/kg)	APHA 3111
Magnesium	(mg/l) (mg/kg)	APHA 3111/ASTM D 3561
Potassium	(mg/l) (mg/kg)	APHA 3111/ASTM D 3561
Cadmium	(mg/l) (mg/kg)	APHA3111
Chromium	(mg/l) (mg/kg)	APHA3111
Lead	(mg/l) (mg/kg)	APHA 3111
Manganese	(mg/l) (mg/kg)	APHA 3111
Iron	(mg/l) (mg/kg)	APHA 3111
Copper	(mg/l) (mg/kg)	APHA 3111
Zinc	(mg/l) (mg/kg)	APHA 3111
PCB	(mg/l) (mg/kg)	EPA method 625

4.3.5.6 Phytoplankton and Zooplankton

Planktons (zooplankton and phytoplankton) samples were collected by standard plankton net of 0.5mm diameter mesh size. The content of the plastic tube beneath the plankton net is transferred into labeled plankton samples container and preserved in 4% formalin. This activity was repeated in subsequent sampling stations.

4.3.5.7 Benthic Macrofauna

The Van-Veen grab was used in taking composite samples of sediment from designated sampling stations along the pipeline route. Grabbed sediment samples were washed with

water through a 0.55 µm mesh size sieve to collect benthic macrofauna. The sieved contents were preserved in 4% formalin in labeled jars for further analysis in the laboratory.

4.3.5.8 Plankton and Benthos Analysis

Five (5) drops (using a dropper) of the concentrated sample (10ml) were investigated at different magnifications (50X, 100X and 400X) using a Wild II binocular microscope with calibrated eyepiece and the average recorded. The drop count microscope analysis method as described by Onyema (2007) was used to estimate the plankton flora and fauna.

Since each sample drop from the dropper accounts to 0.1 ml, the results of the abundance/occurrence were multiplied accordingly to give the values as numbers of organisms per ml which is the standard unit of measurement. To create a suitable plankton sample mount, a dropper was used to take in at least 1.5ml of the sample after shaking properly. This was then allowed to stand for at least 3 minutes. After which, one or two drops of the concentrated sample from the dropper was then gently dropped on a glass slide (7.5 cm by 2.5 cm) while placed on a flat laboratory table and covered with a glass-slide (2cm by 2cm).

The mount was then placed on the microscope stage, fitted in and all transects thoroughly observed for phytoplankton (cells, filaments, colonies) and zooplankton species (e.g. adults and juvenile stages alike). Final data were presented as a number of organisms (cells, filaments, colonies, and whole organism) per ml. Standard methods by Karison, (2010) and Goswami, (2004) were used to aid identification of the species.

Community Structure Analysis

The following diversity indices were used for biological data analysis and the results of these indices are presented in two (2) decimal places.

Species Richness Index (d)

The Species richness index (d) according to Margalef (1951) is a measure of diversity and was used to evaluate the community structure. Species Richness is a measure of the number of different kinds of organisms present in a particular area. This index is also referred to as Margalef index. The equation below was applied.

$$d = \frac{S - 1}{lnN}$$

Where:

d = Species richness index

S = Number of species in a population

N = Total number of individuals in S species.

Menhinick's Index (D) The Menhinick's Index (D) (Ogbeibu, 2005) is one of several diversity indices used to quantify diversity and hence measure diversity in categorical data. It represents a biological association with a number which gives a measure of its community structure. The equation below was applied.

$$D = \frac{S}{\sqrt{N}}$$

S = Number of species in a population and N = Total number of individuals in S species.

Simpson's Diversity Index (D)

This is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

$$\tilde{D} = 1 - \sum_{i=1}^{S} p_i^2,$$

i = Counts denoting the ith species ranging from 1 – n

Pi = Proportion that the ith species represents in terms of numbers of individuals with respect to the total number of individuals in the sampling space as a whole.

S = Number of species in a population

Shannon and Weiner Diversity Index (H_s)

The Shannon and Weiner diversity index (H_s)is one of several diversity indices used to measure diversity in categorical data. It is simply the Information entropy of the distribution, treating species as symbols and their relative population sizes as the probability (Ogbeibu, 2005). Shannon and Wiener (1963) diversity index is also called Shannon index. The equation below was applied.

$$Hs = \frac{N\log N - \sum P_i \log P_i}{N}$$

Where H_s = Shannon And Wiener Diversity Index

i = Counts denoting the ith species ranging from 1 – n

Pi = Proportion that the ith species represents in terms of numbers of individuals with respect to the total number of individuals in the sampling space as a whole.

Species Equitability or Evenness index (j)

The Species Equitability or Evenness index (j)is one of several diversity indices used to measure diversity in categorical data. Evenness is a measure of the relative abundance of the different species making up the richness of an area (Ogbeibu, 2005)**.** The equation below was applied.

$$j = \frac{Hs}{Log_2 S}$$

Where j = Equitability index

H_s = Shannon and Weiner index

S = Number of species in a population

4.3.5.9 Soil / Sediment Analysis

Samples for physicochemical parameters (except for hydrocarbons, microbiology and bulk density) were air dried in the laboratory for 2 weeks. They were ground into fine particles in a mortal, sieved through a 2 mm sieve and about 200 g of the sieved samples were sub-sampled by quartering for analysis. 5g of the sample was dried at 105^{o}C in an oven to a constant weight to determine the percentage of dry matter content.

All soil and sediment samples were analyzed for physicochemical parameters using standard methods (Margesin and Schinner, 2005). Parameter determined to include bulk density, particle size, pH, conductivity, organic matter, total nitrogen, phosphorus, exchangeable cations, heavy metals, oil and grease, total petroleum hydrocarbon (TPH), polynuclear aromatic hydrocarbons (PAHs) and BTEX. Samples for microbiology were analyzed for total heterotrophic bacteria and fungi, and hydrocarbon utilizing bacteria and fungi.

4.3.5.10 Sediment Macrobenthic Analysis

In the laboratory, the preserved benthos samples collected from the different stations were washed with tap water through a 0.5 mm sieve to remove the preservative and any remaining fine sediments, The benthic organism was sorted and identifications were made to species level where possible. The biota was identified using the following identification materials Campbell (1977), Edmunds (1978), Barnes (1980), FAO (1992) and Yankson and Kendall (2001). Statistical analysis involving diversity indices were used as described for planktons analysis.

4.3.6 Statistical Analysis

All data generated in this study were subjected to statistical analysis to test for spatial variation and significance difference between data within the proposed project area and control stations using Excel and SPSS 20.0 packages as applicable. The statistical calculations reported included descriptive statistics (range, mean, standard deviation, the coefficient of variation, frequency, and percentages) and student t-Test. One level of significance ($p < 0.05$) was considered in the results interpretation. In addition, bar chart, pie chart, and line graph were used in comparing results. The analytical results were also compared with local and international standards where applicable and with data from previous studies within the zone.

4.3.7 Quality Assurance/Quality Control

Standard methods and procedures were strictly adhered to in the course of this study. The quality assurance programme covers all aspects of the study, including sample collection, handling, laboratory analysis, data coding, statistical analysis, presenting and communicating results.

Chain of custody procedures including sample handling, transportation, logging and cross-checking in the laboratory were also implemented. Trip blanks were used to assess the quality assurance/quality control of sample preservation, packaging, shipping, and storage.

The following precautions were also observed:

- Samples were collected in bottles that have been thoroughly washed with detergent (nutrient-free) and rinsed thoroughly;

- All sampling equipment is properly protected and maintained in accordance with manufacturers' manuals;
- Sampling bottles were adequately labeled with masking tapes and indelible markers to avoid mistaken identity;
- Only analytical grade (Analar) chemicals were used and where applicable redistilled;
- Automated equipment is calibrated prior to field sampling;

Where samples were sent to another laboratory for analysis, a duplicate copy of the samples' information was sent along with the sample to the laboratory, independent of the sample. All movements of the samples were included in the sample record. Basic information was recorded together with results of the analysis, in a sample register. With proper, sustained calibration of the instrument and the use of standardized observational procedures, equipment errors were brought to an acceptable minimum.

4.4 Climate and Meteorology

4.4.1 Wind direction

The project area of influence is within the Gulf of Guinea with a climate typical of the region. The study area is influenced by two air masses, one over the Sahara desert (tropical continental) and the other over the Atlantic Ocean (maritime). These two air masses meet at the Inter-Tropical Convergence Zone (ITCZ) and the characteristics of weather and climate in the region are influenced by the seasonal migration of the ITC. During the dry months (November/March) the tropical continental air from the northern anticyclone over the Sahara brings in northeasterly trade winds which are dry and have a high dust load (on occasion these penetrate over the Atlantic as far south as 2°N in January). These winds bring a period of dry weather over the region of study. The northward migration of the ITCZ results in the warm humid maritime air reaching further inland over the region. In March, the ITCZ is located between 9°N and 12°N and by May-June, it is located approximately between 15°N and 16°N. During these periods, the region generally experiences the rainy seasons. The most northerly limit of the ITCZ is approximately 18-24°N and occurs between July and August. In general, two seasons are characteristic of the climate in the region, namely the dry and wet seasons.

4.4.2 Wind speed

According to the 30-year climatological period (Figure 4-3), the minimum wind speed is 3.46 m/s while the maximum is 4.02 m/s. A marginal decreasing trend was noted during the period

of measurement. 2009-2017 data (Figures 4-3 and 4-4) shows the highest average annual wind speed and gust is August with a magnitude of 4.03 m/s (9.01 mph) and 5.59 m/s (12.5 mph) respectively, this same month has the highest zonal and meridional components of wind-speed with a magnitude of 4.26 m/s and 2.75 m/s respectively (NIMET, 1984-2012 data).

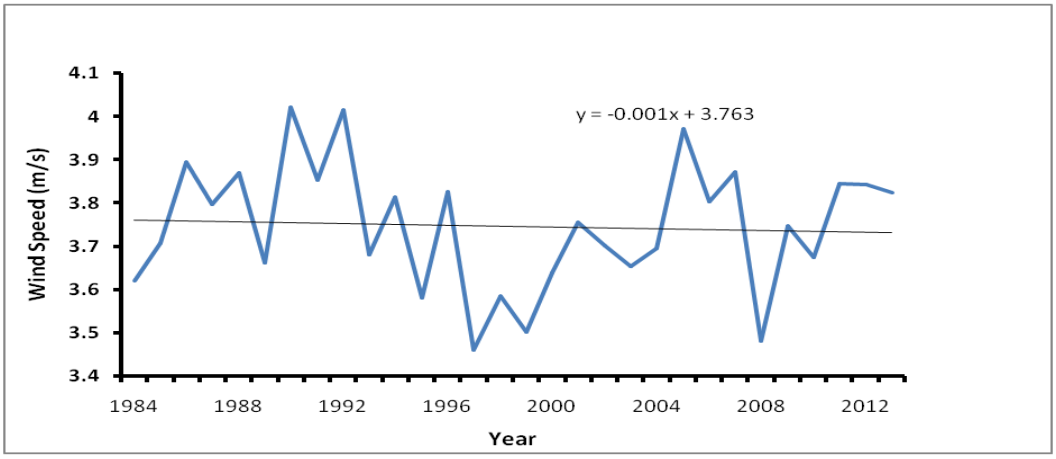


Figure 4-3: Inter-annual variation of Wind Speed

Source: Climatological data, NIMET, ERA-40; ERA-interim data]

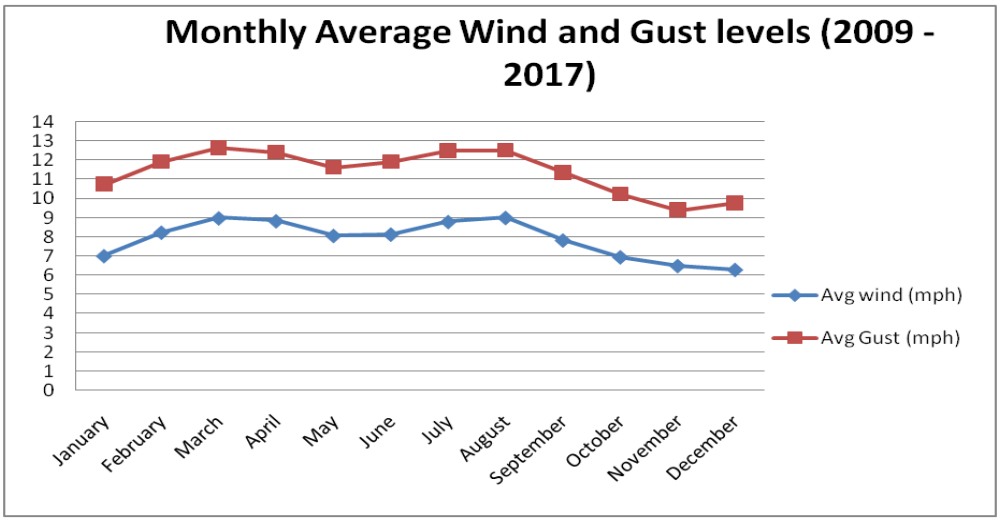


Figure 4-4: Monthly Average Wind Speed and Gust Levels in mph (2009-2017)

4.4.3 Air temperature

Temperatures in Ogun State are high to very high throughout the year. During the wet season, when the Ogun area is under the influence of the maritime air mass, mean daily maximum temperatures are usually between 28^0C and 30^0C, whereas the mean daily temperature is about 24^0C (NIMET Data, 1984-2012). During the dry season, when Lagos is mostly

dominated by the dry north-east trade winds (Harmattan), temperatures are hot and dry with mean daily temperatures rising as high as 34^0C, whereas the minimum temperature experienced is about 30^0C. The lowest temperature recorded is observed in August (28.25^0C) and highest November (32.13^0C), considering both 30-year climatological period (NIMET, 1984-2012 data) and 2009-2017 climatological period (Figures 4-5, 4-6 and 4-7).

The mean temperature observed was 26.80 ± 1.15^0c. It is observed that there were even and uniform distribution of temperature between 24.89^{o}C and 28.26^{o}C which is very important to Engineering Design and Materials (EDM) to be used within this point location.

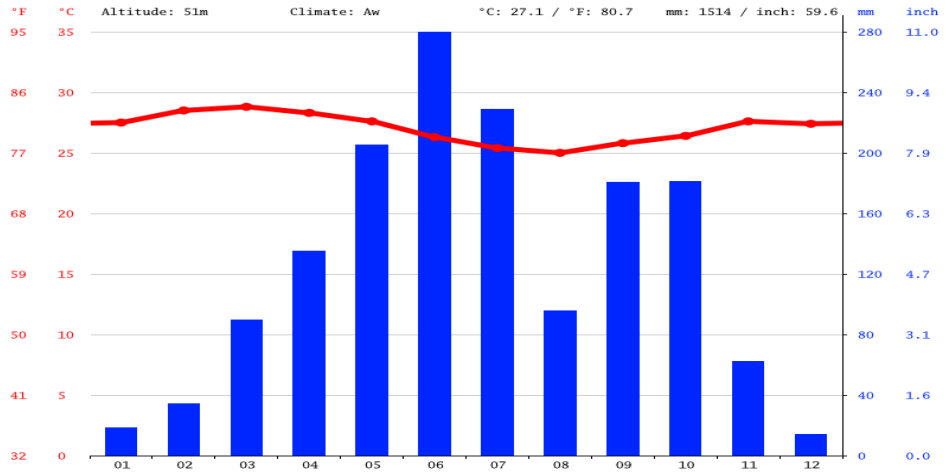


Figure 4-5: Inter-annual Variation of Temperature in Ogun State

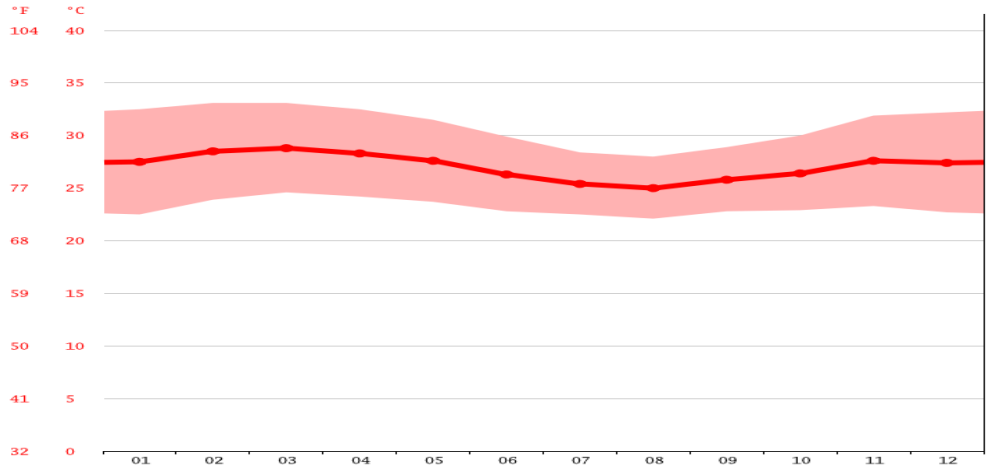


Figure 4-6: Average Annual Variation of Temperature in Lagos (2010-2020)

4.4.4 Cloud and relative humidity

There was variation in cloud cover within and across the year in Ogun. December recorded the peak in cloud cover; 63.5% and the lowest in January; 10.63% (Figure 4-8). The reason for the variation was due to fluctuations in other meteorological parameters. Marht, 1991 reported that temperature and humidity fluctuations influence the cloud cover (Mahrt 1991). 2010-2020 data had a steady increase in the cloud from 2010 to 2020. Humidity had annually decreased from 2010 having the highest (80%) to till date. The cloud and humidity had a milar trend in average monthly variation as shown in Figure 4-9.

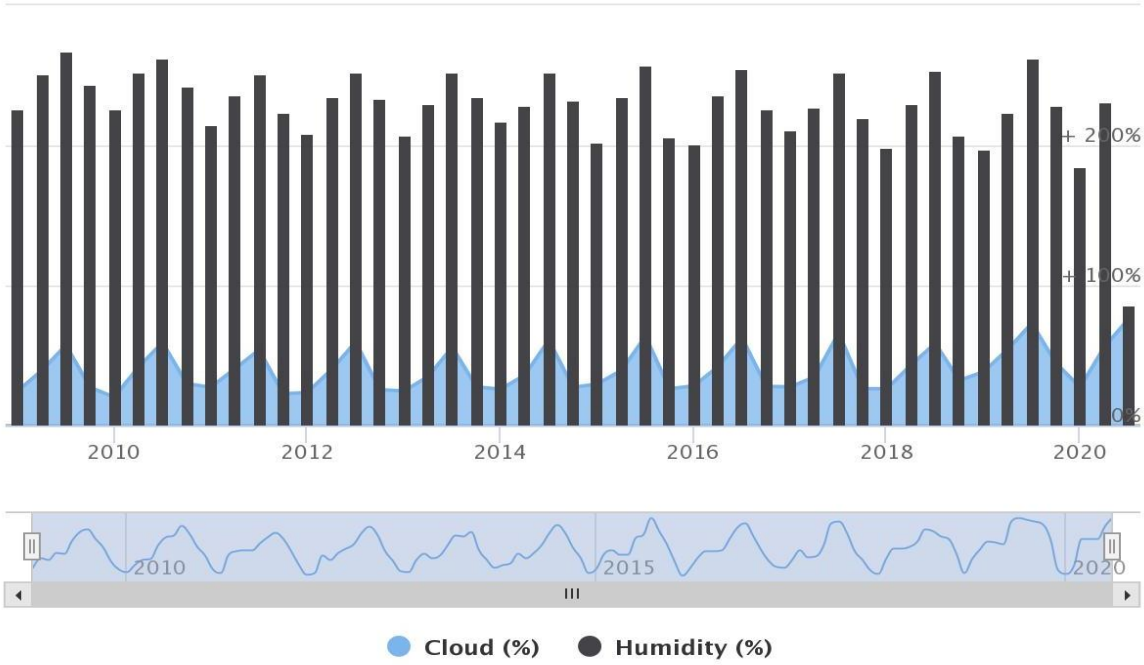


Figure 4-7: Average Annual Variation in Cloud and Humidity in Lagos (2010-2020)

4.4.5 Rainfall

Due to its location in the equatorial zone, the climate of Ogun is mostly under the influence of warm wet tropical maritime air masses. The city experiences two periods of rainfall; the first season begins between April and May and ends in July, while the second starts in late August and ends in early October. Total annual rainfall in Ogun exceeds 1,750 mm. The monthly average rainfall of more than 600 mm characterizes the peak period of the first wet season, whereas the second wet season is characterized by about 300 mm of rain during its peak period. Rainfall distribution is shown in Figures 4-10, 4-11 and 4-11. Rainfall varies from 95 mm to 166 mm during the 30 year period with a mean value of 131±19 mm (NIMET, 1984-2012). Like 1984-2012 NIMET data, 2010-2020 data recorded in July at the peak of 283.43mm of rainfall and the highest rainy days. 2010 had the highest rainfall. A

secondary peak of rainfall according to NIMET, 1984-2010 data, as noted in September and rainfall decreases to a minimum. Rainfall is observed to be increasing at 0.49 mm/year in Lagos. During the dry months of November-December–January-February the Tropical Continental air from the northern anticyclone over the Sahara brings in northeasterly trade winds which are dry and have a high dust load (on occasion these penetrate over the Atlantic as far south as 2°N in January). These winds bring a period of dry weather over the region of study. August creates an irregular dry season over the region, whereby rainfall and temperatures decline.

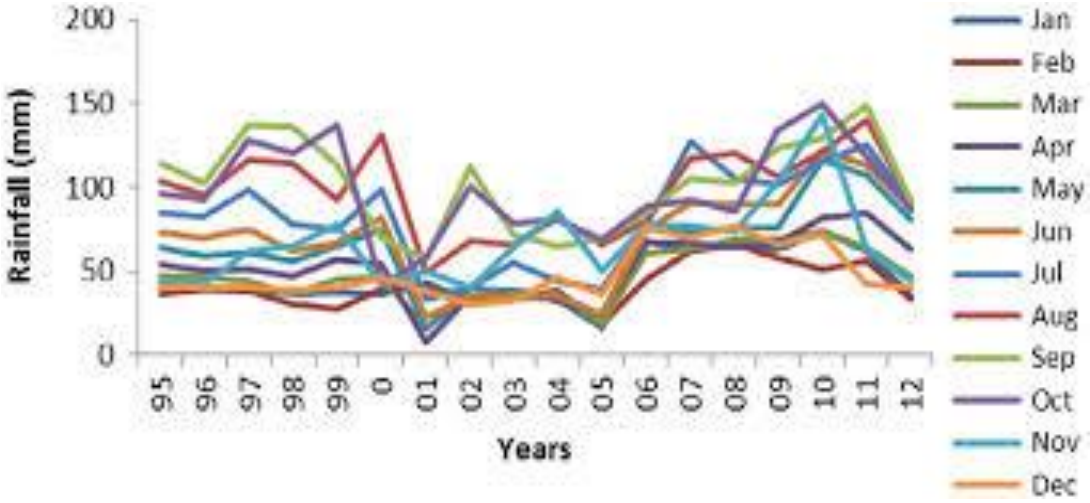


Figure 4-8: Inter-annual Variation of Rainfall

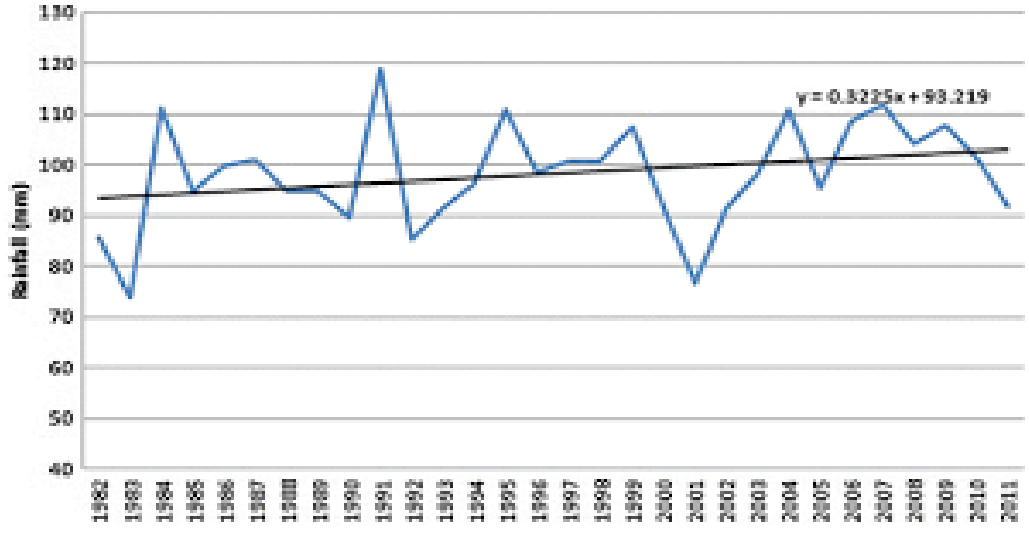


Figure 4-9: Inter-annual Variation of Rainfall

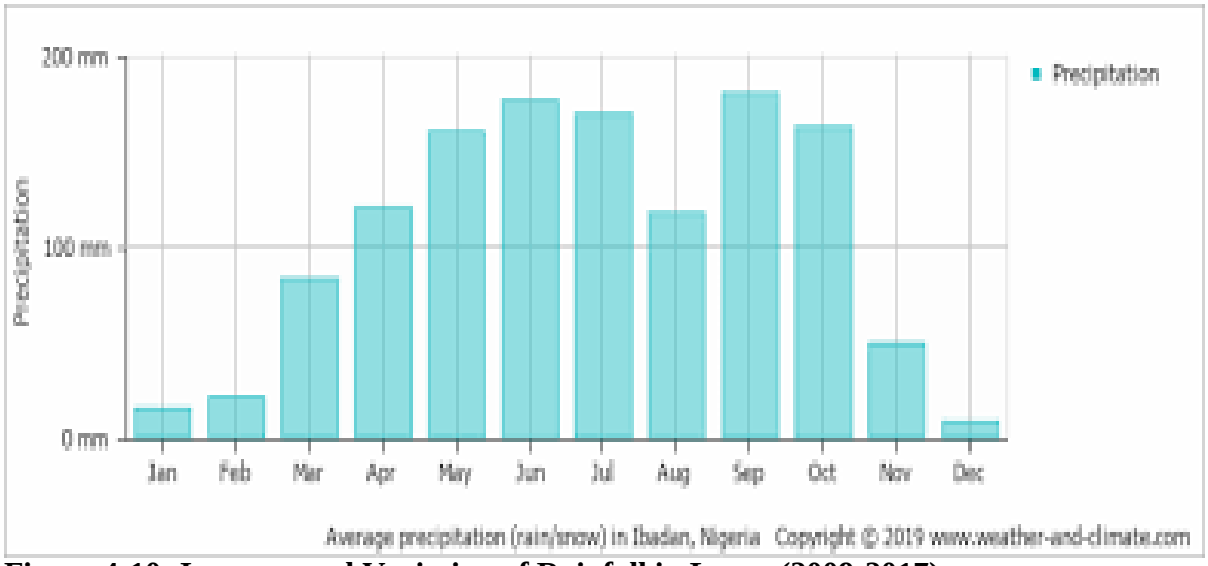


Figure 4-10: Inter-annual Variation of Rainfall in Lagos (2009-2017)

4.5 Air Quality

The ambient air quality of the project area of influence was investigated at selected locations during the fieldwork exercise. The baseline concentrations of potential pollutant gases measured within the study area for the wet and dry seasons are presented in Tables 4-4.

The concentrations of ammonia (NH_3), carbon monoxide (CO), nitrogen dioxide (NO_x), sulfur dioxide (SO_x) methane (CH_4) and hydrogen sulfide (H_2S) measured in all the sampling stations in the wet and dry seasons were found below instrument detection limits. Volatile organic compounds (VOCs) measured at the wet season was below the detection limit, while dry season had from 12.00ppm to 19.00ppm, with mean, 13.88ppm. The suspended particulate matter (SPM) measured at the dry season was higher than the wet season; dry (range, 33.30-49.20 µg/m³, mean, 42.34 µg/m³) and wet (range, 25.70-29.80 µg/m³, mean, 28.36 µg/m³). These concentrations were below DPR and FMEnv regulatory limit of 250 µg/m³ (DPR, 2002, FMEnv, 1991).

Table 4-4: Air Quality Parameters at the project areas of influence

PARAMETERS	Dry Season			Wet Season			FME Limits	DPR Limit (µg/m³)
	Min	Max	Mean	Min	Max	Mean		
Carbon Monoxide (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	10ppm	30
Nitrogen Oxides (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	0.1ppm	400
Sulfur oxides (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	-	350
Methane (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	-	-

Hydrogen Sulfide (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	0.06	-
Volatile Organic Compound (ppm)	12.00	19.00	13.88	BDL	BDL	BDL	-	-
Ammonia Gas (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	-	-
Suspended Particulate Matter (µg/m³)	33.30	49.20	42.34	25.70	29.80	28.36	250µg/m³	150 - 230

Source: NGC ESIA Field Survey, 2017

Plate 4.1: Pre-calibrated equipment used for air & noise study

4.6 Noise Study

Ambient noise levels measured during the field study exercise at selected sampling stations within the project zone of influence are presented in Tables 4-5.

Noise levels within the project area of influence during the field study were generally moderate with minimum of 44.60 dBA (station 10) and maximum of 72.50 dBA (station 4) with mean value of 62.56 dBA for the dry season. Noise levels recorded at the monitoring stations were lower than the 90 dBA FMEnv and 85 dBA DPR limits.

Table 4-5: Noise level of the project areas of influence

Serial Number	Sampling ID	Coordinates	Dry Season dBA
1	Station 1	6.68112°N 3.97400°E	62.4
2	Station 3	6.63779°N 3.94202°E	59.6
3	Station 5	6.60974°N 3.92098°E	71.4
4	Station 6	6.59472°N 3.90811°E	72.5
5	Station 10	6.49124°N 3.89412°E	44.6
6	Station 13	6.44275°N 3.93462°E	52.4
7	Station 16	6.43372°N 4.00440°E	67.6
8	Station 21	6.58973°N 3.92625°E	70.0

9	Station 22	6.60185°N 3.82284°E	73.1
10	Station 23	6.47207°N 3.82786°E	74.7
11	Station 25	6.60826°N 3.71092°E	61.9

Source: NGC ESIA Field Survey, 2017

4.7 Soil Quality

4.7.1 Soil Textural Characteristics

4.7.1.1 Soil Type and Composition

Most soils have different sizes of mineral particles called sand, silt, and clay. Sand is the largest of the mineral particles. Silt is the mid-size soil particle. Clay is the smallest size soil particle. Soil texture describes the proportion of the soil particles and the fineness or coarseness of a soil. The texture of soil determines soil characteristics that affect plant growth. Three of these characteristics are water-holding capacity, permeability, and soil workability. The textural classification of the two soil depths along the sections of TGNL 135km pipeline ROW was described in Table 4-6, Figures 4-13 and 4-14 below.

In section A, the sand, clay and silt contents of the topsoil during the dry season ranged from 70.05% to 70.81%, 14.81% to 15.11% and 10.7% to 10.91%, respectively, while the subsoil recorded values ranging from 68.19% to 70.21% sand content, 20.32% to 21.03% clay content and 18.01% to 18.21% silt content (Tables 4-6). This section gives typical characteristics of a sandy loam soil as shown in Figures 4-13 and 4-14.

In section B the sand, clay and silt contents of the topsoil during the dry season ranged from 41.21% to 41.59%, 24.32% to 24.90% and 28.56% to 29.01%, respectively, while the subsoil recorded values ranging from 32.12% to 34.21% sand content, 24.92% to 25.21% clay content and 30.23 to 31.02% silt content. (Tables 4-6). This section gives typical characteristics of a silt loam soil as shown in Figures 4-13 and 4-14.

In section C, the sand, clay and silt contents of the topsoil during the dry season ranged from 72.56% to 74.45%, 12.67% to 13.64% and 8.09% to 8.21%, respectively, while the subsoil recorded values ranging from 74.78% to 75.90% sand content, 13.45% to 14.39% clay content and 9.01 to 10.29% silt content. (Tables 4-6). This section gives typical characteristics of a sandy loam soil as shown in Figures 4-13 and 4-14.

In section D, the sand, clay and silt contents of the topsoil during the dry season ranged from 36.10% to 38.01%, 20.21% to 22.64% and 27.34% to 27.83%, respectively, while the subsoil

recorded values ranging from 32.01% to 39.56% sand content, 21.34% to 23.78% clay content and 27.69 to 28.92% silt content. (Tables 4-6). This section is similar to section B, typical characteristics of a silt loam soil as shown in Figures 4-13 and 4-14.

In section E, the sand, clay and silt contents of the topsoil during the dry season ranged from 79.34% to 80.01%, 9.61% to 9.69% and 6.45% to 7.59%, respectively, while the subsoil recorded values ranging from 83.01% to 83.21% sand content, 10.23% to 11.01% clay content and 7.21 to 7.52% silt content. (Tables 4-6). This section runs between sandy loam and loamy sand as shown in Figures 4-13 and 4-14.

Table 4-6: Soil Textural Characteristics in the project areas of influence

SECTIONS ALONG THE PIPELINE ROUTE				
Section A	COMPONENTS	DRY SEASON		
		Min	Max	Mean
TOP SOIL	Sand (%)	67.5	68.8	68.15
	Clay (%)	19.34	20.68	20.01
	Silt (%)	15.67	16.9	16.29
	B.Density (g/m^3)	1.37	1.45	1.41
	Porosity (%)	50.92	51	50.96
SUB SOIL	Sand (%)	68.19	70.21	69.20
	Clay (%)	20.32	21.03	20.68
	Silt (%)	18.01	18.21	18.11
	B.Density (g/m^3)	1.62	1.69	1.66
	Porosity (%)	46.54	47.53	47.04
Section B	COMPONENTS	DRY SEASON		
		Min	Max	Mean
TOP SOIL	Sand (%)	30.2	39.1	34.65
	Clay (%)	26.43	27.43	26.93
	Silt (%)	34.98	35.21	35.10
	B.Density (g/m^3)	2.38	2.4	2.39
	Porosity (%)	32.67	34.35	33.51
SUB SOIL	Sand (%)	30.56	32.13	31.35
	Clay (%)	27.23	28.91	28.07
	Silt (%)	37.05	37.51	37.28
	B.Density (g/m^3)	2.43	2.52	2.48
	Porosity (%)	32.12	38.56	35.34
Section C	COMPONENTS	DRY SEASON		
		Min	Max	Mean
TOP SOIL	Sand (%)	69.5	75.61	72.56
	Clay (%)	14.56	15.79	15.18

SECTIONS ALONG THE PIPELINE ROUTE				
	Silt (%)	14.21	14.5	14.36
	B.Density (g/m^3)	1.25	1.35	1.30
	Porosity (%)	56.02	56.89	56.46
SUB SOIL	Sand (%)	71.21	76.21	73.71
	Clay (%)	15.31	16.51	15.91
	Silt (%)	15.21	16.59	15.90
	B.Density (g/m^3)	1.3	1.32	1.31
	Porosity (%)	51.23	53.46	52.35
Section D	COMPONENTS	DRY SEASON		
		Min	Max	Mean
TOP SOIL	Sand (%)	38.5	39.5	39.00
	Clay (%)	22.85	24.11	23.35
	Silt (%)	30.21	34.5	32.07
	B.Density (g/m^3)	2.21	2.26	2.23
	Porosity (%)	39	32.21	35.14
SUB SOIL	Sand (%)	39.91	30.21	30.07
	Clay (%)	23.21	25.01	24.18
	Silt (%)	31.85	34.91	33.11
	B.Density (g/m^3)	2.26	2.3	2.28
	Porosity (%)	33.67	34.9	34.26
Section E	COMPONENTS	DRY SEASON		
		Min	Max	Mean
TOP SOIL	Sand (%)	79.1	79.5	79.30
	Clay (%)	12.6	13.9	13.25
	Silt (%)	8.04	8.5	8.27
	B.Density (g/m^3)	1.01	1.12	1.07
	Porosity (%)	61.9	62.11	62.01
SUB SOIL	Sand (%)	82.21	83.1	82.66
	Clay (%)	13.05	14.71	13.88
	Silt (%)	9.21	10.05	9.63
	B.Density (g/m^3)	1.22	1.28	1.25
	Porosity (%)	55.2	55.21	55.21

Section A = Sandy loam; Section B = Slit loam; Section C = Sandy loam; Section D = Slit loam; Section E = Sandy loam and Loamy sand.

Source: NGC ESIA Field Survey

4.7.1.2 Soil Bulk Density and Porosity

Sand, silt, clay, and organic-matter particles in a soil combine with one another to form larger particles of various shapes and sizes. Soil structure is the arrangement of the soil particles into aggregates. Soil structure affects water and air movement in soil, nutrient availability for plants, root growth, and microorganism activity. Low clay and high sandy soil is porous; it will permit easy leaching of nutrients and pollutants to the groundwater table. Other parameters that determine the dynamics of pollutants in soil include bulk density and porosity.

The lower the bulk density, the higher is the permeability (Margesin and Schinner, 2005). Bulk density varies with structural conditions of the soil, therefore, it is related to packing and often used as a measure for soil structure. The topsoil bulk density at the dry seasons ranged from 0.92 g/cm^3 to 0.98 g/cm^3 and 1.37 g/cm^3 to 1.45 g/cm^3 respectively, in section A. In section B, the topsoil bulk density at the dry seasons ranged from 2.21 g/cm^3 to 2.29 g/cm^3 and 2.38 g/cm^3 to 2.40 g/cm^3 respectively, and the subsoil ranged from 2.32 g/cm^3 to 2.38 g/cm^3 and 2.43 g/cm^3 to 2.52 g/cm^3 respectively. In section C, the topsoil bulk density at the dry and the subsoil ranged from 1.39 g/cm^3 to 1.41 g/cm^3 and 1.30 g/cm^3 to 1.32 g/cm^3 respectively. In section D, the topsoil bulk density at the dry and the subsoil ranged from 2.49 g/cm^3 to 2.62 g/cm^3 and 2.26 g/cm^3 to 2.30 g/cm^3 respectively. In section E, the topsoil bulk density at the dry and the subsoil ranged from 1.69 g/cm^3 to 1.71 g/cm^3 and 1.22 g/cm^3 to 1.28 g/cm^3 respectively.

The porosity of the topsoil at the dry and the subsoil ranged from 43.21% to 46.39% and 46.54% to 47.53% respectively in section A. The porosity of the topsoil at the dry and wet seasons ranged from 32.34% to 34.35% and 32.67% to 34.35%, respectively, and the subsoil ranged from 36.71% to 37.89% and 32.12% to 38.56% respectively in section B. The porosity of the topsoil at the dry and wet seasons ranged from 57.21% to 57.90% and 56.02% to 56.89%, respectively, and the subsoil ranged from 48.01% to 49.29% and 51.23% to 53.46% respectively in section C. The porosity of the topsoil at the dry and wet seasons ranged from 30.20% to 31.23% and 32.21% to 39.00%, respectively, and the subsoil ranged from 30.24% to 31.38% and 33.67% to 34.90% respectively (Tables 4-6) in section D. The porosity of the topsoil at the dry and wet seasons ranged from 64.29% to 65.01% and 61.90% to 62.11%, respectively, and the subsoil ranged from 53.46% to 56.45% and 55.20% to 55.21% respectively for section E (Tables 4-6). Bulk density and porosity values in this study were similar to those reported in previous studies around the study area (Rite Foods ESIA, 2015).

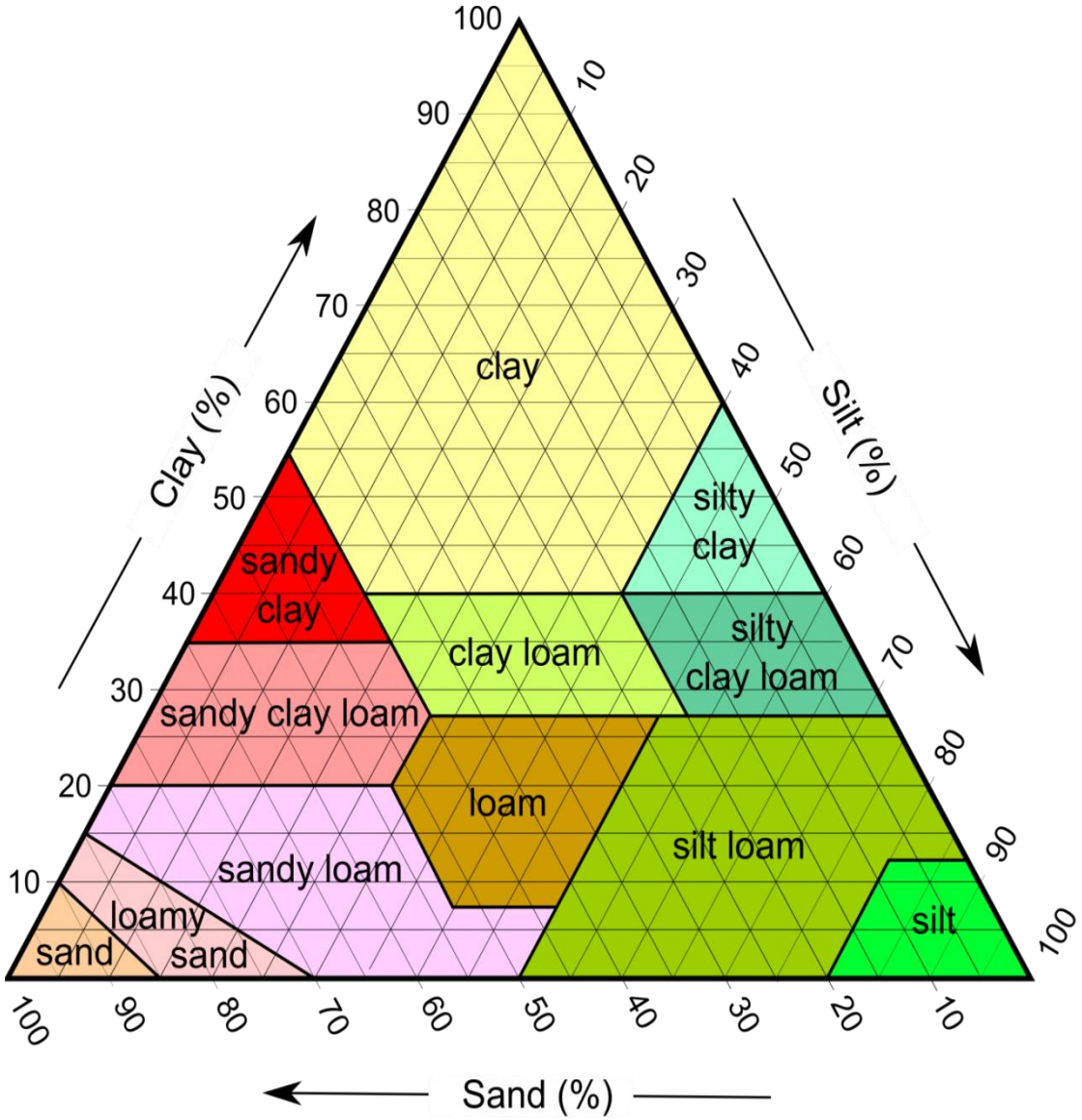


Figure 4-11: Soil type categorization matrix and characteristics.

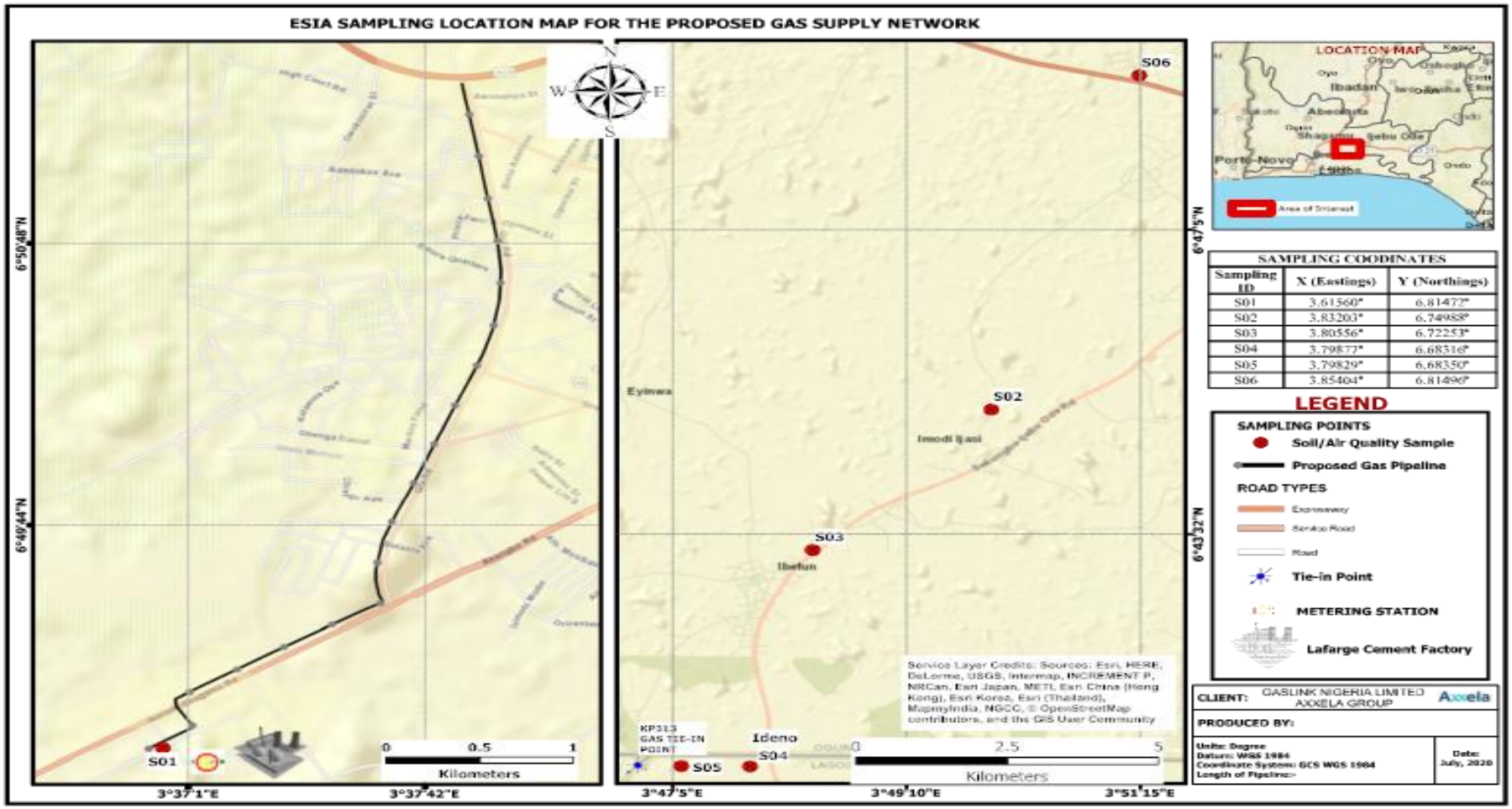


Figure 4-12: Soil Type along the 135km Sagamu LDZ Gas Pipeline route

4.7.2 Soil Physico-chemical Characteristics

The soil physicochemical characteristics of the project area of influence were investigated at selected locations. These characteristics include; pH, Electrical Conductivity, Total organic matter, anions and cations, heavy metals, organics and microbiological characteristics. These are presented in Table 4-7.

Table 4-7: Soil Physico-chemical Characteristics of the study area.

SECTIONS ALONG THE PIPELINE ROUTE			
Section A	DRY SEASON		
	Mean	Min	Max
pH	5.15	4.90	5.60
Electrical conductivity	111.58	48.00	271.00
TOC	0.54	0.15	0.78
O&G	2.03	1.20	2.80
NO_2- N	0.01	0.00	0.01
NO_3-N	0.07	0.02	0.07
$S0_4^{2-}$	3.09	1.94	3.09
Cl^-	37.43	10.30	37.43
Section B	DRY SEASON		
	Mean	Min	Max
pH	4.40	4.00	4.80
Electrical conductivity	300.05	74.10	300.05
TOC	0.57	0.25	0.57
O&G	2.40	1.60	2.40
NO_2- N	0.01	0.01	0.01
NO_3-N	0.06	0.02	0.06
$S0_4^{2-}$	11.76	2.18	11.76
Cl^-	124.95	29.30	220.60
Section C	DRY SEASON		
	Mean	Min	Max
pH	5.56	5.13	5.98
Electrical conductivity	77.75	76.50	79.00
TOC	0.71	0.69	0.72
O&G	2.75	2.70	2.80
NO_2- N	0.01	0.00	0.02
NO_3-N	0.13	0.06	0.20
$S0_4^{2-}$	2.18	1.94	2.42
Cl^-	14.65	14.50	14.80
Section D	DRY SEASON		

SECTIONS ALONG THE PIPELINE ROUTE			
	Mean	Min	Max
pH	5.47	5.10	6.10
Electrical conductivity	192.75	70.70	387.00
TOC	0.63	0.42	0.82
O&G	1.92	1.40	2.80
NO_2- N	0.00	0.00	0.01
NO_3-N	0.13	0.04	0.20
$S0_4^{2-}$	11.76	1.94	48.00
Cl^-	42.10	10.00	104.20
Section E	DRY SEASON		
	Mean	Min	Max
pH	5.15	4.50	5.50
Electrical conductivity	218.60	39.80	636.00
TOC	0.77	0.58	0.92
O&G	2.23	1.50	2.60
NO_2- N	0.01	0.00	0.01
NO_3-N	0.17	0.08	0.26
$S0_4^{2-}$	21.80	2.42	78.73
Cl^-	77.08	13.30	245.90

Source: NGC ESIA Field Survey, 2017.

4.7.2.1 Soil pH

As summarized in Table 4-7, the pH of the soils of project area vary from moderate acidity (4.90) to slightly acidic (5.60), with a mean pH of 5.15 during the dry season in section A, maintain moderate acidity ranging from 4.00 to 4.80, with a mean pH of 4.40 during the dry season in section B, maintain slight acidity within the range of 5.13 to 5.98, with a mean pH of 5.56 during the dry season in section C, maintain slight acidity within the range of 5.10 to 6.10, with a mean pH of 5.47 during the dry season but varies from moderate acidity 4.95 to slightly acidic 5.70 with pH of 5.31 in section D and vary from moderate acidity 4.50 to slightly acidic 5.50, with a mean pH of 5.15 during the dry season maintaining in section E.

In strongly acidic soils, basic cation uptake by plants roots is inhibited. Also, beneficial soil microorganisms as pathological soil-borne micro-organisms are affected by soil reaction (Isirimah *et al.,* 2003). Hence, soil reaction is thus important for nutrient availability for plants uptake as well as the dynamics of pollutants in soil. The present pH condition of the soil may enhance the solubility and mobility of heavy metals and their subsequent percolation to the groundwater table but may slow down microbial degradation. The optimum pH values

for pollutant-degrading microorganisms range from 6.5 to 7.5 ((Margesin and Schinner, 2005).

4.7.2.2 Electrical Conductivity (µS/cm)

Electrical Conductivity (EC) measures the level of ability the soil water carries electrical current. The EC levels of the soil water are good indications of the number of nutrients available for crops to absorb. The soil Electrical Conductivity of section A varied from low EC (48.00µS/cm) to moderate EC (271.00µS/cm), with a mean of (111.58µS/cm) during the dry season. The soil Electrical Conductivity of section B varied from low EC (74.10µS/cm) to moderate EC (300.05µS/cm), with a mean of (300.05µS/cm) during the dry season and the The soil Electrical Conductivity of section C was low and varied from 76.50µS/cm 79.00µS/cm, with a mean of (77.75µS/cm) during the dry season.

The soil Electrical Conductivity of section E varied from low EC (39.8µS/cm) to moderate EC (636µS/cm), with a mean of (218.6µS/cm) during the dry season. A good soil EC level should be between 200µS/cm and 1200µS/cm (1.2 mS/cm) (Grisso et al, 2006; NRCS-USDA FSE Doc). Soils below EC 200 means there is not enough nutrients available to the plant and could perhaps show a sterile soil with little microbial activity.

4.7.2.3 Total Organic Carbon (TOC)

Many important soil properties are dependent to some degree on the quality of organic matter present. These properties include the absorption and retention of water, reserves of exchanged bases, the capacity to supply nitrogen, phosphorus and other elements to growing crops, the stability of soil structure, adequacy of aeration and pollutant bioavailability (Margesin and Schinner, 2005).

Wet season organic carbon content in the soil at the project area's section A ranged between 0.32% and 0.71% with mean, 0.56%, while the dry season ranged, 0.15% to 0.78% with the mean value, 0.54% the dry season ranged, 0.25% to 0.57% with the mean value, 0.57%. Wet season organic carbon content in the soil at the project area's section C ranged between 0.76% and 0.82% with mean, 0.79%, while the dry season ranged, 0.69% to 0.72% with the mean value, 0.71%. Wet season organic carbon content in the soil at the project area's section D ranged between 0.52% and 0.89% with mean, 0.74%, while the dry season ranged, 0.42% to 0.82% with the mean value, 0.63%. The dry season ranged, 0.58% to 0.92% with the mean value, 0.77% (Table 4-7).

4.7.2.4 Soil Exchangeable Anions

Many highly weathered soils can have an anion exchange capacity. This means that the soil will attract and retain anions, rather than cations. Anions are negatively charged. The anions held and retained by soil particles include phosphate, sulfate, nitrate, and chlorine (in order of decreasing strength). In comparison to soils with cation exchange capacity, soils with an anion capacity have a net positive charge. Soils that have an anion exchange capacity typically contain weathered kaolin minerals, iron and aluminum oxides, and amorphous materials. Anion exchange capacity is dependent upon the pH of the soil and increases as the pH of the soil decreases.

Nitrite ion and Nitrate ion

Ammonium (NH_4^+) and nitrate (NO_3^-) are the predominant inorganic forms of nitrogen in soils. Plants normally use nitrogen in only the ammonium and nitrate forms. Nitrite is intermediate of nitrate ion and acutely toxic to plants. In section A of the project area, Nitrite during dry season ranges from 0.00 to 0.01mg/kg with mean, 0.01mg/kg. Nitrate dry season, range 0.02 to 0.07mg/kg with a mean, 0.07mg/kg. In section B of the project area, Nitrite in the dry season ranges from 0.01 to 0.01mg/kg with mean, 0.01mg/kg. Nitrate dry season range 0.02 to 0.06mg/kg with a mean, 0.06mg/kg. In section C of the project area, Nitrite in the dry season ranges from 0.00 to 0.02mg/kg with mean, 0.01mg/kg. Nitrate dry season, range 0.06 to 0.20mg/kg with a mean, 0.13mg/kg.

In section D of the project area, Nitrite in the wet seasons ranges from 0.003 to 0.011mg/kg with a mean, 0.007mg/kg and during dry season ranges from 0.00 to 0.01mg/kg with mean, 0.00mg/kg. Nitrate wet season, range 0.106 to 0.134mg/kg with a mean, 0.128mg/kg and dry season, range 0.04 to 0.20mg/kg with a mean, 0.13mg/kg. In section E of the project area, Nitrite in the wet seasons ranges from 0.002 to 0.009mg/kg with a mean, 0.005mg/kg and during dry season ranges from 0.00 to 0.01mg/kg with mean, 0.00mg/kg. Nitrate wet season, range 0.069 to 0.126mg/kg with a mean, 0.093mg/kg and dry season, range 0.08 to 0.26mg/kg with a mean, 0.17mg/kg.

Sulfate ion

Sulfate in section A of the study area in the dry season, range 1.94 to 3.09mg/kg with a mean, 3.09mg/kg. Sulfate in section B of the study area in the dry season, range 0.02 to 0.06mg/kg with a mean, 0.06mg/kg. Sulfate in section C of the study area in the dry season, range 1.94

to 2.42mg/kg with a mean, 2.18mg/kg. Sulfate in section D of the study area in the dry season, range 1.94 to 48.00mg/kg with a mean, 11.76mg/kg. Sulfate in section E of the study area in the dry season, range 2.42 to 78.73mg/kg with a mean, 21.80mg/kg. Soil sulfate was higher in the dry season.

Acid sulfate soils are safe and harmless when not disturbed. If acid sulfate soils are dug up or drained, they come into contact with oxygen. The pyrite in the soil reacts with the oxygen and breaks down. This process turns pyrite into sulfuric acid, which can cause damage to the environment and to buildings, roads, and other structures. The acid also attacks soil minerals, releasing metals or cations. Rainfall can wash the acid and metals from the disturbed soil into the surrounding environment.

Chloride Ion

Chloride ion in section A of the study area in the dry season, range 10.30 to 37.43mg/kg with a mean, 37.43mg/kg. Chloride ion in section B of the study area in the dry season, range 29.30 to 124.95mg/kg with a mean, 124.95mg/kg. Chloride ion in section C of the study area in the dry season, range 14.50 to 14.80mg/kg with a mean, 14.65mg/kg. Chloride ion in section D of the study area in the dry season, range 10.00 to 104.20mg/kg with a mean, 42.10mg/kg. Chloride ion in section E of the study area in the dry season, range 13.30 to 245.90mg/kg with a mean, 77.08mg/kg.

Plants take up chloride as Cl^- ion from the soil solution. It plays some important roles in plants, including in photosynthesis, osmotic adjustment, and suppression of plant disease. Soil containing chloride concentration of less than 150 mg/kg of chloride is safe for most crops, provided that proper irrigation management practices are applied (White, 2001). However, high concentrations of chloride can cause toxicity problems in crops and reduce the yield.

4.7.2.5 Soil Exchangeable cations

These exchangeable ions are an important reserve of plant nutrients. Roots excrete hydrogen ions (H^+) which can displace the nutrient cations from soil exchange sites into the soil solution where they are available for uptake. The four key elements are the base cations - calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na), together with hydrogen (H) and aluminum (Al) which determine soil pH (Table 4-8).

Table 4-8: Soil Exchangeable cations at the Project Area

SECTIONS ALONG THE PIPELINE ROUTE			
Section A	DRY SEASON		
	Mean	Min	Max
Na^{+}	30.095	18.722	38.040
K^{+}	6.708	2.394	10.115
Ca^{2+}	9.292	5.938	16.458
Mg^{2+}	6.190	2.356	8.399
Section B	DRY SEASON		
	Mean	Min	Max
Na^{+}	52.556	16.433	88.679
K^{+}	13.601	4.150	23.051
Ca^{2+}	7.270	5.904	8.637
Mg^{2+}	7.238	5.147	9.328
Section C	DRY SEASON		
	Mean	Min	Max
Na^{+}	22.175	17.510	26.740
K^{+}	6.099	5.402	6.796
Ca^{2+}	4.845	3.911	5.779
Mg^{2+}	6.309	6.152	6.466
Section D	DRY SEASON		
	Mean	Min	Max
Na^{+}	35.306	11.257	67.263
K^{+}	7.446	2.942	13.157
Ca^{2+}	7.219	2.361	14.601
Mg^{2+}	5.751	2.216	10.923
Section E	DRY SEASON		
	Mean	Min	Max
Na^{+}	13.982	10.637	15.399
K^{+}	2.395	1.313	4.018
Ca^{2+}	7.313	1.183	16.229
Mg^{2+}	4.420	1.111	8.398

Source: NGC ESIA Field Survey, 2017.

Sodium Ion

Soil sodium in section A of the study area in the dry season, range from 18.722 to 38.04mg/kg with a mean, 30.095mg/kg the dry season, range from 16.43 to 88.68mg/kg with a mean, 52.56mg/kg and a Soil sodium in section C of the study area in the dry season, range from 17.51 to 26.74mg/kg with a mean, 22.18mg/kg and Soil sodium in section D of the study area in the dry season, range from 11.26 to 67.26mg/kg with a mean, 35.31mg/kg and a Soil sodium in section E of the study area in the dry season, range from 10.64 to 15.34mg/kg with a mean, 13.98mg/kg.

Base saturation is no less important when we assess the potential hazard posed by soil sodium. The ideal sodium base saturation level is 0-5% (0-85mg/kg) (Mark, 2014). When sodium levels accumulate beyond the critical level of 5% (85mg/kg), a corresponding decline in soluble soil calcium creates a collapse in soil structure and a decrease in permeability. When sodium base saturation exceeds 7-8% (100-130mg/kg), most natural "loam" soils begin to experience obvious problems with drainage and compaction. Beyond 9-10% (150-170mg/kg) the structure of a soil can be compromised so severely that turf may not be able to survive the ensuing permeability problems.

Potassium Ion

Soil potassium in section A of the study area in the dry season range from 2.39 to 10.12mg/kg with a mean, 6.71mg/kg while wet season had potassium ranged 1.86 to 7.69mg/kg with a mean, 5.83mg/kg. Soil potassium in section B of the study area in the dry season range from 4.15 to 23.05mg/kg with a mean, 13.60mg/kg while wet season had potassium ranged 7.89 to 22.10mg/kg with a mean, 15.00mg/kg. Soil potassium in section C of the study area in the dry season range from 5.40 to 6.80mg/kg with a mean, 6.10mg/kg while wet season had potassium ranged 4.26 to 4.94mg/kg with a mean, 4.60mg/kg. Soil potassium in section D of the study area in the dry season range from 2.94 to 13.16mg/kg with a mean, 7.45mg/kg while wet season had potassium ranged 2.87 to 11.24mg/kg with a mean, 5.91mg/kg.

Soil potassium in section E of the study area in the dry season range from 1.31 to 4.02mg/kg with a mean, 2.40mg/kg while wet season had potassium ranged 1.33 to 2.75mg/kg with a mean, 1.96mg/kg. Availability in the soil of K to the plant is mediated by many factors including cation exchange capacity (CEC), type of clay, amount of exchangeable K, soil moisture, soil pH, and temperatures. Mostly found in concentrations of 30-300 mg/kg, 30 mg/kg being deficient and 300 mg/kg being high (Mark and Scott, 2015). Exchangeable K in the study area is low.

Calcium ion and Magnesium ion

Calcium and magnesium ions in section A of the study area in the dry season, ranged from 5.94 to 16.46mg/kg with a mean, 9.29mg/kg and 2.36 to 8.40mg/kg, with a mean, 6.19mg/kg respectively. Calcium and magnesium ions in section B of the study area in the dry season,

ranged from 5.90 to 8.64mg/kg with a mean, 7.27mg/kg and 5.15 to 9.33mg/kg, with a mean, 7.24mg/kg respectively. Calcium and magnesium in section C of the study area in the dry season, ranged from 3.91 to 5.78mg/kg with a mean, 4.85mg/kg and 6.15 to 6.47mg/kg, with a mean, 6.31mg/kg respectively

Calcium and magnesium ions in section D of the study area in the dry season, ranged from 2.36 to 14.60mg/kg with a mean, 7.22mg/kg and 2.22 to 10.92mg/kg, with a mean, 5.75mg/kg respectively. Calcium and magnesium ions in section E of the study area in the dry season, ranged from 1.18 to 16.23mg/kg with a mean, 7.31mg/kg and 1.11 to 8.40mg/kg, with a mean, 4.42mg/kg respectively. Calcium and magnesium are attracted to negatively charged sites on clay and organic matter in the soil where they are easily leached from the soil but available to plants.

4.7.2.6 Heavy metals in the Soil

Heavy metal concentrations in the project area are presented in Table 4-9 with the discussion on each metal.

Table 4-9: Soil Heavy metals of the study area.

SECTIONS ALONG THE PIPELINE ROUTE			
Section A	DRY SEASON		
	Mean	Min	Max
Fe	55.066	31.905	75.937
Cu	1.742	1.072	3.319
Zn	35.055	31.495	38.910
V	0.00	0.00	0.00
Pb	4.349	2.046	6.727
Cd	0.687	0.566	0.795
Ni	4.017	3.003	4.844
Cr	0.990	0.233	1.491
Section B	DRY SEASON		
	Mean	Min	Max
Fe	65.897	63.556	68.237
Cu	2.444	1.478	3.409
Zn	42.437	41.226	43.647
V	0.00	0.00	0.00
Pb	2.020	2.004	2.036
Cd	0.799	0.718	0.880
Ni	6.927	6.010	7.844
Cr	0.435	0.391	0.478
Section C	DRY SEASON		
	Mean	Min	Max

SECTIONS ALONG THE PIPELINE ROUTE			
Fe	57.248	43.468	71.028
Cu	2.529	2.036	3.022
Zn	42.183	40.256	44.109
V	0.00	0.00	0.00
Pb	4.233	3.008	5.458
Cd	0.646	0.494	0.797
Ni	5.531	4.980	6.082
Cr	0.179	0.138	0.220
Section D	DRY SEASON		
	Mean	Min	Max
Fe	62.733	45.398	72.985
Cu	1.064	0.507	1.500
Zn	38.283	29.122	45.092
V	0.00	0.00	0.00
Pb	4.265	2.858	7.592
Cd	0.738	0.505	0.977
Ni	4.276	3.792	5.081
Cr	0.286	0.088	0.734
Section E	DRY SEASON		
	Mean	Min	Max
Fe	57.547	43.090	73.545
Cu	1.245	0.605	2.025
Zn	38.048	33.755	41.713
V	0.00	0.00	0.00
Pb	4.043	1.571	5.710
Cd	0.660	0.406	0.921
Ni	4.419	3.429	5.115
Cr	0.676	0.519	0.860

Iron ion (Fe^{2+})

Iron concentration in the soil at section A of the project area ranged 31.91mg/kg to 75.94mg/kg with mean, 55.07mg/kg for the dry season. Iron concentration in the soil at section B of the project area ranged 63.56mg/kg to 68.24mg/kg with mean, 65.90mg/kg for the dry season Iron concentration in the soil at section C of the project area ranged 43.47mg/kg to 71.03mg/kg with mean, 57.25mg/kg for the dry season. Iron concentration in the soil at section D of the project area ranged 45.40mg/kg to 72.99mg/kg with mean, 62.73mg/kg for the dry season.

Iron concentration in the soil at section E of the project area ranged 43.09mg/kg to 73.55mg/kg with mean, 57.55mg/kg for the dry season and the wet season ranged 34.17mg/kg to 69.31mg/kg with mean, 49.89mg/kg. This was lower than that reported in

previous studies within similar terrain; ranged 354mg/kg to 458 mg/kg (Rite Foods Nig.). These values were below target values (DPR, EGASPIN, 2018). The Target value indicates the soil quality required for sustainability or expressed in terms of remedial policy, the soil quality required for the full restoration of the soil's functionality for human, animal and plant life. Target values, therefore, indicate the soil quality levels ultimately aimed for. Intervention values indicate the quality for which the functionality of soil for human, animal and plant life are, or threatened with being seriously impaired (DPR, EGASPIN, 2018). However, iron concentration in soil above 360 mg/kg is considered high and may adversely affect crop yield (FAO, 1990).

Zinc ion (*Zn^{2+}*)

Total Zn^{2+} concentrations in soil usually fall in the range 10 to 300 mg/kg, with concentrations above 150 mg/kg regarded as high (Landon, 1991), and likely to result in reduced plant growth. Zn concentration in section A of the project area ranged 31.50mg/kg to 38.91mg/kg with mean, 35.06mg/kg in the dry season, Zn concentration in section B of the project area ranged 41.23mg/kg to 43.65mg/kg with mean, 42.44mg/kg in the dry season in section C of the project area ranged 40.26mg/kg to 44.11mg/kg with mean, 42.18mg/kg in the dry section D of the project area ranged 29.12mg/kg to 45.09mg/kg with mean, 38.28mg/kg in the dry season. Zn concentration in section E of the project area ranged 33.76mg/kg to 41.71mg/kg with mean, 38.05mg/kg in the dry season. This was higher than previous studies within a similar terrain; ranged 7.89mg/kg to 13.50mg/kg (Rite Foods ESIA). These values were below the target values (DPR, EGASPIN, 2018). The project area is slightly acidic, zinc level above 10 mg/kg is considered potentially harmful in acid soils (Landon, 1991).

Copper ion (Cu)

Copper is a micronutrient and a healthy soil has copper concentrations ranged from 2mg/kg to 50mg/kg (Streit, 1984). Cu concentration in section A of the project area ranged 1.07mg/kg to 3.32mg/kg with mean, 1.74mg/kg in the dry season. Cu concentration in section B of the project area ranged 1.48mg/kg to 3.41mg/kg with mean, 2.44mg/kg in the dry season. Cu concentration in section C of the project area ranged 2.04mg/kg to 3.02mg/kg with mean, 2.53mg/kg in the dry season and the wet season ranged, 1.67mg/kg to 2.55mg/kg with mean, 2.11mg/kg.

Cu concentration in section D of the project area ranged 0.51mg/kg to 1.50mg/kg with mean, 1.06mg/kg in the dry season. Cu concentration in section E of the project area ranged 0.61mg/kg to 2.03mg/kg with mean, 1.25mg/kg in the dry season. This was lower than previous studies within a similar terrain; ranged 3.22mg/kg to 4.73mg/kg (Rite Foods Nig. ESIA). These values were below the target values (DPR EGASPIN, 2018).

Vanadium ion (V)

Vanadium is a transition metal with an atomic number of 23 and an atomic weight of 50.94. Like other elements in the transition group, vanadium forms numerous and frequently complicated compounds because of its many valence states, which may range from +2 to +5, with +5 being the principle oxidation state (Lagerkvist et al. 1986). Vanadium was not detected in the project area in both seasons.

Lead ion (Pb)

Lead occurs naturally in soils, typically at concentrations that range from 10 to 50 mg/kg. Pb^{2+} concentration in section A of the project area ranged 2.05mg/kg to 6.73mg/kg with mean, 4.35mg/kg in the dry season Pb^{2+} concentration in section B of the project area ranged 2.00mg/kg to 2.04mg/kg with mean, 2.02mg/kg in the dry season. Pb^{2+} concentration in section C of the project area ranged 3.01mg/kg to 5.46mg/kg with mean, 4.23mg/kg in the dry season.

Pb^{2+} concentration in section D of the project area ranged 2.86mg/kg to 7.59mg/kg with mean, 4.27mg/kg in the dry season. Pb^{2+} concentration in section E of the project area ranged 1.57mg/kg to 5.71mg/kg with mean, 4.04mg/kg in the dry season. This was higher than previous studies within a similar terrain; ranged 2.48mg/kg to 4.77mg/kg (Rite Food ESIA).

These values were below the FME limits values. At low soil pH (pH<5, acidic conditions) lead has high soil solubility potential. At near neutral or higher pH (pH>6.5, neutral to basic conditions) soil lead has less or low solubility potential. Lead is held very tightly by soil organic matter, so as organic matter increases, lead availability decreases.

Cadmium (Cd)

The average natural abundance of cadmium in the earth's crust has most often been reported from 0.1mg/kg to 0.5mg/kg, but much higher and much lower values have also been cited depending on a large number of factors. Igneous and metamorphic rocks tend to show lower values, from 0.02mg/kg to 0.2mg/kg whereas sedimentary rocks have much higher values, from 0.1mg/kg to 25mg/kg (Cook and Morrow 1995). Cd^{2+} concentration in section A of the project area ranged 0.57mg/kg to 0.80mg/kg with mean, 0.69mg/kg in the dry season. Cd^{2+} concentration in section B of the project area ranged 0.72mg/kg to 0.88mg/kg with mean, 0.80mg/kg in the dry season.

Cd^{2+} concentration in section C of the project area ranged 0.49mg/kg to 0.80mg/kg with mean, 0.65mg/kg in the dry season. Cd^{2+} concentration in section D of the project area ranged 0.51mg/kg to 0.98mg/kg with mean, 0.74mg/kg in the dry season. Cd^{2+} concentration in section E of the project area ranged 0.41mg/kg to 0.98mg/kg with mean, 0.71mg/kg in the dry season. This was lower than previous studies within a similar terrain; ranged 0.64mg/kg to 1.98mg/kg Rite Foods ESIA). These values were below the target values (DPR, EGASPIN, 2018).

Nickel (Ni^{2+})

The distribution of nickel in the soil profile is uniform, with typical accumulation at the surface soil due to deposition through anthropogenic activities (Cempel and Nikel, 2005). Nickel can exist in several forms in soils that include; adsorbed or complex on organic cation surfaces or on inorganic cation exchange surfaces, inorganic crystalline minerals or precipitates, water soluble, free-ion or chelated metal complexes in soil solution (EHC, 1991; Bennett, 1982). Ni^{2+} concentration in section A of the project area ranged 3.00mg/kg to 4.84mg/kg with mean, 4.02mg/kg in the dry season and the. Ni^{2+} concentration in section B of the project area ranged 6.01mg/kg to 7.84mg/kg with mean, 6.93mg/kg in the dry season in section C of the project area ranged 4.98mg/kg to 6.08mg/kg with mean, 5.53mg/kg in the dry season.

Ni concentration in section D of the project area ranged 3.79mg/kg to 5.08mg/kg with mean, 4.28mg/kg in the dry season. Ni^{2+} concentration in section E of the project area ranged 3.43mg/kg to 5.12mg/kg with mean, 4.42mg/kg in the dry season (Figure 4-31). This was higher than previous studies within a similar terrain; ranged 3.73mg/kg to 4.22mg/kg (Rite Foods ESIA). With decreasing pH, the solubility and mobility of nickel increases,

hence, soil pH is the major factor controlling nickel solubility, mobility, and sorption (Suavé et al., 2000; Tye et al., 2004).

Chromium (Cr^{2+})

Cr concentration in section A of the project area ranged 0.23mg/kg to 1.49mg/kg with mean, 0.99mg/kg in the dry season. Cr concentration in section B of the project area ranged 0.39mg/kg to 0.48mg/kg with mean, 0.44mg/kg in the dry season. Cr concentration in section C of the project area ranged 0.14mg/kg to 0.22mg/kg with mean, 0.18mg/kg in the dry season. Cr concentration in section D of the project area ranged 0.09mg/kg to 0.73mg/kg with mean, 0.29mg/kg in the dry season Cr concentration in section E of the project area ranged 0.52mg/kg to 0.86mg/kg with mean, 0.68mg/kg in the dry season. This was lower than previous studies within a similar terrain; ranged 2.96mg/kg to 5.52mg/kg (Rite Foods ESIA, 2015). These are below regulatory limits.

4.7.3 Organic Contaminants

Oil and Grease

The oil and grease content of the soil was detected in the dry. (Table 4-10).

Total PAH

Sixteen PAHs were chosen by the US EPA to be analyzed in environmental samples because they are the most abundant at hazardous waste sites and more information is available on these than on other PAHs. Moreover, the chosen compounds exhibit harmful effects that are representative of PAHs and exposure to these is more frequent than that of other PAHs (Margesin and Schinner, 2005). None of the sixteen PAHs analyzed in the soil samples was detected in both seasons (Appendix 4-1).

Aliphatic Hydrocarbon

The aliphatic hydrocarbon in the soil in section A of the project area during dry season. The aliphatic hydrocarbon in the soil in section B of the project area during the 0.013mg/kg and 0.00 to 0.024mg/kg with mean, 0.012mg/kg for the dry season. The aliphatic hydrocarbon in the soil in section C of the project area during the dry season ranged 0.028 to 0.029mg/kg with mean, 0.029mg/kg for the dry season. The aliphatic hydrocarbon in the soil in section D of the project area during the ranged 0.021mg/kg and 0.00 to 0.103mg/kg with mean, 0.028mg/kg for the dry season. The aliphatic hydrocarbon in the soil in section E of the

project area during the 0.021 to 0.049mg/kg with mean, 0.034mg/kg for dry season (Table 4-10).

Table 4-10: Soil Total Petroleum hydrocarbon in the Project area.

SECTIONS ALONG THE PIPELINE ROUTE			
Section A	DRY SEASON		
	Mean	Min	Max
Aliphatic (mg/kg)	0.062	0.000	0.147
PAH (mg/kg)	0.000	0.000	0.000
Section B	DRY SEASON		
	Mean	Min	Max
Aliphatic (mg/kg)	0.012	0.000	0.024
PAH (mg/kg)	0.000	0.000	0.000
Section C	DRY SEASON		
	Mean	Min	Max
Aliphatic (mg/kg)	0.029	0.028	0.029
PAH (mg/kg)	0.000	0.000	0.000
Section D	DRY SEASON		
	Mean	Min	Max
Aliphatic (mg/kg)	0.028	0.000	0.103
PAH (mg/kg)	0.000	0.000	0.000
Section E	DRY SEASON		
	Mean	Min	Max
Aliphatic (mg/kg)	0.034	0.021	0.049
PAH (mg/kg)	0.000	0.000	0.000

Source: NGC ESIA Field Survey, 2017.

4.7.4 Soil Microbiology

The summary of microbiological characteristics of soil along the pipeline ROW for dry seasons are presented in Table 4-11, while details are presented in Appendix 4-2. The most predominant organisms among the isolates are the *Bacillus sp, Proteus vulgalis, Rhizobium sp, Staphylococcus* and *Micrococcus s*p (Appendix 4-2).

Hydrocarbon utilizing bacteria had 0.25-0.82 x 10^2 CFU/g (dry season) in section A of the pipeline route, Hydrocarbon utilizing bacteria had 1.97-2.50 x 10^2 CFU/g (dry season) in section B of the pipeline route, Hydrocarbon utilizing bacteria had 0.25-0.27 x 10^2 CFU/g (dry season) in section C of the pipeline route, Hydrocarbon utilizing bacteria had 0.29-1.00 x

10^2 CFU/g (dry season) in section D of the pipeline route, Hydrocarbon utilizing bacteria had 0.40-1.80 x 10^2 CFU/g (dry season) in section E of the pipeline route. The ratio of total heterotrophs to hydrocarbon utilizing bacteria is 100 to 1. The relative abundance of this group is dependent on the presence of hydrocarbon, used as a substrate for energy and growth. The continuous input of petroleum-based pollutants has resulted in an enriched microbial community capable of surviving toxic contamination.

Table 4-11: Soil Microbial Characteristics in the Project area.

SECTIONS ALONG THE PIPELINE ROUTE			
Section A	DRY SEASON		
	Mean	Min	Max
THB (CFU/kg x 10^2)	1.84	0.75	3.80
THF (CFU/kg x 10^2)	2.48	0.75	5.75
HUB (CFU/kg x 10^2)	0.50	0.25	0.82
HUF (CFU/kg x 10^2)	1.21	0.12	3.25
Section B	DRY SEASON		
	Mean	Min	Max
THB (CFU/kg x 10^2)	3.13	2.50	3.75
THF (CFU/kg x 10^2)	9.38	9.25	9.50
HUB (CFU/kg x 10^2)	1.08	0.94	1.21
HUF (CFU/kg x 10^2)	5.17	5.15	5.18
Section C	DRY SEASON		
	Mean	Min	Max
THB (CFU/kg x 10^2)	2.06	1.12	3.00
THF (CFU/kg x 10^2)	6.38	5.50	7.25
HUB (CFU/kg x 10^2)	0.26	0.25	0.27
HUF (CFU/kg x 10^2)	3.63	0.25	5.00
Section D	DRY SEASON		
	Mean	Min	Max
THB (CFU/kg x 10^2)	2.76	1.25	4.85
THF (CFU/kg x 10^2)	1.75	0.22	8.00
HUB (CFU/kg x 10^2)	0.68	0.29	1.00
HUF (CFU/kg x 10^2)	0.58	0.02	3.00
Section E?'	DRY SEASON		
	Mean	Min	Max
THB (CFU/kg x 10^2)	2.47	1.75	3.50
THF (CFU/kg x 10^2)	5.38	0.25	9.50
HUB (CFU/kg x 10^2)	1.30	0.40	1.80
HUF (CFU/kg x 10^2)	2.33	0.05	5.50

Source:NGC ESIA Field Survey, 2017.

4.8 Geology, Hydrogeology and Hydrology

4.8.1 Geology and Hydrogeology

The study area and its environs lie within the extensive Dahomey basin, containing Recent - Cretaceous sediment built-up. The basin (Figure 4-15) extends from the eastern part of Ghana through Togo and Republic of Benin to the western margin of the Niger/Delta basin, just before the Mahin mud coast in Nigeria. The basin is separated from the Benue trough by a basement ridge, the Okiti pupa ridge, a paleographic highland. It is bounded in the east by the Benin hinge line, a major regional fault structure marking the western limit of the delta basin (Adegoke, 1969).

The sedimentary succession consists of near-surface recent alluvial deposits. These deposits are underlain by the Coastal Plain Sands or the Benin Formation. The sediments of the Coastal Plain deposited during the Late Tertiary - Early Quaternary (Jones and Hockey, 1964), consist of unconsolidated, coarse to medium sands (Okosun, 1998). The sands are generally moderately sorted and poorly cemented. The Benin Formation is underlain by the Paleocene Akinbo Formation. The formation is predominantly shally. The Akinbo shale is underlain by the continental Cretaceous sediments of the Abeokuta Group (Omatsola and Adegoke, 1981).

The Alluvial:

This unit occurs as lenses of sands within less permeable beds of silt and clays. Aquifers within occur at shallow depths, with very erratic lateral extent. Alluvial aquifers in this environment are very susceptible to pollution since they occur mostly at shallow depths and in many locations have direct contact with surface runoff and river waters. There is also the likelihood of saline intrusion into alluvial aquifer systems in the area due to the distance of the site to the shoreline.

The Benin Formation:

This stratigraphic unit constitutes the main aquifer system in most parts of the Dahomey Basin. Benin Formation is significantly thick. Its lithologic composition is mostly sand and sandstone (about 90%) while clays and lignitic beds constitute about 10%. The Benin Formation constitutes a large continuous aquifer system with enormous storage capacity.

4.8.2 Hydrology and Hydrogeology of the Project Area

Freshwater resources are essential components of the earth's hydrosphere and an indispensable part of all terrestrial ecosystems. The freshwater environment is characterized by the hydrological cycle, including floods and droughts. The increased concern on the rapid ecological changes in the natural environment has provided major challenges to the scientific community (Chindah 1998). According to Olaniyan (1957), Hill and Webb (1958), two physiographic factors, rainfall, and salinity, determine the hydro-climatic conditions of the coastal lagoons of south-western Nigeria. Rainfall in this region is concentrated in one season (May to October) and has two peaks (June and September) but varies from year to year. The dry season is known to extend from November to April. Hill and Webb (1958), Olaniyan (1969) and Nwankwo (2004) highlighted the importance of rainfall in the ecology of the lagoons of south-western Nigeria.

Global climatic change and atmospheric pollution could also have an impact on freshwater resources and their availability. Water is a vital source of life, especially for drinking, input for crop, forage, and fodder growth, input for artisan and industrial activities. Groundwater and surface water are fundamentally interconnected. It is often difficult to separate the two because they feed (complement) each other. The source of groundwater (recharge) is through precipitation or surface water that percolates downward. Hence, one can contaminate the other.

Borehole records

There are Records of boreholes within the project area, covering some sections of the pipeline were got from a previous study.

Groundwater recharge and discharge

In environmental impact assessment, an understanding of recharges and discharges of an aquifer system is of great importance. It enables to determine the quantity of water available for use where necessary and the rate and direction of migration of pollutants in the event of an incident of pollution. Groundwater recharge is usually as result of meteoric precipitation (rainfall), Also, lateral/vertical groundwater movement, flow from streams, rivers and river tributaries are other potential sources of recharges. Discharges to rivers groundwater abstraction from shallow boreholes and evapotranspiration are major discharge sources of groundwater.

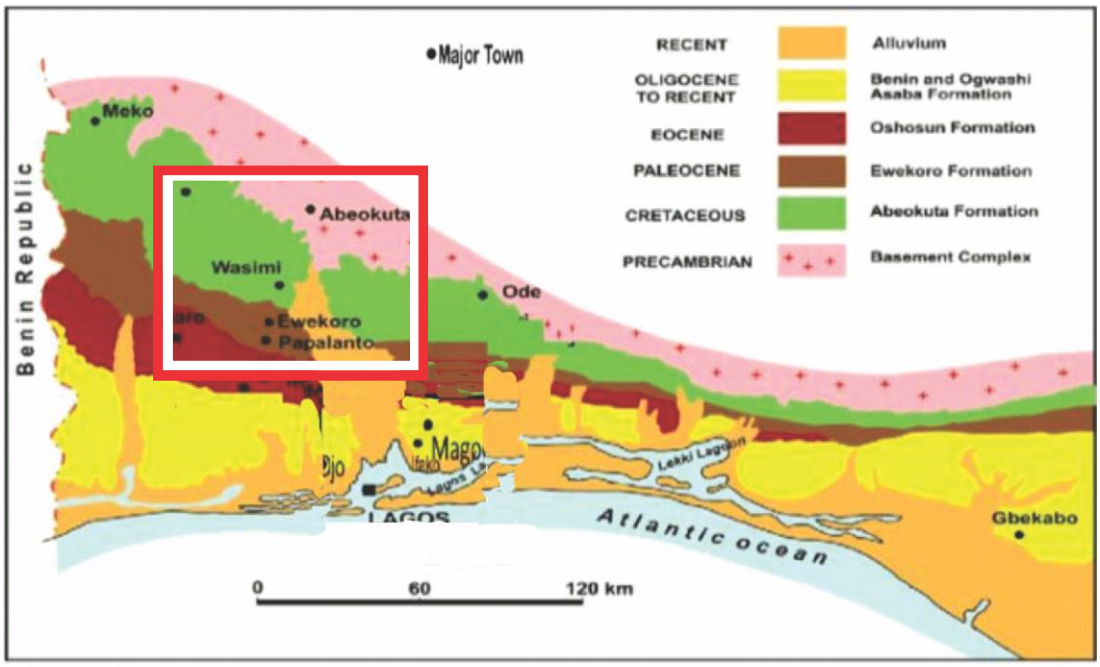


Figure 4-13: Generalised Geological Map of Dahomey Basin

Static water level

Static water levels, an equivalent of depths to the water table, were measured across the three (3) test boreholes drilled in the area. Static water level ranged from 0.37 m to 0.80 m across the boreholes. From the records of static water levels in the area, the mean groundwater depth was computed as 0.62m.

Groundwater flow direction

Besides the static water level in each borehole, the elevation above sea level at each well location was also determined. These parameters were used to compute the general hydraulic head (HH) across the boreholes, based on Buddermeir and Schloss (2000). In the subsurface, water flows from the region of the high hydraulic head to the region of the low hydraulic head. Hydraulic head ranges from 7.63 m to 9.32 m across the area. Figure 4-16 shows that groundwater generally flows southwards in the study area. In reference to the source, Well 1 (with the high hydraulic head (HH), the groundwater flows southwest to Well 2 and northwest to Well 3. Well, 2 and 3 are located east of Well 1. Well, 2 later feeds Well 3 since it has higher hydraulics (Figure 4-14).

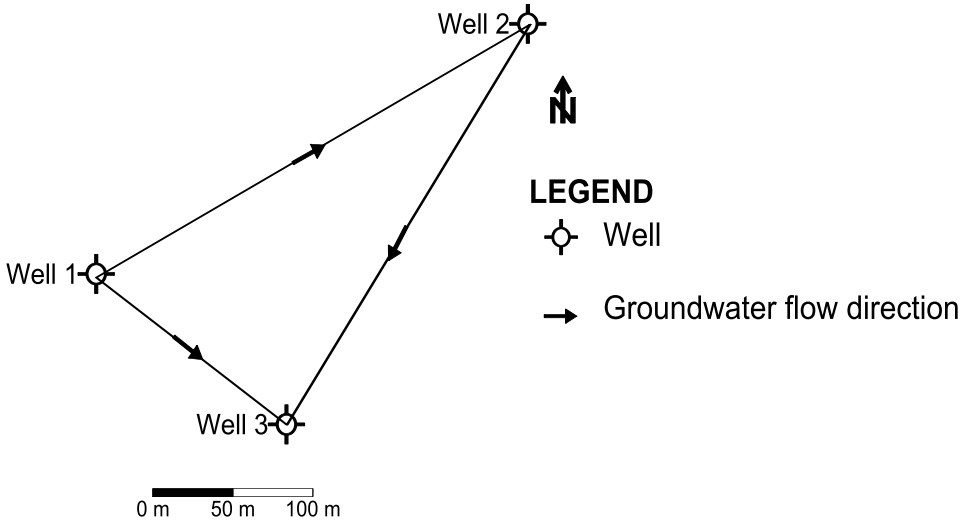


Figure 4-14: Borehole Locations and groundwater flow directions as determined from the test boreholes

Groundwater vulnerability (Hydrogeologic evaluation)

The concept of aquifer vulnerability derives from the assumption that the physical geologic materials may provide some level of protection to groundwater, especially with regard to pollutants infiltrating from the surface. Consequently, the lithologic variations and the thickness of the unsaturated zone (vadose zone), constitute the focus in aquifer vulnerability assessment. In the study area, the depth to static water level (water table), an approximation of vadose zone thickness, ranges from 0.37m in borehole 3 to 0.80m in borehole 2. Based on index rating for depth to groundwater (Aller et al., 1987), the vadose zone thickness falls within the high vulnerability rating, thus suggesting that the near-surface aquifers in the area are vulnerable to contaminants deriving from surface activities.

Geophysical investigation

Four (4) vertical electrical soundings (VES) were conducted within the influence zone of the proposed project. The VES data are contained in Appendix 4-2. The VES data are presented as sounding curves. Preliminary quantitative interpretation of the VES curves was carried out using the partial curve matching method (Patra and Nath, 1998). The models derived from manual interpretation were interactively refined using a computer interaction algorithm.

Geophysical (geoelectric) characteristics

The VES curves are the AKQ and KQQH types. The AKQ curves predominate with 75% frequency of occurrence. The interpretation results of the VES data are presented in Table 4-12.

Table 4-12: VES Interpretation Results

VES NO	THICKNESS (m) $D_1/d_2/d_3/\ldots\ldots d_n$	RESISTIVITY (Ω m) $\rho_1\rho_2\ \rho_3\ldots\ldots\rho_n$
1	1.0/4.1/3.8/10.5	129.9/2338.2/592.3/49.1/31.0
2	1.3/8.6/7.3/12.5	535.2/1105.1/199.8/27.5/115.1
3	1.0/5.3/5.7/17.4	230.5/1686.3/1084.9/86.3/25.8
4	0.5/1.7/5.0/15.7/11.8	1938.6/671.4/2057.8/47.2/64.3/556.1

Two geoelectric sections were drawn along two approximately orthogonal directions (W-E and N-S). The sections display a geologic sequence of five to six geoelectric layers (Appendix). The geoelectric parameters are the following:

1st Layer: Topsoil

Resistivity Range: 130 - 749 ohm-m

Thickness:1.0m - 1.3m

2nd Layer: Layer underlying the topsoil

Resistivity Range:1099 - 2338 ohm-m

Thickness range: 3.8m - 8.6m

3rd Layer: 1st Aquifer layer

Resistivity Range: 90 - 1085 ohm-m

Thickness range: 3.9m - 7.3m.

4th Layer: 2nd Aquifer Layer

Resistivity Range: 28 - 86 ohm-m

Thickness range: 10.5 - 17.4m.

5th Layer: Lowermost layer

Resistivity Range: 15 - 26 ohm -m

Thickness range (not delineated), except in the one outside the premises.

Groundwater prospect

The 3rd geoelectric layer in the Refinery Site constitutes the first aquifer horizon across the study area. The depth of occurrence of the first aquifer ranges from 5.1 m to 17.2 m. The depth of occurrence of the second aquifer unit ranges from 8.9 m (VES1) to 29.7 m (VES2), with resistivity parameter ranging from 27.5 to 49 ohm-m. The low resistivity values suggest salinity intrusion into the aquifer unit.

Groundwater vulnerability (Geophysical evaluation)

The protective capacity of the materials overlying the aquifer(s) is assumed to be proportional to its thickness and inversely proportional to its hydraulic conductivity (Henriet, 1976). But high clay contents generally correspond with low resistivities and low hydraulic conductivities. Hence the protective capacity of the materials overlying the aquifer(s) can be considered as being proportional to the longitudinal unit conductance (S), defined as the ratio of the thickness of material overlying the aquifer to the resistivity. In essence, the higher the longitudinal conductance value, the higher is the protective capacity, while low values suggest that the underlying aquifer is vulnerable. The longitudinal conductance values of the materials overlying the aquifer units in the area are shown in Table 4-13. The table shows that the aquifer systems in the area are poorly/weakly protected, based on the rating of Henriet (1976). Consequently, the aquifer units in the area are vulnerable to polluting or contaminating fluids infiltrating from the surface.

Table 4-13: Table showing longitudinal conductance values and aquifer protective capacity at the VES locations

VES No	Longitudinal Conductance (mhos)	Protective Capacity
1	0.009513	Poor
2	0.010250	Weak
3	0.012740	Weak
4	0.005220	Poor

4.9 Groundwater Quality

4.9.1 Physico-chemical Characteristics

The chemistry of groundwater varies from place to place depending on the nature of the subsoils and rocks that it passes through. Daly (1994) observed that in areas where limestone bedrock and limestone-dominated subsoils are common, groundwater is often 'hard', containing high concentrations of calcium, magnesium, and bicarbonate. However, in areas

where volcanic rocks of sandstones are present, softer water is normal. Therefore, in considering the impact of human activities, it is necessary to first consider the natural (or baseline) water quality. 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 project area of influence are presented in Tables 4-14 to 4-17. 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 of environmental performance.

Table 4-14: Groundwater physicochemical parameters

PARAMETER	Dry Season			FMEnv Limit	WHO Limit
	Min	Max	Mean		
pH	5.98	6.50	6.29	6.00 – 8.50	6.00 – 8.50
Electrical Conductivity (µS/cm)	78.60	84.50	81.23	1,000	-
Total Dissolved Solids (mg/l)	39.30	42.25	40.62	500	-
Temperature (^{0}C)	28.95	29.00	28.98	-	-
Alkalinity (mg/l)	22.99	24.79	24.15	-	30 - 50
Total Suspended Solids (mg/l)	BDL	BDL	BDL	<10	-
Turbidity (NTU)	BDL	BDL	BDL	5.0	5.0
Chloride (mg/l)	6.98	7.99	7.44	250	-
Sulfate (mg/l)	1.84	2.93	2.48	500	250
Hardness (mg/l)	6.03	7.94	6.91	200	80 - 100
Nitrate (mg/l)	0.03	0.08	.055	50 (10 as N)	50
Nitrite (mg/l)	BDL	BDL	BDL		
Oil and Grease (mg/l)	0.00	0.00	0.00		
Chemical Oxygen Demand (mg/l)	6.79	9.26	7.96		
Acidity (mg/l)	25.40	26.80	26.33		
Dissolved Oxygen (mg/l)	4.00	4.60	4.37		
Biological Oxygen	0.60	0.80	0.70		

PARAMETER	Dry Season			FMEnv Limit	WHO Limit
	Min	Max	Mean		
Demand$_5$ (mg/l)					
Sodium ion (mg/l)	6.12	6.84	6.41		
Potassium ion (mg/l)	2.04	2.28	2.16		
Magnesium ion (mg/l)	0.06	0.13	0.10		
Calcium ion (mg/l)	0.37	0.53	0.47		

pH

The pH of the groundwater collected during the wet season ranged from slightly acidic to neutral; pH, ranged 6.32 to 6.73, with mean, 6.51 the same implies to the dry season sample; pH, ranged 5.98 to 6.50 with mean, 6.29. These values were similar to previous studies within the project area; pH ranged from 6.04 to 6.30. The pH values of the groundwater in the area, however, is low than WHO/ DPR limit of 6.5-8.5.

Turbidity

Turbidity in water is a measure of the cloudiness. It is caused by the presence of suspended matter, which scatters and absorbs light (Kiely, 1998). The analyzed values indicated that the groundwater of area is very clear with values that are below the detection limit of the equipment (< 1.0) for the wet and dry seasons in the project area.

Electrical Conductivity (µS/cm)

Electrical Conductivity is the ability of a solution to permit the flow of electrical current. It varies with the number and type of ions in the solution. The conductivity in water is proportional to the concentration of dissolved solids, mostly inorganic salts. The higher the salinity of water the higher the conductivity value (Kiely, 1998). The conductivity values in

the project area of influence ranged from in the dry season ranged from 78.6µS/cm to 84.5µS/cm with a mean, 81.23 µS/cm. The readings obtained in this study, conform to FMEnv limit of 1000 µS/cm (FMEnv, 1991).

Dissolved Oxygen

Dissolved oxygen concentration has a significant effect upon groundwater quality by regulating the valence state of trace metals and by constraining the bacterial metabolism of

organic species. The DO levels of the groundwater in the project area during the dry season sampling ranged between 4.1mg/l and 4.5mg/l with a mean, 4.27mg/l.

Total Dissolved Solid (TDS)

Total Dissolved Solids (TDS) of water is the differences between the total solids (TS) and the suspended solids (SS). The result of the Total Dissolved Solids (TDS) showed relatively moderate values with a range of 39.3mg/l to 42.25 mg/l with a mean, 40.52mg/l and 41.5mg/l to 44.8mg/l with a mean, 43.3mg/l for the dry seasons. The readings obtained in this study were generally below FMEnv limit of 500 mg/l.

Chemical Oxygen Demand (COD)

The Chemical Oxygen Demand is the total measurement of all chemicals in the water that can be oxidized. The Chemical Oxygen Demand (COD) test is commonly used to indirectly measure the number of organic compounds in water. COD values ranging from 6.79mg/l to 9.26mg/l with a mean, 7.96mg/l were recorded within the area during the dry season.

Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at a certain temperature over a specific time period. BOD values ranging from 0.60mg/l to 0.80mg/l with a mean, 0.70mg/l were recorded in dry season sampling. Using the BOD values as the standard for evaluating the groundwater in the area, the groundwater in the area may be classified as very clean water (Pipkin, 1974).

Water Hardness (Carbonate and Bicarbonate)

Groundwater passing through limestone dissolves the calcium and magnesium compounds, which cause hardness. Consequently, hard groundwater is common in limestone areas. Hard water is beneficial to health; it helps to build strong bones and teeth. In addition, it gives a pleasant taste. However, very high levels can be a nuisance, resulting in scale formation in kettles, pipes, and boilers. The hardness of the groundwater at the dry season was between 6.03mg/l and 7.94mg/l with a mean, 6.91mg/l. These values were below the FMEnv limit (200 mg/l) of carbonate and bicarbonate.

Exchangeable Anions

Chloride

This is a measure of solids of oxides and chlorides in water. It affects the taste of groundwater quality. The chlorides were between 6.98mg/l and 7.99mg/l with a mean, 7.44mg/l in the dry season. However, all the values obtained were all below the FMEnv limit of 250 mg/l.

Nitrates (NO_3^-)

NO_3^- is a good indicator of contamination by waste organic matter. The consumption of nitrate-rich water by children may give rise to a condition known as methemoglobinemia, also called blue boy syndrome (Kiely, 1998). The concentration of nitrates (NO_3^-) was between 0.03mg/l to 0.08 mg/l with a mean, 0.052mg/l in the dry season. The values obtained were very low and below the FMEnv limit of 10 mg/l.

Sulfates (SO_4^{2-})

Sulfates (SO_4^{2-}) are also a good indicator of contamination by Foods and waste organic matter. Many aquatic and microscopic organisms utilize sulfate for their growth. Sulfates (SO_4^{2-}) recorded ranged between 1.84mg/l to 2.93mg/l during the dry seasons. Generally, these values were very low.

Exchangeable Cations

Sodium, potassium, magnesium and calcium ions (Na^+, K^+, $Mg^{2+}$and Ca^{2+}) are common cations that are essential macronutrients present in a water environment.

Sodium Ion

Sodium is a principal chemical in bodily fluids, and it is not considered harmful at normal levels of intake from combined food and drinking water sources. However, increased intake of sodium in drinking water (exceeding 200mg/l) may be problematic for people with hypertension, heart disease or kidney problems that require them to follow a low sodium diet (B.C Ministry Health, 2007). Sodium ion measured in the groundwater during the dry season, ranged 6.12mg/l to 6.84 mg/l with a mean, 6.41mg/l.

Potassium Ion

The concentration of Potassium ion depends greatly on the type of aquifer sediments present. It occurs in various minerals, from which it may be dissolved through weathering processes. It ranges between 2mg/l and 542mg/l. and varies in a similar way as sodium. Potassium ion measured in the groundwater during the dry season ranged from 2.04mg/l to 2.28 mg/l with a mean, 2.16mg/l.

Calcium and Magnesium

Calcium and magnesium ions measured in the groundwater during the dry season ranged, 0.37mg/l to 0.53 mg/L and 0.06mg/l to 0.13 mg/L respectively. The dry season had very low magnesium and calcium, a good reason for the softness. Values from the control were also not significantly different from that of the project site. Undesirable effects due to the presence of calcium in drinking water may result from its contribution to hardness. However, mention has been made of the possible contribution of drinking water to total daily intake of calcium and magnesium and that drinking-water could provide important health benefits, including reducing cardiovascular disease mortality (magnesium) and reducing osteoporosis (calcium), at least for many people whose dietary intake is deficient in either of those nutrients (WHO, 2008).

4.9.2 Groundwater Heavy metals

Water is a vital resource, necessary for all aspects of human and ecosystem survival and health. Depending on the quality, bore water may be used for human consumption, irrigation purposes and livestock watering. The quality of bore water can vary widely depending on the quality of groundwater that is its source. Heavy metals are important environmental pollutants, particularly in areas with high anthropogenic sources. Heavy metals detected within the areas of the project influence include; zinc, cadmium, manganese, copper, lead, and iron. Metals not detected in the groundwater include; nickel, barium, arsenic, and mercury.

Table 4-15: Groundwater heavy metals

PARAMETER	Dry Season		
	Min	Max	Mean
Zinc(mg/l)	0.033	0.063	0.046
Cadmium (mg/l)	BDL	0.002	0.001
Manganese (mg/l)	0.001	0.002	0.002
Nickel (mg/l)	BDL	BDL	BDL
Copper (mg/l)	0.080	0.120	0.095
Lead (mg/l)	0.042	0.046	0.044
Iron (mg/l)	0.137	1.118	0.516
Barium (mg/l)	BDL	BDL	BDL
Arsenic (mg/l)	BDL	BDL	BDL
Mercury (mg/l)	BDL	BDL	BDL

Zinc

Zinc is found naturally at low concentrations in many rocks and soils principally as sulfide ores and to a lesser degree as carbonates. Zinc can be introduced into water naturally by erosion of minerals from rocks and soil, however since zinc ores are only slightly soluble in water. Zinc is only dissolved at relatively low concentrations. High natural levels of zinc in water are usually associated with higher concentrations of other metals such as lead and cadmium (Saskwater Quality Report 2006). Zinc measured in the groundwater during the dry seasons, ranged from 0.033mg/l to 0.063mg/l. These values were less than that reported in similar terrain; 0.234mg/l to 0.268mg/l. The values are below the WHO regulatory limit, 0.5mg/l.

Cadmium

Cadmium measured in the groundwater during the dry season ranged from 0.000mg/l. The previous study in this terrain, could not detect cadmium. The values are below the WHO regulatory limit, 0.05mg/l.

Manganese

Manganese measured in the groundwater during the dry season ranged from 0.001mg/l. The values are below the WHO regulatory limit, 0.05mg/l.

Copper

Copper measured in the groundwater during the dry season, ranged from 0.080mg/l to 0.12mg/l respectively. The values are below the WHO regulatory limit, 1.00mg/l.

Lead

Lead measured in the groundwater during the dry ranged from 0.015mg/l to 0.056mg/l. The values are higher than the WHO regulatory limit, 0.01mg/l. Aside from industrial sources, the reason for the high level of lead in the aquifer system could be due to leaching of lead from metal casting materials, domestic products from waste dumps and dumpsites (Brain et al, 1999).

Iron

Iron measured in the groundwater during the dry seasons ranged from 0.158mg/l to 0.382mg/l respectively. The values are lower than the FMEnv and WHO regulatory limit, 1.00mg/l.

4.9.3 Groundwater Organic contaminants

Oil and grease and total petroleum hydrocarbons were not detected in the groundwater samples collected from the project areas of influence.

4.9.4 Microbiological Characteristics in Groundwater (MCB)

The summary of the microbial characteristics of groundwater samples from the TGNL 49.5km pipeline project area is presented in Table 4-16. The total heterotrophic bacteria (THB) and hydrocarbon degraders (HUB) determined in the dry season, ranged from 0.6 x 10^4 to 0.87 x 10^4 CFU/ml and 0.18 x 10^2 to 0.8 x 10^2 CFU/ml respectively. The THB were hundred times more than the HUB. A similar level of THB in groundwater was reported in previous studies within the project area, but this study reported higher levels of HUB. HUF and THF were low in dry seasons, however, coliforms were high at the dry season sample5. Most prevalent among the bacteria isolates are *Bacillus sp*. and *Micrococcus luteus*

Table 4-16: Microbiological Characteristics in Groundwater (MCB)

PARAMETER	Dry Season		
	Min	Max	Mean
HUB (CFU/ml x 10^2)	0.18	0.80	0.45
HUF (CFU/ml x 10^2)	0.33	0.61	0.48
THB (CFU/ml x 10^2)	60	87	73
THF (CFU/ml x 10^2)	0.07	0.33	0.20
Total Coliform	21.00	24.00	22.33

Source: NGC ESIA Field Survey, 2017.

4.10 Surface Water Quality

The surface water quality baseline conditions which include, physicochemical parameters, heavy metals, total petroleum hydrocarbons and microbial characteristics in the dry seasons at TGNL 135km gas pipeline crossing at the Ososa are discussed below.

4.10.1 Physical - Chemical Parameters

Temperature

For the dry season water temperature ranged from 28.70^{0}C to 30.20^{0}C with a mean of 29.50^{0}C. The temperature range of both seasons is within the FMEnv standard (20^{0}C to 30^{0}C) for aquatic life. The observed slight spatial variation for the one seasons is attributable to the period of sample collection and measurement.

Alkalinity

Alkalinity refers to the capacity of water to neutralize the acid. Alkalinity measured in the dry and wet seasons ranged from 13.160mg/l to 15.08 mg/l with a mean value of 14.03 mg/l . These values are within the WHO limit of 600mg/l.

Acidity

Acid deposition can have serious effects on aquatic ecosystems. Acidified waters can impair the ability of fish gills to extract oxygen from water and change the mobility of certain trace metals (e.g., aluminum, cadmium, manganese, iron, arsenic, mercury), which in turn can place fish and other species sensitive to these metals at risk (NAPAP, 1991). Acidity measured in the dry seasons ranged from 10.90mg/l to 12.30 mg/l with a mean value of 11.47 mg/l.

Table 4-17: Physical-Chemical Characteristics of Surface Waters of the Study Area

PARAMETER	Dry Season			FMEnv Limit	WHO Limit
	Min	Max	Mean		
pH	6.28	6.76	6.48	6.5 – 8.5	6.5 – 8.5
Electrical Conductivity (µS/cm)	118.76	124.62	121.78	NA	100
Total Dissolved Solids (mg/L)	59.38	62.31	60.89	<2000	250
Temperature (^{0}C)	28.70	30.20	29.50	30	20 - 30
Total Phosphorus	0.02	0.03	0.03		
Alkalinity (mg/l)	13.160	15.08	14.03	NA	600

PARAMETER	Dry Season			FMEnv Limit	WHO Limit
	Min	Max	Mean		
Total Suspended Solids (mg/l)	2.00	7.00	4.00	30	30
Turbidity (NTU)	1.20	4.50	3.00	10	5
Chloride ion (mg/l)	23.63	35.70	29.06		
Sulfate ion (mg/l)	6.64	7.51	7.06	NA	250
Hardness (mg/l)	7.57	9.28	8.32	NA	250
Sulfide (mg/l)	BDL	BDL	BDL		
Nitrate (mg/l)	0.03	0.08	0.04600		
Nitrite (mg/l)	0.00	0.03	0.02		
Phenol (mg/L)	BDL	BDL	BDL	0.5	NA
Oil and Grease (mg/l)	BDL	BDL	BDL	10	NA
Chemical Oxygen Demand (mg/l)	9.28	13.45	10.98	40	40
Carbonates (mg/l)	0.00	0.00	0.00		
Acidity (mg/l)	10.90	12.30	11.47		
Dissolved Oxygen (mg/l)	4.50	5.90	5.23	10	10
Biological Oxygen Demand (mg/l)	1.10	1.60	1.40	10	10
Sodium ion (mg/l)	71.76	75.15	73.68		
Potassium (mg/l)	12.20	14.94	13.42		
Magnesium ion (mg/l)	5.87	6.41	6.08		
Calcium ion (mg/l)	2.31	2.93	2.55		

NA = Not Analyzed

pH

The pH of the surface water taken during the dry season falls within the freshwater range with values ranging from 6.28 to 6.76. The pH of freshwater typically ranges between 6.5 and 7.5 (DWAF, 1996). It is also within the FMEnv limit for aquatic life.

Hardness (mg/L$CaCO_3$)

Hardness in water comprises the determination of calcium and magnesium as the main constituents with magnesium ions contributing more to the measured hardness in this study. Hardness values measured in the water samples during the dry season ranged from 7.57 to 9.28 mg/L$CaCO_3$ with a mean value of 5.94 mg/L$CaCO_3$. These values are within the FMEnv and WHO limit.

Electrical Conductivity (EC)

The electrical conductivity (EC) values which are measures of the ionic richness of the surface water ranged from 118.76µS/cm to 124.62µS/cm and with a mean of 121.78µS/cm in the dry season, Studies from Nigerian Inland water bodies show that conductivity value is much less than 500µS/cm at the peak of the dry season are reported (Egborge 2001).

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) is a measure of dissolved ions in water and its value is related to dissolved solids. TDS ranged between 59.38 mg/L and 62.31 mg/L with a mean of 60.81mg/L for the dry season. The TDS values obtained for dry seasons were less than 500 mg/L guideline limit (FEPA, 1991; USEPA, 2002; Health Canada, 2003; WHO, 2008). At higher TDS levels, excessive hardness, mineral deposition, and corrosion may occur.

Total Suspended Solid (TSS)

Total Suspended Solids (TSS) are solids in water that can be trapped by a filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. It ranged from 2.0 mg/L to 7.0 mg/l with a mean 4.0 mg/l for the dry season. The range for the values for the Total Suspended within the WHO (30.0 mg/L) and Federal Ministry of Environment limits (30.0 mg/l).

Turbidity (NTU)

Turbidity is a measure of the cloudiness of water- the cloudier the water, the greater the turbidity. Turbidity in water is caused by suspended matter such as clay, silt, and organic matter and by plankton and other microscopic organisms that interfere with the passage of light through the water (American Public Health Association, 1998). Suspended solid is closely related to the turbidity of water which defines its clarity. Turbidity values measured in the surface water samples during the dry season ranged 1.2 to 4.5 NTU. These values are within the FMEnv regulatory limit (10.0NTU).

Exchangeable cation

Exchangeable cations are abundant natural elements and are important in ensuring primary and secondary productivity of the marine ecosystem. They include sodium, potassium, magnesium and calcium ions.

Sodium and potassium ions

Sodium and potassium ions measured in the surface water during the dry season ranged from 71.76mg/l to 75.15mg/l and 12.2mg/l to 14.94mg/l.

Magnesium and calcium ions

Magnesium and calcium ions measured in the surface water in the dry season ranged from 5.87mg/l to 6.41mg/l and 2.31mg/l to 2.93mg/l.

Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) is the amount of oxygen that is required to chemically stabilize the organic matter contained in a solution under aerobic conditions. The chemical oxygen demand (COD) test is commonly used to indirectly measure the number of organic compounds in water. A value over 50 mg/l is usually indicative of polluted waters. Chemical Oxygen Demand (COD) values for the dry season ranged from 9.28mg/l to 13.45mg/l with mean 10.98mg/l. The COD values in the dry seasons were below FMEnv Limit (40 mg/l).

Dissolved Oxygen (DO)

Dissolved oxygen is the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis. Oxygen is a necessary element to all forms of life and natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As DO levels in water drop below 5.0 mg/l aquatic life is put under stress. The lower the concentration of oxygen, the greater the stress will be. Oxygen levels that remain below 1 to 2 mg/l for a few hours can result in large fish kills (Francis- Floyd, 2003). Hence, adequate dissolved oxygen is necessary for good water quality.

Dissolved Oxygen (DO) values for the dry season ranged from 4.5mg/l to 5.9mg/l with mean 5.23mg/l. Dissolved oxygen level in dry seasons was lower than FMEnv limits (10 mg/l).

Biological Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. Biological Oxygen Demand (BOD) values for the dry season ranged from 1.1mg/l to 1.6mg/l. The BOD values in dry seasons were below FMEnv (10 mg/l).

Exchangeable Anions

Nutrients are essential chemical substances required by living organisms for growth and life. They can also be seen as substances used in an organism's metabolism, which must be taken in from their environment. Marine animals, thus depend on water to supply their nutrients. However, if these nutrients are present in high concentration, they could become detrimental to the organisms. The major nutrients analyzed in marine water are chlorides, sulfates, phosphates, nitrates, and carbonates. The measured chloride, sulfate, total phosphorus, and nitrate values are considered normal for the sampled environment and are comparable with the dry season values measured at recent studies in the project area (Global Environmental Technology Ltd, 2008).

Chlorides

Chloride ion measured in the surface water during the dry season ranged from 23.63mg/l to 35.70mg/l with mean, 29.06mg/l. These were lower than previous studies reported within similar terrain, ranging from 61.70mg/l to 102.80mg/l.

Sulfate ion

Sulfate ion measured in the surface water during the dry season ranged from 6.64mg/l to 7.51mg/l with mean, 7.09mg/l. These were lower than previous studies reported within similar terrain, ranging from 24.70mg/l to 32.80mg/l.

Nitrate and Nitrite ions

Nitrate and nitrite ions are very essential to the growth of tropic producers in the aquatic ecosystem. They are produced mainly by nitrifying bacteria. Their excess level in the water could be toxic. Nitrate and nitrite measured in the surface water during the dry season ranged from 0.03mg/l to 0.08mg/l with mean, 0.046mg/l for nitrate and 0.00mg/l to 0.03mg/l with mean 0.02mg/l for nitrite. Nitrate values were lower than previous studies reported within similar terrain, ranging from 14.00mg/l to 29.00mg/l

4.10.2 Heavy Metals in surface waters

The heavy metal analysis in the surface water samples revealed low concentrations below regulatory limits for surface waters (FEPA, 1991; WHO, 2008). The order of concentrations in the water samples for the dry season was Fe > Cu > Ba > Zn > Ni > Mn > Cd > Pb, while Arsenic (Ar) and mercury (Hg) were below instrument detection limit. The low levels of

heavy metals in the water column could be attributed to possible flocculation and subsequent sedimentation of the metals. It is also an indication of the unpolluted water body. These are summarized in Table 4-18 below.

Table 4-18: Concentrations (ppm) of Metals in Surface Water in the Study Area

PARAMETER	Dry Season		
	Min	Max	Mean
Zinc(ppm)	0.038	0.045	0.041
Cadmium (ppm)	0.004	0.009	0.006
Manganese (ppm)	0.009	0.015	0.013
Nickel (ppm)	0.025	0.036	0.029
Copper (ppm)	0.075	0.092	0.084
Lead (ppm)	BDL	0.006	0.002
Iron (ppm)	0.260	0.769	0.464
Barium (ppm)	0.054	0.062	0.057
Arsenic (ppm)	BDL	BDL	BDL
Mercury (ppm)	BDL	BDL	BDL

Zinc

Zinc is a naturally occurring element found in rock-forming minerals. Its concentrations in marine and estuarine sediments vary widely and may be high in uncontaminated sediments remote from human activities (Neff, 2002). Other sources of Zinc in the marine environment include aerial depositions and industrial discharges. Zinc dry season ranged from 0.038ppm to 0.045ppm with mean, 0.045ppm. These values are below FMEnv limits (1.0ppm)

Cadmium

Dissolved and particulate forms of cadmium (Cd) enter the marine environment from rivers; atmosphere and other anthropogenic origins while small concentrations could also be present in produced water. In bio-available form, Cd is one of the more toxic metals to plants and animals and in some forms; it may be mutagenic or carcinogenic in mammals. Cadmium ranged from 0.004ppm to 0.009ppm in the dry season with mean, 0.006ppm and wet season ranged from 0.000ppm to 0.004ppm with mean, 0.003ppm. These values are below FMEnv limits (0.05ppm).

Manganese

Manganese ranged from 0.009ppm to 0.015ppm in the dry season with mean, 0.013ppm. These values are below FMEnv limits (0.3ppm).

Nickel

Nickel (Ni) enters the marine environment through weathering of minerals and rocks and a wide range of anthropogenic activities. It is an abundant element in the earth crust and occurs naturally in combination with sulfur, arsenic, and antimony. It enters the environment mainly through the weathering of minerals and rocks and as a result of anthropogenic activities (GEMS, 1992). Ni ranged from 0.025ppm to 0.036ppm in the dry season with mean, 0.029ppm. These values are below FMEnv limits (0.05ppm)

Copper

Copper (Cu) enters the marine environment through river inflows, discharge of produced water, etc and occurs mostly in inorganic complexes. It is an essential element in the nutrition of organisms and is required for the function of several enzymes and in the biosynthesis of chlorophyll. The metal has a strong affinity for complexation with organic ligands such as humic substances and dissolved organic matter and bacterial particles, so little is present in true solution in sea environment as toxic inorganic species. Dissolved reactive copper is toxic to marine plants and animals (GEMS, 1992). Copper ranged from 0.075ppm to 0.092ppm in the dry season with mean, 0.084ppm. These values are below FMEnv limits (1.5ppm)

Iron

Iron ranged from 0.260ppm to 0.769ppm in the dry season with mean, 0.464ppm and These values are below FMEnv limits (1.0ppm).

Barium

Barium ranged from 0.054ppm to 0.062ppm in the dry season with mean, 0.057ppm. These values are below FMEnv limits (1.0ppm).

4.10.3 Organic contaminants

The summary of total petroleum hydrocarbons, oil and grease, total polyaromatic hydrocarbons and total aliphatics of the surface water for the dry season are presented in Table 4-19, while detailed analytical results are shown in Appendix 2

Total Petroleum Hydrocarbons.

TPH in the surface water, during the dry season, ranges from 0.002 mg/l to 0.01 mg/l, values were all below the detection limit of the instrument used. Chemicals that may be found in TPH are hexane, jet fuels, mineral oils, benzene, toluene, xylenes, naphthalene, and fluorine,

as well as other petroleum products and gasoline components. However, it is likely that samples of TPH will contain only some, or a mixture, of these chemicals. The values for TPH for both seasons were below WHO and DPR limits (10.0 mg/l) for inland waters.

Oil and grease

Oil and grease (Total Hydrocarbon Content) are made up of hydrocarbon oil of both petrogenic and biogenic origin; fats, oils, and waxes of both plant and animal origin. Oil and grease values recorded in the surface water sample for the seasons were all below the detection limit of the equipment used.

Table 4-19: Concentrations (mg/L) of Organics in Surface Water in the Study Area

Parameters	Dry Season			DPR Limit	FME Limit
	Min	Max	Mean		
TPH (mg/l)	0.002	0.01	0.007	20	NA
Oil and Grease (mg/l)	<0.001	<0.001	<0.001	10	NA
TPAHs (mg/l)	0.002	0.004	0.003	NA	NA
Aliphatics	<0.001	0.008	0.005	NA	NA

Source: NGC ESIA Field Survey, 2017.

4.10.4 Microbiology in Surface water

The summary of microbial characteristics of the surface water bodies within the study area for wet and dry seasons is presented in Table 4-20. The heterotrophic bacterial counts for the dry and wet seasons ranged from 135 x 10^4 to 260 x 10^4 CFU/ml and 112 x 10^4 to 195 x 10^4 CFU/ml respectively showing higher counts in the dry season. The Hydrocarbon Utilizing (degrading) Bacteria count for the dry and wet seasons ranged between 4.20 x 10^2 CFU/ml to 6.52 x 10^2 CFU/ml and 4720 x 10^2 CFU/ml to 5280 x 10^2 CFU/ml.

Table 4-20: Microbial Composition of Surface water in the Study Area

PARAMETER	Dry Season		
	Min	Max	Mean
HUB (CFU/ml x 10^2)	4.20	6.52	5.36
HUF (CFU/ml x 10^2)	0.07	0.08	0.08
THB (CFU/ml x 10^4)	135	260	182
THF (CFU/ml x 10^2)	0.19	0.24	0.2150
Total Coliform	19.00	28.00	22.67

Source: NGC ESIA Field Survey, 2017.

4.11 Sediments Study

This section provides results for sediment analysis for the Ososa along the TGNL 135km pipeline route.

4.11.1 Physiochemical Characteristics

The sediment quality baseline conditions based on the dry season data gathering is discussed below. The survey found that the sediment type varies from sandy loam, sand, silt-loam, clay-loam to silt. The physicochemical parameters of the sediment are summarized in Table 4-21 below.

Table 4-21: Sediment physicochemical characteristics

PARAMETERS	Dry Season		
	Min	Max	Mean
pH	5.36	5.85	5.53
Electrical Conductivity (µS/cm)	131.00	140.00	136.33
Nitrite (mg/kg)	1.49	2.419	2.07
Oil and Grease (mg/kg)	1.30	1.90	1.53
Chloride (mg/kg)	35.86	37.12	36.43
Sulfate (mg/g)	10.33	13.41	11.48
Nitrate (mg/kg)	3.84	4.69	4.24
Sodium (mg/kg)	10.39	15.52	13.29
Potassium (mg/kg)	10.79	13.87	12.40
Calcium (mg/kg)	3.24	11.21	6.43
Magnesium (mg/kg)	5.84	8.60	7.36

pH

The pH of the sediment in the sampled project areas of influence ranges from 5.36 to 5.85 with a mean of 5.53 in the dry season while the mean pH. The moderate acidic nature of the sediment in both seasons could be due to the high rate of decomposition of matter. This process reduces the amount of oxygen in the sediments thus low pH. Limiting these changes sustains the adaptations and survival of benthic communities. Measured pH values are within Nigerian regulatory guidelines and standards for aquatic life (FEPA, 1999) and considered normal for the sampled environment.

Electrical conductivity (EC - µS/cm)

The electrical conductivity (EC) values of the sediment were lower in the dry season it ranged from 131.00 µS/cm to 140.00 µS/cm and a mean of 136.33`µS/cm. This is within the WHO and Federal Ministry of Environment limit.

Exchangeable Anions

The results of the dry season survey chemical analysis of marine sediments from the study area are summarized in Table 4-19.

Total Nitrate available ranges from 3.84mg/kg to 4.69mg/kg with a mean concentration of 4.24mg/kg in the dry season. The abundance of inorganic nitrogen compounds in the sediment samples occur in the ranking order of NO_3-N >NO_2-N.

Sulfate (SO_4^{2-}) ions are also present in quantities ranging from 10.33 mg/kg to 13.41 mg/kg with a mean concentration of 11.48mg/kg in the dry season while a mean concentration of 9.07mg/kg was obtained in the wet season.

The Chloride (Cl^-) ions are present in the marine sediment samples in concentrations ranging from 35.86 mg/kg to 37.12 mg/kg with a mean value of 36.43 mg/kg in the dry season.

The measured values for these nutrients and anions in the marine sediments are considered within the normal range of concentrations for the sampled marine environment when compared with the FMEnv guidelines.

Exchangeable Cations

The exchangeable cations determined were sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg). These are abundant natural elements, essential in ensuring optimal primary and secondary productivity of the aquatic ecosystem. The ion exchange capacity of sediment is the number of moles of sorbed ion charge that can be desorbed from unit mass, under given conditions of temperature, pressure, sediment solution composition (including pH), and sediment solution mass-ratio" (Sposito, 1994). Cation exchange capacity is a function of grain size, amount of organic matter, amount of coatings on the grains and mineralogy of the sorbing material.

Sodium and Potassium ions

Sodium and potassium ions in the sediment for dry season range from 10.39 mg/kg to 15.52 mg/kg with mean, 13.29 mg/kg and 10.79 mg/kg to 13.87 mg/kg with mean, 12.40 mg/kg respectively.

Calcium and Magnesium ions

The concentrations of calcium and magnesium ions for dry season range from 3.24 mg/kg to 11.21 mg/kg with mean, 6.43 mg/kg and 5.84 mg/kg to 8.60 mg/kg with mean, 7.36 mg/kg respectively.

4.11.2 Heavy metals

Eleven (11) heavy metals were analysed in the sediment in both seasons, which include Barium (Ba), Chromium (Cr), Cadmium (Cd), Copper (Cu), lead (Pb), Iron (Fe), Nickel (Ni), Vanadium (V), Zinc (Zn), Arsenic (As), Manganese (Mn). All the metals showed measurable concentrations with Fe recording the highest concentration (14.381 – 27.511 mg/kg) in the dry season. (Table 4-22). The occurrence and levels of Fe are more of lithological or crustal origin as the higher iron level has been reported for most Nigerian sediment (Odu, 1996).

Generally, the presence of metals in river sediments originates from several sources and they are present in different forms. Most of the metals in their stable state are derived from natural weathering, erosion and anthropogenic activities. The order of concentrations of the heavy metals in the sediment for the dry season is: Fe > Ni > Mn> Zn > Cu > Pb > Cd > Ba > Cr. Vanadium and Arsenic readings were below the detection limit of the instrument used.

Table 4-22: Sediment heavy metals

PARAMETERS	Dry Season		
	Min	Max	Mean
Barium (mg/kg)	0.279	0.552	0.461
Chromium(mg/kg)	0.308	0.474	0.381
Cadmium (mg/kg)	0.499	1.117	0.738
Copper (mg/kg)	1.954	2.534	2.205
Lead (mg/kg)	0.618	1.024	0.796
Iron (mg/kg)	14.381	27.511	19.948
Nickel (mg/kg)	9.579	10.651	10.204
Vanadium (mg/kg)	0.000	0.000	0.000
Zinc (mg/kg)	4.612	5.913	5.192
Arsenic (mg/kg)	0.000	0.000	0.000

PARAMETERS	Dry Season		
	Min	Max	Mean
Manganese (mg/kg)	4.744	6.182	5.224

Chromium

Chromium concentrations ranged 0.308mg/kg to 0.474mg/kg with mean, 0.381mg/kg at the dry season .

Iron

Iron concentrations ranged 14.381mg/kg to 27.511mg/kg with mean, 19.948mg/kg at dry season.

Lead

Lead concentrations ranged 0.618mg/kg to 1.024mg/kg with mean, 0.796mg/kg at dry season.

Copper

Copper concentrations ranged 1.954mg/kg to 2.534mg/kg with mean, 2.205mg/kg at dry season. These values were below the target values, 36mg/kg (DPR, 2002).

Nickel

Nickel concentrations ranged 9.579mg/kg to 10.651mg/kg with mean, 10.204mg/kg at dry season. These values were below the target values, 35mg/kg (DPR, 2002).

Zinc

Zinc concentrations ranged 4.612mg/kg to 5.913mg/kg with mean, 5.192mg/kg at dry season. These values were below the target values, 140mg/kg (DPR, 2002).

Manganese

Manganese concentrations ranged 4.744mg/kg to 6.182mg/kg with mean, 5.192mg/kg at dry season These values were above the target values, 36mg/kg (EGASPIN, 2018).

Cadmium

Cadmium concentrations ranged 0.499mg/kg to 1.117mg/kg; mean, 0.738mg/kg at dry season. These values were below the target values, 0.80mg/kg (EGASPIN, 2018).

4.11.3 Organic Contaminant

Oil and grease

The concentration of oil and grease in the sediments is within the range of 1.3mg/kg to 1.9mg/kg in the dry season with a mean of 1.53 mg/kg. These values are within background concentrations of oil and grease values for sediments from coastal inland waters (ERML, 2010). These values are below regulatory limits (DPR/FMEnv, 100 ppm).

Total petroleum hydrocarbons

A summary of results of measured petroleum hydrocarbons detected in the sediment samples showed that the Total Aliphatic hydrocarbons were present in the sediment samples in trace amounts with values ranging from 0.013mg/kg to 0.015mg/kg in the dry season and from 0.007mg/kg to 0.009mg/kg while Polyaromatic Hydrocarbons were not detected. The TPH concentration in the sediment samples indicate inputs from petroleum sources but concentrations do not portend pollution of the marine sampled waters (ERML, 2010) as the TPH concentration for the water samples were lower in concentration

Table 4-23: Concentrations (mg/kg) of Organics in Sediment in the Study Area

PARAMETERS	Dry Season		
	Min	Max	Mean
Aliphatics	0.013	0.015	0.014
PAH	BDL	BDL	BDL
Total TPH (mg/kg)	0.013	0.015	0.014
Oil and Grease (mg/kg)	1.3	1.9	1.53

4.11.4 Sediment Microbiology

The heterotrophic bacteria dominated the wet and dry seasons; 1.99 x 10^2 CFU/g – 2.20 x 10^2 CFU/g (dry), 11.5 x 10^2 CFU/g – 17.4 x10^2 CFU/g (dry). compared to hydrocarbon utilizers; The reason for the high relative abundance and dominance of heterotrophic bacteria were due to low hydrocarbon contamination level and less competition.

Table 4-24: Sediment Microbiological Characteristics

PARAMETERS	Dry Season		
	Min	Max	Mean
HUB (CFU/kg x 10^2)	1.99	2.20	2.12
HUF (CFU/kg x 10^2)	2.56	3.85	3.39
THB (CFU/kg x 10^2)	190	670	430
THF (CFU/kg x 10^2)	4.40	5.30	4.80

4.12 Hydrobiology

4.12.1 Planktons

The word plankton according to Thurman (1977) was from the Greek word planktons meaning drifters. They usually refer to the large class of microscopic organisms (2 -200 micrometer) that are carried around by the water current in any natural body of water. Biologists have divided plankton into two (2) classes; phytoplankton and zooplankton. The phytoplankton is free-floating organisms of the water body that undergo photosynthesis with the help of chlorophyll and thereby contribute to primary production in their endemic aquatic environment. The zooplankton, on the other hand, is the animal component of the plankton spectrum.

Phytoplankton

Species Composition and Abundance

A checklist of the phytoplankton found within the project area of influence in the dry seasons is presented in Appendix 4-2. They include the Diatoms (Division-Bacillariophyta), Blue-green algae (Division- Cyanophyta), Euglenoids (Division - Euglenophyta) and Chlorophytes (Division - Chlorophyta). The dominant group of phytoplankton in find was Diatoms, followed by the Blue-green algae. The diatoms were the notable group among the phytoplankton identified in the water body. The changes or variation in species of phytoplankton from station to station recorded for this study were likely reflections of the variety of species available in the region and the variation of species from point to point.

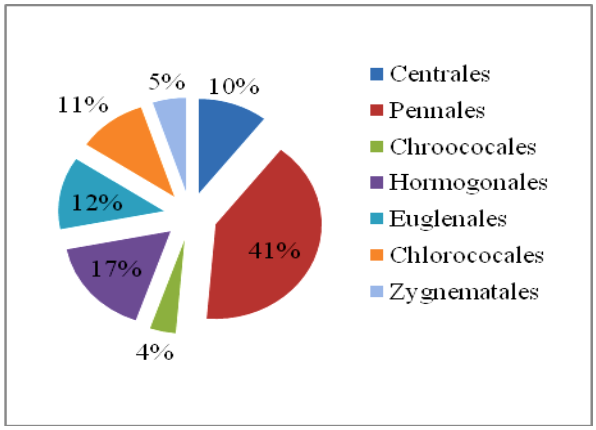


Figure 4-15: Abundance of Major Divisions of Phytoplankton in the Study Area for dry season

Distribution and Species Diversity

The spatial distribution of the phytoplankton in the various sampled stations in the lagoon showed that all the species were largely dispersed with 100% distribution during the wet and dry seasons. All these species were found in all the sampled locations. The detailed list showing the composition and percentage distribution can be found in the Appendix. Ecological indices of phytoplankton communities in the project area of influence show no changes in diversity in both seasons. Dominance, Shannon Index, and Margalef Index are common indices that measure diversity.

These indices indicated that in the project areas of influence had moderate diversity (<2.0 – low, 2.0 to 3.0 – moderate, and >3.0 – High). These are shown in Tables 4-25. Previous studies in the Ososa axis Rite Foods had reported a higher diversity of phytoplankton with Margalef index ranged from 3.20 to 3.96.

Table 4-25: Ecological Indices and Diversity of Phytoplankton in Wet and Dry Seasons in the Project Areas of Influence.

Indices	Dry season
Taxa S	21
Individual	904
Dominance	0.051
Shannon H	3.005
Evennesse e^H/S	0.9614
Simpson index	0.9488
Menhinick	0.6984
Margalef	2.938
Equitability	0.9871

Indices	Dry season
Fisher alpha	3.843
Berger-parker	0.0752

Zooplanktons

Species Composition and Abundance

The wet and dry season recorded two (2) phyla, three (3) classes, three (3) orders, and twelve (12) species and the dry season recorded two (2) phyla, three (3) classes, three (3) orders, and eight (8) species. In the season under studies the species belonging to crustacean order had Cyclopioda (24.0%) and Eucladocera (44.0%), while the rotiferan order, Ploima (32.0%). The checklist of the zooplankton presents within the project area of influence in the dry and wet seasons is presented in Appendix 4-2.

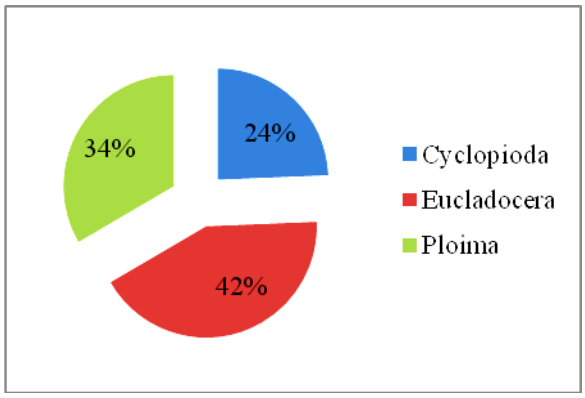


Figure 4-16: Abundance of Major Divisions of Phytoplankton in the Study Area for dry season

Species Distribution and Diversity

There was moderate diversity with low dominant species. The indices indicated for the project areas of influence had low diversity (<2.0 – low, 2.0 to 3.0 – moderate, and >3.0 – High). This was similar to previous studies carried out around the project area also reported low diversity with Margalef index ranged 1.98 to 2.34 and Shannon index ranged from 1.97 to 2.06. These are shown in Tables 4-26.

Table 4-26: Diversity Indices of Zooplanktons in the Project area of Influence

	Dry Season
Taxa_S	8
Individuals	425
Dominance_D	0.1276
Shannon_H	2.069
Simpson_1-D	0.8724
Evenness_e^H/S	0.9895
Menhinick	0.3881
Margalef	1.157
Equitability_J	0.9949
Fisher_alpha	1.399
Berger-Parker	0.1553

4.12.2 Bentho fauna

Species composition and Abundance

The wet and dry seasons recorded three (3) phyla, four (4) classes, and eight (8) species. The dominant groups in both seasons were the gastropods for dry (gastropoda, 48.0%, bivalve, 30.0%, insect, 18.0%, polychaeta, 4.0%) and wet (gastropoda, 61.0%, bivalve, 19.0%, insect, 15.0%, polychaeta, 5.0%) (Figure 4-19). The checklist of the benthic organisms found within the project area of influence in the Sagamu lagoon in the dry and wet seasons is presented in Appendix 4-2.

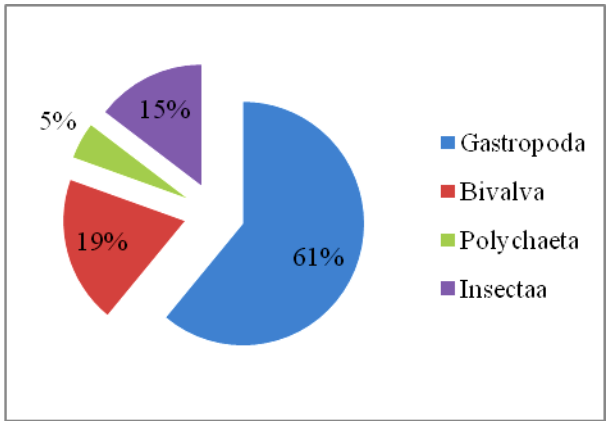


Figure 4-17: Abundance of Major Classes of Benthic Communities in the Study Area dry season

4.13 Vegetation

4.13.1 General

The vegetation on the Sagamu LDZ Ibefun project area forest is or flooded forests, which are inundated with freshwater either permanently in some part or seasonally in another part. The

vegetation is found in tropical climates and belongs to Afrotropic freshwater swamp forest. There is an enormous supply of freshwater from inland rivers and rainfall runoffs. The intricate network of creeks and lagoons results in inaccessible swamps of forest vegetation in some parts of the study area (Figure 4-21).

4.13.2 Floral Composition, Density and Distribution along the Pipeline ROW

The vegetation of the proposed TGNL 135km gas pipeline showed that eighty-one (81) species belonging to thirty-three (34) families (Table 4-29) were present. The family Poaceae contained nine (9) species, which was the highest among the families enumerated. This was followed by Cyperaceae and Euphorbiaceae, each with seven (7) species; while Asteraceae and Papilionoideae families had six (6) species each. Family Fabaceae contained five (5) species in the study site. The families, Araceae, Lamiaceae and Malvaceae contained three-member species each; while eight (8) other families: Onagraceae, Mimosoideae, Melastomaceae, Rubiaceae, Convolvulaceae, Caesalpinioideae, Curcubitaceae, and Combretaceae were enumerated to contain two species each. However, Arecaceae, Tiliaceae, Sterculiaceae, Verbenaceae, Phyllantaceae, Athyriaceae, Hippocrataceae, Thelypteridiaceae, Connaraceae, Bignoniaceae, Bromeliaceae, Loganiaceae, Nymphiaceae, Nyctaginaceae, Verbenaceae, Lemnaceae and Commelinacea families composed of only one species each (Table 4-29).

Relative Importance value (RIV) as shown in Table 4-29, demonstrated differences in the composition of the most dominant species across the pipeline ROW. It considers the relative density, frequency, relative basal areas of trees and shrubs in each section (A-E) along the pipeline ROW. The high relative importance value (RIV) rated for species above 3.5, indicates that these species are well represented in the stand in each of the sections along the pipeline ROW. This consideration is based on two combinations according to quantitative methods by Mueller Dombois and Ellenberg (1974); population size and density of relative species in the stand and the vegetative types and structure in each section along the pipeline route.

Among the eighty-one (81) species encountered, based on their prevalence in frequency and density of occurrence at each section (A-E) along the pipeline ROW, *Aspilia Africana* (family: Asteraceae) had the highest relative importance value (RIV) of 6.005 and closely followed by *Triumfetta cordifolia* (Family: Tiliaceae) and *Croton hirtus* (family: Euphorbiaceae) with RIVs of 5.862 and 5.451 respectively (Table 4-29). Other high ranked

species within (RIV > 3.5) encountered were *Cyclosorus striatus* (family: Thelypteridiaceae), *Ipomoea involucrata* (family: Convolvulaceae), *Calopogonium mucunoides* (Papilionoideae) and *Chromolaena odorata* (Asteraceae) with RIVs of 4.932, 4.298, 3.708 and 3.670 respectively.

There were intermediate ranked species with RIV > 3.5 < 2.0, such as *Walthera indica* (family: Sterculiaceae), *Ludwigia decurens* (family: Onagraceae), *Sporobolus pyramidalis* (family: Poaceae), *Hyptis suaveolens*(family: Lamiaceae) *and Digitaria horizontalis* (family: Poaceae), *Manihot esculentus* (family: Euphorbiaceae), *Alchornea cordiflora* (family: Euphorbiaceae), *Rhynchelytrum repens* (family: Poaceae), *Andropogun gayanus* (family: Poaceae), *Commelina diffusa* (family: Commelinaceae), with RIVs 3.333, 3.225, 2.825, 2.804, 2.672, 2.444, 2.383, 2.370, 2.264 and 2.009 respectively.

Many species belonged to the low- ranked category with the lowest value obtained at 0.169 for *Digitaria longiflora* (Poaceae), *Newbouldia laevis* (family: Bignoniaceae), *Combretum racemosum* (family: Combretaceae), *Indigofera hirsuta* (family: Papilionoideae) and *Euphorbia heterophylla* (family: Euphorbiaceae). Meanwhile, some arable crops were enumerated and were ranked among the lowest RIVs. These include *Ananas comosus* (family: Bromeliceae) and *Telfairia occidentalis* (family: Curcubitaceae) at 0.409 and 0.373 respectively (Table 4-29).

The prevalence of species like *Aspila africana* and other herbaceous species of agricultural and ruderal importance within the high and moderate RIV category, indicated that the sections A-E along the pipeline ROW had from slight to moderate disturbance at the time of the study, with minimal impact topsoil, as indicated by the very low relative importance values for agricultural crops enumerated, as well as the presence of members of the Convolvulaceae and Onagraceae families indicative of hydromorphic nature of pockets of places like water holes and wetlands along the corridor. All the plant species, identified in each of the sections (A-E) along the pipeline ROW are either not evaluated (NE) or of least concern (LC) in the International Union for Conservation of Nature (IUCN) red list as shown in Table 4-29 below.

Table 4-27: Species composition and Relative Importance Value (RIV) of the Herbaceous Flora of the Proposed 135km Gas pipeline at Sagamu LDZ Natural Gas Nigeria.

S/N	Species	Family	Type	IUCN Status	RIV	Station A	Station B	Station C	Station D	Station E
1	*Aspilia Africana*	Asteraceae	Herb	Not Evaluated	6.005	Present	Present	Present	Present	Present
2	*Triumfetta cordifolia*	Tiliaceae	Herb	Not Evaluated	5.862	Present	Present	Present	Present	
3	*Croton hirtus*	Euphorbiaceae	Herb	Not Evaluated	5.451		Present		Present	
4	*Cyclosorus striatus*	Thelypteridiaceae	Herb	Not Evaluated	4.932		Present		Present	
5	*Ipomoea involucrata*	Convolvulaceae	Herb	Not Evaluated	4.298		Present	Present	Present	Present
6	*Calopogonium mucunoides*	Papilionoideae	Herb	Not Evaluated	3.708	Present	Present		Present	
7	*Chromolaena odorata*	Asteraceae	Herb	Not Evaluated	3.670	Present		Present	Present	
8	*Walthera indica*	Sterculiaceae	Herb	Not Evaluated	3.333	Present			Present	Present
9	*Ludwigia decurens*	Onagraceae	Herb	Not Evaluated	3.225	Present	Present			Present
10	*Sporobolus pyramidalis*	Poaceae	Grass	Not Evaluated	2.829	Present			Present	Present
11	*Hyptis suaveolens*	Lamiaceae	Herb	Not Evaluated	2.804		Present		Present	
12	*Digitaria horizontalis*	Poaceae	Grass	Not Evaluated	2.672				Present	
13	*Manihot esculentus*	Euphorbiaceae	Agro-plant	Not Evaluated	2.444	Present		Present		Present

S/N	Species	Family	Type	IUCN Status	RIV	Station A	Station B	Station C	Station D	Station E
14	*Alchornea cordiflora*	Euphorbiaceae	Tree	Not Evaluated	2.383		Present	Present		Present
15	*Rhynchelytrum repens*	Poaceae	Grass	Not Evaluated	2.370	Present			Present	
16	*Andropogun gayanus*	Poaceae	Grass	Not Evaluated	2.264	Present	Present		Present	
17	*Commelina diffusa*	Commelinaceae	Climbers	Not Evaluated	2.009	Present	Present		Present	
18	*Alchorne laxiflora*	Euphorbiaceae	Tree	Not Evaluated	1.780		Present		Present	
19	*Platostoma africanum*	Lamiaceae	Herb	Not Evaluated	1.756	Present		Present		
20	*Stachtarpheta cayennensi*	Verbenaceae	Herb	Not Evaluated	1.661	Present				Present
21	*Phyllantus niuri*	Phyllantaceae	Herb	Not Evaluated	1.649			Present		Present
22	*Diplazium samatti*	Athyriaceae	Shrub	Not Evaluated	1.589		Present		Present	
23	*Scleria naumanniana*	Cyperaceae	Grass	Not Evaluated	1.492	Present				Present
24	*Reissantia indica*	Hippocrateaceae	Shrub	Not Evaluated	1.433		Present		Present	
25	*Stylosanthes guianensis*	Fabaceae	Grass	Not Evaluated	1.481		Present		Present	
26	*Sida acuta*	Malvaceae	Herb	Not Evaluated	1.300	Present		Present		
27	*Cyperus rotundus*	Cyperacee	Grass	Not Evaluated	1.239	Present		Present		
28	*Panicum maximum*	Poaceae	Grass	Not	1.168	Present	Present		Present	

S/N	Species	Family	Type	IUCN Status	RIV	Station A	Station B	Station C	Station D	Station E
				Evaluated						
29	*Panicum laxum*	Poaceae	Grass	Not Evaluated	1.119		Present	Present	Present	
30	*Mimosa pudica*	Mimosoideae	Herb	Not Evaluated	1.035				Present	Present
31	*Cnetis ferruiginea*	Connaraceae	Tree	Not Evaluated	0.999		Present		Present	
32	*Urena lobata*	Malvaceae	Herb	Not Evaluated	0.855			Present	Present	
33	*Herotis rotundifolia*	Melastomaceae	Shrub	Not Evaluated	0.855		Present	Present		
34	*Centrosema pubescens*	Papilionoideae	Herb	Not Evaluated	0.855	Present				Present
35	*Fimbrystylis littoralis*	Cyperceae	Grass	Not Evaluated	0.769	Present			Present	
36	*Solenostemom monostachyus*	Lamiaceae	Herb	Not Evaluated	0.758			Present		Present
37	*Mariscus alternifolius*	Cyperaceae	Grass	Not Evaluated	0.758	Present	Present		Present	
38	*Albizia zygia*	Mimosoideae	Tree	Least Concern	0.747		Present	Present	Present	
39	*Raphia hookeri*	Araceae	Tree		0.650		Present		Present	
40	*Spermacocoe verticilata*	Rubiaceae	Herb	Not Evaluated	0.650	Present		Present		
41	*Fureina ciliaris*	Cyperaceae	Grass	Not Evaluated	0.650	Present	Present			
42	*Ludwigia octovalvis*	Onagraceae	Macrophyte	Not Evaluated	0.626		Present			
43	*Combretum hispidum*	Combretaceae	Shrub	Not	0.614		Present	Present		

S/ N	Species	Family	Type	IUCN Status	RIV	Station A	Station B	Station C	Station D	Station E
				Evaluated						
44	*Melastomastrum capitatum*	Melastomaceae	Herb	Not Evaluated	0.554					Present
45	*Elaeis guineensis*	Arecaceae	Tree	Least Concern	0.518		Present		Present	
46	*Senna occidentalis*	Caesalpinioidea e	Tree	Not Evaluated	0.518		Present	Present	Present	
47	*Crotolaria retusa*	Papilionoideae	Herb	Not Evaluated	0.482					
48	*Mariscus alternifolius*	Cyperaceae	Grass	Not Evaluated	0.482		Present	Present		
49	*Pennisetum polystachion*	Poaceae	Grass	Not Evaluated	0.482	Present				Present
50	*Desmodium salicifolium*	Fabaceae	Herb	Least Concern	0.445		Present			Present
51	*Sida gaeckerna*	Malvaceae	Herb	Not Evaluated	0.445		Present			Present
52	*Alysicarpus vaginalis*	Papilionoideae	Creepers	Not Evaluated	0.445	Present		Present		
53	*Oplismenus burmani*	Poaceae	Grass	Not Evaluated	0.421	Present			Present	
54	*Ananas comosus*	Bromeliaceae	Agro-plant	Not Evaluated	0.409	Present			Present	Present
55	*Vernonia cinerea*	Asteraceae	Herb	Not Evaluated	0.409			Present		Present
56	*Cyrtosperma senegalensis*	Araceae	Shrub/Ma crophyte	Not Evaluated	0.409		Present			
57	*Diodia samentosa*	Rubiaceae	Creepers	Not Evaluated	0.373	Present	Present			

S/N	Species	Family	Type	IUCN Status	RIV	Station A	Station B	Station C	Station D	Station E
58	*Telfairia occidentalis*	Cucurbitaceae	Agro-plant	Not Evaluated	0.373	Present		Present		
59	*Puereria phaseoloides*	Fabaceae	Climbers	Not Evaluated	0.349		Present			
60	*Desmodium scorpiurus*	Papilionoideae	Creepers	Not Evaluated	0.337		Present			
61	*Indigofera spicata*	Fabaceae	Climbers	Not Evaluated	0.277				Present	
62	*Ricinus communis*	Euphorbiaceae	Shrub	Not Evaluated	0.277		Present			
63	*Fimbrystylis ferruginea*	Euphorbiaceae	Shrub	Not Evaluated	0.240			Present		
64	*Luffa cylindrical*	Cucurbitaceae	Agro-plant	Not Evaluated	0.241	Present				
65	*Spigelia anthelmia*	Loganiaceae	Herb	Not Evaluated	0.241				Present	
66	*Basella alba*	Asteraceae	Herb	Not Evaluated	0.240	Present				
67	*Nymphea lotus*	Nymphaceae	Macrophyte	Not Evaluated	0.205		Present			
68	*Emilia praetermissia*	Asteraceae	Herb	Not Evaluated	0.205				Present	
69	*Tridax procumbens*	Asteraceae	Herb	Not Evaluated	0.205			Present		
70	*Acalypha segetalis*	Euphorbiaceae	Shrub	Not Evaluated	0.205		Present			
71	*Boerhivia difusa*	Nyctaginaceae	Shrub	Not Evaluated	0.205			Present		
72	*Rhyncospora*	Cyperaceae	Grass	Not	0.205	Present				

S/N	Species	Family	Type	IUCN Status	RIV	Station A	Station B	Station C	Station D	Station E
	corymbosa			Evaluated						
73	*Vigna unguiculata*	Fabaceae	Climbers	Not Evaluated	0.204					Present
74	*Digitaria longiflora*	Poaceae	Grass	Not Evaluated	0.169		Present			
75	*Newbouldia laevis*	Bignoniaceae	Herb	Not Evaluated	0.169					Present
76	*Combretum racemosum*	Combretaceae	Shrub	Not Evaluated	0.169		Present		Present	
77	*Indigofera hirta*	Papilionoideae	Creepers	Not Evaluated	0.169		Present		Present	
78	*Euphorbia heterophylla*	Euphorbiaceae	Shrub	Not Evaluated	0.169		Present		Present	
79	*Ipomea erecta*	Convolvulaceae	Macrophytes	Not Evaluated	0.146		Present		Present	
80	*Pistia stratiotes*	Araceae	Macrophytes	Least Concern	0.146		Present		Present	
81	*Lemna sp*	Lemnaceae	Macrophytes	Not Evaluated	0.146		Present		Present	

RIV > 3.5		RIV < 3.5 > 2.0		RIV < 2.0	

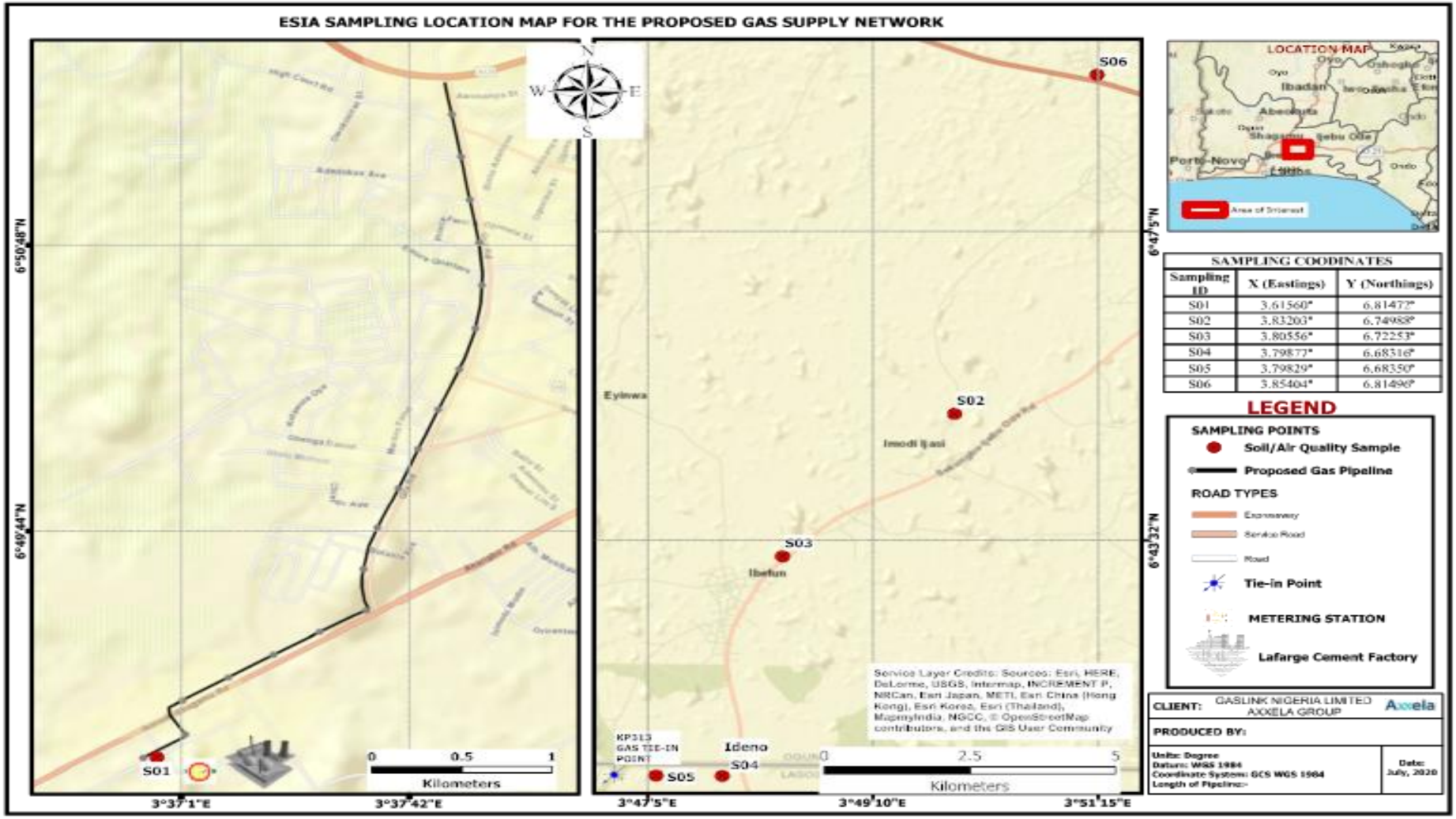


Figure 4-18: Land Use and Vegetation Distribution along the 135km gas pipeline ROW

4.13.3 Habitat Description of the Sections A-E along the Pipeline route

The vegetation of the sections along the pipeline ROW varies from slightly dense to moderate dense freshwater swamp forest. Section A is a modified habitat with herbs and grasses and few shrubs with sandy loam soil type (Plate 4-8). It has some herbs of high important values such as *Aspillia africana, Trumfetta cordifolia, Calopogonium mucunoidea, Chromaleana odorata, Walthera indica,* and *Ludwiga decurens*. Economic crops found in this section include; root crops, *Manihot esculentus;* fruit crops, *Ananas comosus;* and vegetable crops, *Telfairia occidentalis, Luffa cylindrical.* These crops indicate the level of habitat modification.

Communities around pipeline route include Majoda, Igbodu, and Shala. The human activities in this area include farming and lumbering. These activities have in varying degrees, led to a reduction in biodiversity in much of the natural habitat transformed to a modified habitat along the pipeline ROW (Figure 4-22). Conservation of such impacted areas requires an understanding of the composition and structure of the particular modified habitat, the effects of past disturbances, and the present impact of neighboring land use on such habitat. Presence of farmlands in section A also indicates the level of conservation in spite of the human impact.

Plate 4-2: Section A of the Sagamu LDZ 135km gas pipeline route showing a modified habitat with herbs and grasses and few shrubs with sandy loam soil type.

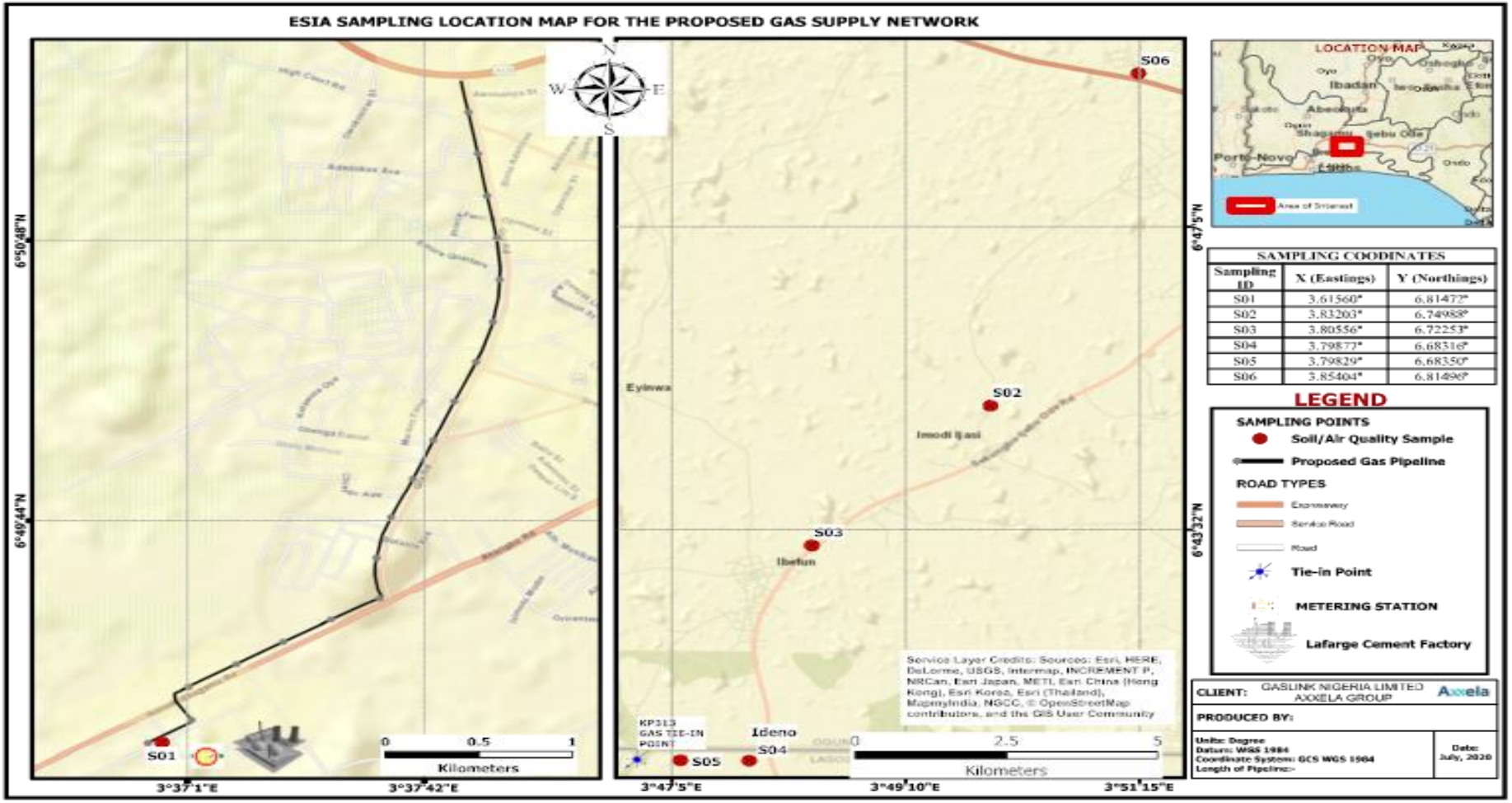


Figure 4-19: Habitat Type, Land Use and Human Activities along the Sections of pipeline ROW

Conservation Concern on Forest Resources

The International Union for the Conservation of Nature and Natural Reserve (IUCN) evaluates the endangerment of taxa (regardless of trade), placing species of concern into three categories on its so-called Red List, starting with the most imperiled: Not assessed (NA), least concern (LC), near threaten (NT), critically endangered (CR), endangered (EN), and vulnerable (VU). All the plant species, identified along the TGNL 135km gas from Ibefun-Ososa Ogun in the project area of influence are either not assessed (NA) or of least concern (LC). The previous study at the Ososa Ogun axis of the project area had reported more plant species and also had reported *Albizia ferruginea* and *Lophira alata*, categorizing these species as Vulnerable (VU). These are represented in Tables 4-30, 4-31, and 4-32.

Table 4-28 IUCN Status and Relative Occurrence of Tree Species in the Study Area Based on 'DAFOR' Scale.

S/N	*Species*	Frequency	Status of occurrence	IUCN STATUS/Redlist
1	*Alstonia boonei*	28	Frequent	Not Assessed
2	*Alstonia congensis*	1	Rare	Not Assessed
3	*Alchornia cordifolia*	11	Frequent	Not Assessed
4	*Anthocleistha djalonensis*	12	Frequent	Not Assessed
5	*Anthocleistha nobilis*	4	Occasional	Not Assessed
6	*Albizia zygia*	3	Occasional	Not Assessed
7	*Albizia ferruginea VU*	9	Frequent	Vulnerable
8	*Bambusa vulgaris*	1	Rare	Not Assessed
9	*Baphia nitida LC*	1	Rare	Least Concern
10	*Carpolobia lutea*	3	Occasional	Not Assessed
11	*Cassia nodosa*	2	Rare	Not Assessed
12	*Celtis zenkeri*	5	Frequent	Not Assessed
13	*Elaeis guineensis LC*	8	Frequent	Least Concern
14	*Fagara microphylla*	2	Rare	Not Assessed
15	*Harungana madagascariensis*	16	Frequent	Not Assessed
16	*Lophira alata VU*	3	Occasional	Vulnerable
17	*Marcarangabarteri*	8	Frequent	Not Assessed
18	*Mitragyna stipulosa*	7	Frequent	Not Assessed
19	*Mitragyna ciliate*	8	Frequent	Not Assessed
20	*Mussangacecropoides*	1	Rare	Not Assessed
21	*Phyllanthus discoideus*	11	Frequent	Not Assessed
22	*picralimanitida*	3	Occasional	Not Assessed

S/N	*Species*	Frequency	Status of occurrence	IUCN STATUS/Redlist
23	*Rauvolfia vomitoria*	10	Frequent	Not Assessed
24	*Raphia farinifera*	2	Frequent	Not Assessed
25	*Rothmannia megalostigma*	3	Occasional	Not Assessed
26	*Sterculia tragacanth*	1	Rare	Not Assessed
27	*Stombosia postulate*	1	Rare	Not Assessed
28	*Trema Orientalis*	16	Frequent	Not Assessed
29	*Uapaca togoensis*	1	Rare	Not Assessed
	Total	**181**		

Frequent *– Commonly encountered species*

Occasional *– Species with a low frequency of occurrence*

Rare *– Species found only once or very few times.*

4.13.4 Plant Pathology

The plants encountered in the sections along the pipeline ROW are generally healthy except for pockets of pathological problems like chlorosis (mealybug wilt) and black rot on *Ananas comosus* caused by mealybugs (insects) and fungi respectively; seedling blight on *Raphia hookeri* caused by *Glomerella cingulata*; and pod rots on *Telfaira occidentalis* caused by *Rhizopus stolonifer*. Few of the common virus and bacteria diseases were also observed in the agricultural fields and they include cassava mosaic caused by virus and bacteria strip on maize caused by *Pseudomonas sp* (Table 4-33). It is important to note that the plant communities in the study area are generally in a normal state of health. The disease severity indices revealed that the few diseases encountered in agricultural fields were of very light infections. There was no evidence of endemic vegetation problems. It is pertinent to remark that none of the diseases encountered was unusual either in nature or severity. The few diseases observed are common and are comparable in nature and intensity to those on plant species in similar ecotypes in Nigeria.

Table 4-29: Pathology Status of Plant Species in the Study Area

Plant species	Disease symptom	Causative organisms
Zea mays	bacterial stripe	*Pseudomonas andropogonii*
Manihot esculanta	Cassava mosaic	Virus
Telfairia occidentalis	Pod rots	*Rhizopus stolonifer*
Zea mays	Stem borer	Weevils
Raphia Hookeri	Seedling blight	*Glomerella cingulata*

Ananas comosus	Mealybug wilt	Mealbybug insects
Ananas comosus	Black rot	Fungi

4.14 Wildlife

Thirty-three species of animals, belonging to families were observed along the sections of the pipeline ROW. These are composed of six classes; arthropoda, mollusca, amphibian, reptilia, aves, and mammalia. These include; nine species of arthropods, one species of molluscs, two species each of amphibians and reptiles, twelve species of birds and seven species of mammals. Some of those spotted at the project area are presented in Plates 4-17 to Plate 4-22.

Arthropods

The species of arthropods encountered in the sections along the pipeline ROW include *Colias electo, Danaus plexippus, Macrotermes sp, Palpaleura lucialucia, Mantis religiosa, Zonocerus varigatus, Anopheles sp, Simullum sp, and Glossina sp*.

Insects population is the key to the ecological balance of any ecosystem particularly the trophic levels. In particular, they forage on terrestrial and aquatic weeds while they also serve as food (prey) for other carnivorous invertebrates and vertebrates including birds. In a study conducted in the rainforests of Nigeria, insects in the order Orthoptera, Coleopteran, Odonata, Hemiptera, and Lepidoptera were isolated from three spec imens of chameleons (Akani et al, 2001). Others such as mosquitoes, tsetse flies, and black flies constitute health hazards by spreading diseases among the forest-dwelling communities.

Amphibians

The amphibian groups are represented by *Bufo bufo* (Toad) and *Rana sp* (Frog). The Amphibians are the dominant group of aquatic vertebrates other than fish in terms of their numbers and distribution, particularly the frog and toads in section 2 along the pipeline ROW. The *Rana sp* (frog) are edible in Nigeria and are harvested as wild bushmeat from ponds and waterlogged areas in both rural and urban centers. Dried, skinned meat of frogs and fresh frogs have been found useful in the feeding of catfish and poultry either as raw materials for processed feed or whole as food for catfish. In Nigeria, it is a common practice for fish farmers to supplement the feeding of *Clarias sp, and Heterobranchus bidorsalis* in pond culture by feeding them frogs and toads.

Reptiles

The reptiles associated with the study area include *Agama agama* (Lizard) and *Crocodylus niloticus* (Nile crocodile). Crocodiles were the first group and spend most of their time in the

water, the tortoises, monitor lizards, and snakes spend a greater part of their time on land near water. They all, however, contribute to the biological function of the aquatic community. Crocodiles feed on fish, frogs, and toads that inhabit water bodies. Active predation among this group of animals, therefore, contributes to the stabilization of the animal communities. Crocodiles are hunted extensively, even to the point of extinction, for their meat and skins which are important foreign exchange earners. The high demand for crocodile skins, meat and body parts for traditional medicine certainly have contributed to the noticeable decline in their populations in Nigeria. Around the late 1960s, most large bodies of water in Nigeria harbored crocodiles, but now both crocodiles are listed as threatened species in Nigeria (Ebin, 1983, Anon,1986).

Birds

Birds are one of the best known faunal group in the world (Tvardikova, 2010). They are ecologically highly diverse and inhabit a wide range of habitats. They are frequently used taxa to indicate the effects of environmental changes (Carignan et al, 2002). Several birds were encountered in the sections (A-E) along the pipeline ROW. They include *Pycnonotus barbatus, Cecropis domicella, Egretta intermedia, Buteo jamaicensis, Zenaida macroura, Cossypha niveicapilla, Spilopelia senegalensis, Corvus albus, Actitis hypoleucos, Ploceus cuculatus, Spermestes cuculatus,* and *Gallus gallus.*

The presence of feathers in birds has distinguished the class and with the advantage of high mobility and their extraordinary hardness made them be described as earth's ambassadors as they do not recognize human boundary except those set by nature (Matthews, 2008). While in many countries, aquatic birds are hunted for sport, in Nigeria they are predominantly regarded as a source of meat (Ajayi, 1971). Waterfowl and other large birds such as Goliath heron and fish eagles are hunted around River Niger and Lake Kainji (Okaema et al; 1988). The Sagamu freshwater swamps forest where the study was conducted is an important habitat for birds for drinking, feeding, resting, sheltering, nesting, rearing of young, foraging and social interaction.

Mammals

Wildlife is important to the national economy both as a source of meat and as a basis for tourism and recreation. Wild animal meat is the main source of cheap protein in the majority of rural communities in Nigeria. Over 80% of the populations are rural dwellers who depend on bush meat, compared with urban dwellers that depend on ruminant meat (Ajayi, 1971).

Many species of animals in the mammalian category sighted at the sections along the pipeline ROW include; *Capra aegagrus hircus* (goat), *Boa taurus* (cattle), *Cercopithecus mona* (Mona monkey), *Phataginus tricuspis* (White-bellied Pangolin), *Epixerus sp* (Tree squirrels), *Xerus erythropus* (Ground squirrels) and *Cercophitecus nictitans* (Putty nose monkey). These animals were reported in previous studies around the project area.

Plate 4-3: An African weaver bird (arrowed) and nests on a cashew tree and on degraded Raphia palm at a section of pipeline ROW.

Plate 4-4: Intermediate egrets along the pipeline right of way

Plate 4-5: Agama lizard found on a development site and domestic fowl on farmland pipeline ROW.

Plate 4-6: A Termitarium located at African giant snail collected for sale some section of the pipeline ROW.

Plate 4-7: *Phataginus tricuspis* (Pangolin) rescued and freshly hunted Nile crocodile and Mona monkey of the pipeline ROW.

4.14.1 Species and Habitats of Conservation Concern

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which deals only with organisms involved in international trade, lists species of concern into three categories, Appendices I through III, with Appendix I species being the most imperiled by trade. The International Union for the Conservation of Nature and Natural Res

erve (IUCN; presently known as, (the World Conservation Union) evaluates the endangerment of taxa (regardless of trade), placing species of concern into three categories on its Red List, starting with the most imperiled: critically endangered (CR), endangered (EN), and vulnerable (VU). The Nigerian version of CITES, Endangered Species (Control of International Trade and Traffic) Decree No. 11 of 1985, also has two schedules. Hunting, the

capture of, or trade of those species listed in Schedule I is absolutely prohibited. Tables 4-34 and 4-35 list the species observed in the various sections along the TGNL 135km gas pipeline route and their conservation status under IUCN and CITES. Based on the IUCN Red list, only *Phataginus tricuspis* is classified vulnerable, other observed animal species are either classified as Least Concerned (LC) or not evaluated (NE) on the Red List (Plate 4-22).

Table 4-30: Animal Species composition and Abundance along the Proposed TGNL 135 km Gas pipeline at Ibefun - Ososa Ogun State, Nigeria

S/N	Common Name	Scientific name	Family	Mode of Detection	IUCN status
Arthropoda					
1	Clouded yellow butterfly	*Colias electo*	Pieridae	Sighted	LC
2	Monarch butterfly	*Danaus plexippus*	Nymphalidae	Sighted	NE
3	Mound building Termites	*Macrotermes sp*	Termitidae	Termitaria	NE
4	Dragonfly	*Palpoleura lucialucia*	Libelulidae	Sighted	LC
5	Grasshopper	*Zonocerus variegatus*	Pyrgomorphidae	Sighted	LC
6	Praying mantis	*Mantis religiosa*	Mantolidea	Sighted	NE
7	Mosquito	*Anopheles sp*	Culicidea	Sighted	NE
8	Blackfly	*Simullum sp*	Simuliidea	Sighted	NE
9	Tse-tsefly	*Glossina sp*	Glossinidea	Sighted	NE
Mollusca					
10	African Giant Snail	*Achatina fulica*	Achatinidae	Sighted	LC
Amphibian					
11	Toad	*Bufo bufo*	Bufonidea	Vocalization	LC
12	Puddle frog	*Rana sp*	Ranidea	Vocalization	LC
Reptilia					
13	Agama Lizard	*Agama agama*	Agamidae	Sighted	LC
14	Nile Crocodile	*Crocodylus niloticus*	Crocodylidae	Sighted	LC
Birds					
15	Common Bulbul	*Pycnonotus barbatus*	Pycnonotidae	Testimony	LC
16	Swallow	*Cecropis domicella*	Hirundinidae	Sighted	LC

S/N	Common Name	Scientific name	Family	Mode of Detection	IUCN status
17	Intermediate egret	*Egretta intermedia H*	Ardeidae	Sighted	LC
18	Hawk	*Buteo jamaicensis W*	accipitridae	Sighted	LC
19	Mourning Dove	*Zenaida macroura L*	Columbidae	Sighted	LC
20	Laughing Dove	*Spilopelia senegalensis*	Columbidae	Sighted	LC
21	Snowy-crowned Robin-chat	*Cossypha niveicapilla*	Muscicapidae	Testimony	LC
22	Pied crew	*Corvus albus*	Corvidae	Sighted	LC
23	Common sandpiper	*Actitis hypoleucos*	Scolopacidae	Sighted	LC
24	Village weaver bird	*Ploceus cuculatus*	Plocidae	Sighted	LC
25	Bronze manikin	*Spermestes cucullata*	Estrildidae	Sighted	LC
26	Domestic fowl	*Gallus gallus L*	Phasianidae	Sighted	D
Mammals					
27	Nigerian Dwarf Goat	*Capra aegrus hircus*	Bovidae	Sighted	NE
28	Cattle	*Bos Taurus*	Bovidae	Sighted	D
29	Mona monkey	*Cercopithecus mona*	Cercopithecidae	Sighted	LC
30	Pangolin	*Phataginus tricuspis*	Manidae	Sighted/Rescued	VU
31	Tree squirrels	*Epixerus sp*	Sciuridae	Testimony	NE
32	Ground squirrels	*Xerus erythropus*	Sciuridae	Testimony	LC
33	Putty nose monkey	*Cercophitecus nictitans*	Cercopithecidae	Sighted	NE

Absent; + Present; ++ Common; +++ Abundant; D = Domesticated; NE = Not Evaluated; LC = Least concern; NT = Near Threaten; VU = vulnerable;

EN = Endangered; CR = Critically Endangered; EW = Extinct in the Wiild.

Table 4-31: Habitat Characteristics and Categories along 135km TGNL Pipeline Route based on IFC and IUCN Definitions

Section	Coordinates	Habitat Category	Habitat Characteristics	Endangered Status
Section A		Modified Habitat	• Modified habitat with low natural habitat • Grasses, herbs and few shrubs and trees • Wild birds and mammals • Sandy loam soil type • Deforestation • Hunting/Poaching Activities • Land Farmlands	Based on the IUCN Red list Observed Animals are classified as Least Concerned (LC) and others not evaluated (NE) on the Red List.
Section B		Natural Habitat	• Natural habitat • Freshwater mangrove swamp forest with a significant diversity of flora and fauna. • Grasses, Herbs, Shrubs, and Trees • Birds, mammals, reptiles, and amphibians • Slit loam soil type • Swampy/wetland • Lagoon crossing, Ejirin with macrophytes. • Fishing activities • Hunting/Poaching • Deforestation	Based on the IUCN Red list Observed Animals except *Phataginus tricuspis* are classified as Least Concerned (LC) and others not evaluated (NE) on the Red List. *Phataginus tricuspis* (VU) sighted was rescued and kept at the conservation center, University of Lagos.
Section C		Modified Habitat	• Modified habitat • Freshwater mangrove forest • Grasses, Herbs, with few shrubs and trees	Based on the IUCN Red list Observed bird species are classified as Least Concerned (LC) and others not evaluated (NE) on the Red List.

Section	Coordinates	Habitat Category	Habitat Characteristics	Endangered Status
			• Bird species • Sandy loam soil type • Dredging Activities • Housing development • Poultry and Aquaculture	
Section D		Natural Habitat	• Natural habitat • Freshwater mangrove swamp forest with a significant diversity of flora and fauna. • Grasses, Herbs, Shrubs, and Trees • Birds, mammals, reptiles, and amphibians • Slit loam soil type • Swampy/wetland • Hunting/Poaching	Based on the IUCN Red list Observed Animals except *Phataginus tricuspis* are classified as Least Concerned (LC) and others not evaluated (NE) on the Red List.
Section E		Modified Habitat	• Rite FoodsFacility • Highly modified habitat • Grasses, Herbs, Shrubs with few trees • Trend between sandy loam and loamy sand soil type. • Species of birds and mammals • Deforestation • Housing development • Sand dredging	Based on the IUCN Red list Observed Animals are classified as Least Concerned (LC) and others not evaluated (NE) on the Red List.

CHAPTER FIVE

SOCIO-ECONOMIC IMPACT ASSESSMENT

5.1 Introduction

It is suffice to mention that socioeconomic study is a sub-field of the social science that is developing a knowledge base to provide a systemic appraisal in advance of the probable impacts on the day-to-day quality of life of the households and communities whose environment may be impacted by a proposed project. Such day-to-day activities of the people will include the way they live, work, play, relate to one another, organize to meet their needs and generally cope as members of a common society bonded with interwoven social interactions.

Socioeconomic, therefore, is done as part of the planning process to identify the likelihood of social impacts particular project proposals and such impacts needed to be identified and measured in order to be understood and communicated to decision-makers and other stakeholders including the community residents. Indeed, social impact assessment provides a realistic appraisal of possible social infractions to the livelihood of the people and suggestions for project alternatives and possible mitigation measures to address the negative narratives of a proposed human developments.

This report therefore gives a summary and synthesis of the social impact assessment survey of the LDZ natural gas pipeline network construction project of Transit Gas Nigeria Limited.

5.2 Overview of the Study Area

The study area is majorly located in Ogun state but takes off from the City Gate at Ibefun KP 312 of the Escravos Lagos Pipeline system located in Ikosi-Ejinrin Local Council Development Area of Lagos state. Ogun state which is the epicenter of the entire project was created on the 3rd of February 1976 and bordered in the east by Ondo state and in the north by Oyo and Osun states. In the south it is bordered by Lagos and Atlantic ocean and in the west by Republic of Benin. Ogun state takes its name from the popular Ogun river and was carved out of the old Western state of Nigeria. Indeed, the project is specifically

covered from Obafemi-owode Local Government to Sgamu, Odogbolu, Ijebu-ode, Ijebu-east areas of Ogun state and Ikosi-ejinrin LCDA where it terminates.

The local government areas are inhabited by the Yoruba race of Egba, Remo and Ijebu lineage. There are however, other settlers like the Igbos, Hausas, including ethnic nationality from the Niger Delta. The states accommodate other foreign citizens from Republic of Benin who contribute to the annual food basket.

Traditionally, the local government areas are governed by prominent Obas namely: the Oniro of Iro, Akarigbo of Remo and the arc Oba, Oba Sikiru Adetona of Ijebu-Ode. The institution of rulership and leadership is designed in such a way that these Obas are assisted by numerous Baales (village heads) who are closer and interact more often with the community residents at the village level.

In terms of infrastructure, the project area has many intra and inter-city roads including the Siu-Owode-Ofada-Mowe road; Siu-Iperu-Ilisan road; Owode-Obafemi road, Ikorodu-Ijebu-ode road (which is in a very bad state during the conduct of the exercise) and some federal roads like the popular Lagos-Ibadan expressway, the Abeokuta-Sagamu dual carriage way (undergoing repairs) and Sagamu-Papalanto road (equally in a bad sate) as well as the Sagamu-Benin expressway. Many of her communities are connected to the national grid.

Education wise, there are many public and private institutions of learning spanning from elementary to tertiary. Prominent varsities in the project area include privately-owned ones like Babcock University (established by the Seventh Day Adventist Church) in Ilisan, and a public varsity, Tai Solarin University of Education, in Ijebu-ode.

Economically, prominent activities in the local governments include farming, quarry business, handcrafts such as dye making and pottery. The Omo wood forest project located in Ijebu-east is a key economic value for Ogun state as well as the rubber plantation in Ikene and the arrays of industries in the state. Indeed, the occupation of the

people spans from farming, hunting, trading, artisanship and civil service. With its proximity to Lagos and product take-off, the project study area is an emerging urban settlement with quite a number of functioning industries providing significant employment opportunity for the youths.

5.2.1 Socio-economic Study Scope of Work

Socioeconomic study report is expected to cover the under mentioned scope of work among others:

- The economic base which is the means of the inhabitant livelihood
- The income distribution of the people
- The settlement and housing structure
- The demographics of the study area
- The historical/archeological sites if available
- The social organizations and social problems
- The state of infrastructure on ground
- The concerns and needs of the people
- Mitigations to counter adverse effect of the project

5.2.2 Identification of Project Affected Communities

The pipeline project affected communities includes all settlements and habitations that situate directly on either side and along the pipeline's route (ROW). Twenty-six (26) communities were identified as potential project-affected communities (PACs). The PACs are as listed in Table 1 below.

It is worth to note that not all the impacted communities were surveyed for reasons bothering on security, community-overlap cases and inaccessibility. However, thirteen communities were surveyed as indicated in the table.

Table 5.1: Project-impacted Communities

S/N	Community	LGA	State	Remarks
1.	Sagamu	Sagamu	Ogun	Surveyed
2.	Ikene	Ikene	-do-	-do-
3.	Ilisan	Ikene	-do-	-do-
4.	Odogbolu	Odogbolu	-do-	-do-
5	Ososa	Odogbolu	-do-	-do-
6	Ijebu-ode	Ijebu-ode	-do-	Not Surveyed
7	Itele	Ijebu-east	-do-	Not Surveyed
8	Ogbere	Ijebu-east	-do-	Not Surveyed
9	J4	Ijebu-east	-do-	Not Surveyed
10	Ibefun	Odogbolu	-do-	-do-
11	Ilado	Odogbolu	-do-	-do-
12	Imaguwen	Odogbolu	-do-	Not Surveyed
13	Odo Agin	Odogbolu	-do-	Not Surveyed
14	Odo Raguwa	Odogbolu	-do-	Not Surveyed
15	Imodi Ijasi	Odogbolu	-do-	-do-
16	Kajola	Obafemi Owode	-do-	-do-
17	Bara	Obafemi Owode	-do-	-do-
18	Lagbara	Obafemi Owode	-do-	-do-
19	Onile Imo	Obafemi Owode	-do-	-do-
20	Idofin	Obafemi Owode	-do-	Not Surveyed
21	Ajetutu	Obafemi Owode	-do-	Not Surveyed
22	Jibowu	Obafemi Owode	-do-	Not Surveyed
23	Onibata	Obafemi Owode	-do-	Not Surveyed
24	Siun	Obafemi Owode	-do-	-do-
25	Iyana Ashipa	Obafemi Owode	-do-	Not Surveyed
26	Kobape	Obafemi Owode	-do-	Not Surveyed

5.2.3 Methodology

This socioeconomic survey of the LDZ pipeline focused much more on understanding and analyzing what people in communities along the pipeline route really think about the potential impacts of the project. These are the households who, more than any other parts of the community, will be impacted by the development.

As is conventional in most socioeconomic surveys, this report gathered community baseline information and initiated a process of dialogue with stakeholders that is

encouraged and recommended to be continued during the construction phase of the project and afterwards.

Conventionally, an effective socio-economic baseline data collection will involve the use of multi-techniques and methods varying from the use of interview schedules, questionnaire administration via simple random method, Focus Group Discussion (FGD) and Key Informant Interviews (KIIs). This approach has yielded better results when appropriately utilized.

Detailed socioeconomic study lasted between March 24th and July 11th 2020. The survey exercise took extended weeks owing to the lockdowns necessitated by COVID-19 saga that prevented interstate travels between Ogun and Lagos states. A number of indigent residents familiar with the terrain of the project area facilitated the data gathering exercise. Indeed, there was very good cooperation and participation of households in the communities.

It is also important to observe that owing to the campaign of social distancing championed by W.H.O and other health institutions as an effective protocol of flattening the COVID-19 curve, the study confronted some difficulties on the field in trying to get stakeholders together in a particular venue as some households are fearful that they might contact the disease. However, efforts of the team were geared toward a community-wide interactive consultation involving the leadership of all visited and surveyed communities except for communities who are inaccessible due to insecurity of their environments.

The simple random technique was employed in the administration of questionnaires to the respondents with the adult population as the main object of focus. Questionnaires were administered face-to-face to respondents with the assistance of four field assistants knowledgeable and well trained on survey techniques. Literate respondents were also allowed to self-administer to the questionnaire. In all, a total of two hundred and sixty copies of the structured questionnaire were administered across the visited communities (Table 2), while 232 copies were retrieved, amounting to 89% retrieval.

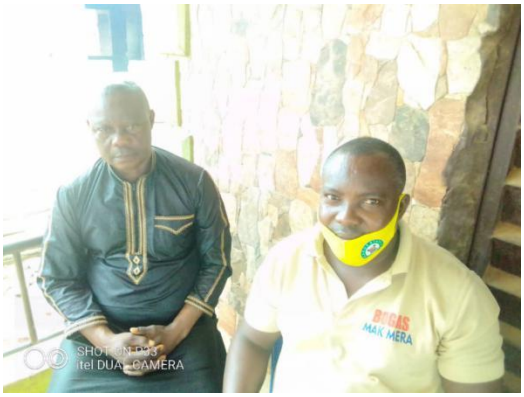
Some general guidelines or rules were developed and followed by the survey teams. In particular, interviewers did their best to:

- Replace households that are not available or who are too busy to cooperate;
- Explain clearly the purpose of the visit;
- Be patient, showing respect for the community people;
- Make phrasing as simple and easily understandable as possible to illiterate households;
- Confirm answers with interviewees by repeating both questions and answers;
- Moderate stakeholder discussions so that some people do not dominate the discussion thereby creating avenue for distractions.

With due approval from community heads in most cases, the socioeconomic team took photographs of the prevailing infrastructure and social amenities. It should also be captured that in some instances, community resist taking of photographs for fear of salient future government intervention which they envisage would not be beneficial to the community.

Table 5.2: Questionnaires administered and retrieved

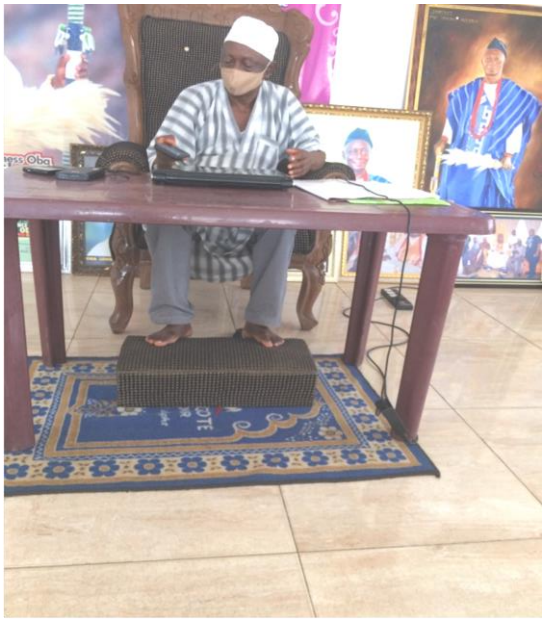
S/N	Project-affected community	No. of questionnaires administered	No. retrieved	Percentage retrieved
1.	Sagamu	20	19	95
2.	Ikene	20	18	90
3	Ilisan	20	20	100
4	Odogbolu	20	20	100
5	Ososa	20	20	100
6	Ibefun	20	20	100
7	Ilado	20	16	80
8	Imodi Ijasi	20	14	70
9	Kajola	20	20	100
10	Bara	20	16	80
11	Logbara	20	14	70
12	Onile-Imo	20	15	75
13	Siun	20	20	100
	Total	**260**	**232**	**89%**



(A)

(B)

Plate 5.1: Consultation at the Palaces of (A) Baale of Imodi-Ijasi and (B)Baale of Kajola



(A) (B)

Plate 5.2: Consultation in the Palace of Olu of Siun Land

Plate 5.3: Consultation at Ilado with the Depute Baale

5.2.4 Socioeconomic data presentation

Simple descriptive methods and averages (means and percentages) in tabular were preferred data presentation. These statistical presentations have the advantage of making information simple and easily understood by the reader at a glance. It should also be stressed that in the discussion analysis below, the average percentage figures for the entire study area for the various human elements was employed.

5.2.5 Outcomes Project Location and Affected Communities

The LDZ pipeline project is a linear project however, its activities and impact zone of influence cut across both ways of the right-of-way (ROW). The 129 km pipeline runs through built-up areas and located majorly within Ogun state and part of Ikosi-Ejinrin LCDA in Lagos state. The pipeline project impacted twenty-six settlements/communities along the pipeline's route/ ROW though only thirteen communities were captured in this report due to insecurity and other factors as earlier mentioned. All the accessible communities were visited for the field survey, and were administered copies of the structured questionnaires.

5.2.6 Cultural Heritage and Religion

The people of the study area are majorly the Yoruba race and therefore the cultures of the communities were largely and expectedly similar. Important to stress that while the Obafemi-owode LGA of the project area is majorly dominated by the Egbas, the Sagamu et al LGAs are Ijebu and Remo founded. However, the dressing pattern, marriage and burial ceremonies and rites were identically inclined. Again, age long inter-communal marriages further blend the cultures of the area. Similarly, the religion of the study area shows similar pattern as Christianity appears as the dominant religion. This is buttressed with the large number of both orthodox and Pentecostal churches in the communities. The responses from the surveyed communities indicated 47.3% affirmation to Christianity, while about 42.3% practiced Islam. Only 10.3% claim allegiance to ‘’African Traditional Religion (ATR)’’. Especially, the chieftains of most communities still insist on making certain rite and rituals to appease some deities for the security, development and peace of the entire community.

From the analysis of field data, it is self-evident that majority of the respondents are either Christian, or Muslims. As a result, the Easter, Christmas and Ileya are well celebrated annually. Apart from these two major modern religious celebrations, the egungun (masquerade), igunuko, obatala, alaale, sango, ooro e.t.c. are other parts of their cultural heritage and are celebrated annually. Worthy of note is that during these traditional cultural festival celebrations, movements are usually restricted after prior notice usually between hours of 12 midnight and 6 am in the morning. This is to enable cult members make sacrifices/rituals on behalf of the community to the gods to invoke their blessings upon the land for the year.

Apart from the common cultural heritage and believe, custom practice also varies across the study area. In Imodi-Ijasi, whistling for example is forbidden in the community while in Ibefun, the hawking of water yam made delicacy of the Ijebus called Ikokore is forbidden. This pattern of taboos and beliefs vary from one community to another and is therefore necessary for strangers to beware of stringent taboos and limitations of the particular community in which they live.

Plate 5.4: A mysterious Tree acclaimed to be Obaluaiye deity at Imodi-Ijasi

Plate 5.5: The Reformed Ogboni Confraternity in Sagamu and Hubert Ogunde edifice painting at Ososa

Table 5.3: Religion Distribution

S/N	COMMUNITY	CHRISTIAN	%	ISLAM	%	TRADITIONAL	%
1	SAGAMU	11	57.9	7	36.8	1	5.3
2	IKENE	12	66.7	4	22.2	2	11.1
3	ILISAN	13	65.0	6	30.0	1	5.0
4	ODOGBOLU	8	40.0	9	45.0	3	15.0
5	OSOSA	7	35.0	12	60.0	1	5.0
6	IBEFUN	8	40.0	11	55.0	1	5.0
7	ILADO	7	43.8	6	37.5	3	18.7
8	IMODI-IJASI	6	42.9	7	50.0	1	7.1
9	KAJOLA	11	55.0	8	40.0	1	5.0
10	BARA	9	56.3	6	37.5	1	6.3
11	LOGBARA	7	50.0	5	35.7	2	14.3
12	ONILE-IMO	2	13.3	9	60.0	4	26.7
13	SIUN	10	50.0	8	40.0	2	10.0
	AVERAGE		**47.4**		**42.3**		**10.3**

5.2.7 Politics and Community Governance

The leadership of the communities is rested in the hand of the community heads. In Yoruba culture, such head is referred to as the 'Baale'. The Baale, most times are the community pioneer/founder. They are usually hunters or great warriors who migrate from other settlements closer or further from the present community.

However, in hierarchy, the traditional governance in most communities consist of the village head (referred to as Baale) and village appointed chiefs who are usually the elderly, leaders of Youth Organisation or Movement and the Women Association/Wing respectively, Community Development Association (CDA), and other community-based organizations (CBOs). The hierarchy terminates at the bottom with the settlers and strangers in the community.

Conflict being part of human society is as old as the existence of man. However, the onus lies in the promptness of resolution of the conflict before it degenerates into crisis. In the study area, since the presence of the Nigeria Police Force (NPF) is absent in most communities apart from Sagamu, Ilisan, Odogbolu, Ikene, e,t.c. conflicts are resolved by the community head with support and contribution from elders and other respected and recognized organizations of the community like the Vigilante Group of Nigeria (VGN).

In the event that a particular issue goes out of hand or in the case of a murder/armed robbery, such are brought before the police for proper prosecution.

Generally, the traditional channels of conflict resolution were through:

- Families
- Elders' council
- Traditional head and
- Courts of law (as the last resort)

5.2.8 Demographic Characteristics

5.2.9 Population size, growth and distribution

The project affected communities population was based on the National Population Commission (NPC) conducted exercise of 2006. The CIA World fact-book put the population growth rate at 2.44%. This is in deviation to the NPC national growth rate of 3.28%. In order to harmonize information to align with the Commission's growth rate, the presented population projection for the impacted communities is based on 3. 28%. However, the CIA World factbook defines growth rate as 'the average annual percent change in the population, resulting from a surplus (or deficit) of births over deaths and the balance of migrants entering and leaving a country. The rate may be positive or negative. The growth rate is a factor in determining how great a burden would be imposed on a country by the changing needs of its people for infrastructure (e.g. schools, hospitals, housing, roads), resources (e.g. food, water, electricity), and jobs'.

In projecting population figures, both the linear and exponential models are often used:

A. Linear Extrapolation Model

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

Where:

P_o = the base population

r = growth rate of the population

n = time lapse, in years

B. Exponential Growth Model

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

Where:

P_o, r and n are as above.

The exponential growth model provides the best population growth estimates and has been used by most demographic expert overtime. In lieu of this, the projections of population for the affected local governments were calculated using the exponential growth model.

Table 5.4: Population Figures for the Project-Affected Local Governments

	1991			2006			2026 (Projection)		
LGA	Male	Female	Total	Male	Female	Total	Male	Female	Total
Sagamu	77,945	77,781	155,726	126,855	129,030	241,898	241,898	246,045	487,943
Ikene	54,688	57,047	111,735	60,607	58,510	119,117	115,571	111,572	227,143
Odogbolu	42,963	45,421	88,384	63,838	61,819	125,657	121,732	117,882	239,614
Obafemi-Owode	64,685	71,089	135,774	118,574	118,574	235,071	226,107	222,146	448,253
Epe	49,802	51,662	101,464	91,925	89,809	181,734	175,290	171,255	346,545

Source: Data extrapolated from Nigeria Bureau of Statistics figures

5.2.10 Marital Status of Household

Table 5 below presents the statistics of the marital status of the population. Generally speaking, households in Nigeria are predominantly headed by men. In the most African context, the male is saddled with the responsible for all major household decisions. In the study area, the married population is about 63.7% while about 20.4% are single. The divorced respondents are 25.6% while the individual and widowed/separated are 11.5% and 2.5% respectively.

Table 5.5: Marital Status of Respondents

S / N	COMM-UNITY	MARRIED	%	SINGLE	%	DIVORCED	%	INDIVIDUAL	%	SEPERATED /WIDOWED	%
1	SAGAMU	10	52.6	5	26.3	0	0.0	3	15.8	1	5.3
2	IKENE	14	77.8	2	11.1	1	5.6	1	5.6	0	0.0
3	ILISAN	15	75.0	3	15.0	0	0.0	2	10.0	0	0.0
4	ODOGBO-LU	17	85.0	2	10.0	0	0.0	1	5.0	0	0.0
5	OSOSA	9	45.0	5	25.0	2	10.0	3	15.0	1	5.0
6	IBEFUN	12	60.0	6	30.0	0	0.0	1	5.0	1	5.0
7	ILADO	14	87.5	1	6.3	0	0.0	1	6.2	0	0.0
8	IMODI IJASI	8	57.2	3	21.4	0	0.0	3	21.4	0	0.0
9	KAJOLA	12	60.0	6	30.0	2	10.0	0	0.0	0	0.0
10	BARA	8	50.0	5	31.3	0	0.0	2	12.5	1	6.2
11	LOGBAR	7	50.0	2	14.3	0	0.0	5	35.7	0	0.0
12	ONILE-IMO	11	73.3	3	20.0	0	0.0	1	6.7	0	0.0
13	SIUN	11	55.0	5	25.0	0	0.0	2	10.0	2	10.2
	AVE.		**63.7**		**20.4**		**25.6**		**11.5**		**2.4**

5.2.11 Population structure

The population structure reflects the age and sex composition of a population. Information on age and sex composition is very crucial in a study like this.

5.2.12 Age distribution

Age structure as a demographic variable portends many uses including shaping the direction of government policies on social and other welfare packages for the population which in turn shapes the needs of the present and future population. This is the more reason why data on the population age is periodically collected for update in every national census conducted in a nation. In Nigeria, issues rallying on age are usually contentious. Some people do not really know the exact date of their birth and can only relate to event surrounding the period. Therefore, demographic age reporting does not give accurate figure in most national census

Table 5.6: Age Distribution of Household

S/N	COMMUNITY	15-25	%	26-36	%	37-47	%	48-58	%	59 & above	%
1	SAGAMU	2	10.5	1	5.3	4	21.0	5	26.3	7	36.8
2	IKENE	1	55.6	3	16.7	6	33.3	6	33.3	2	11.1
3	ILISAN	2	10.0	1	5.0	6	30.0	8	40.0	3	15.0
4	ODOGBO-LU	2	10.0	4	20.0	7	35.0	7	35.0	0	0.0
5	OSOSA	3	15.0	2	10.0	8	40.0	4	20.0	3	15.0
6	IBEFUN	4	20.0	2	10.0	7	35.0	6	30.0	1	5.0
7	ILADO	1	6.25	4	25.0	2	12.5	9	56.3	0	0.0
8	IMODI IJASI	3	21.4	2	14.3	5	35.7	3	21.4	1	7.1
9	KAJOLA	4	20.0	2	10.0	4	20.0	8	40.0	2	10.0
10	BARA	5	31.3	2	12.5	5	31.3	3	31.3	1	6.2
11	LOGBAR	2	14.3	2	14.3	7	50.0	1	7.1	2	14.3
12	ONILE-IMO	3	20.0	3	20.0	3	20.0	5	33.3	1	6.7
13	SIUN	3	15.0	5	25.0	3	15.0	7	35.0	2	10.0
	AVERAGE		**19.2**		**14.5**		**29.1**		**31.5**		**10.6**

According to the outcome of the study, in Table 6 presented above, majority(about 32%) of the respondents falls under the highest age grouping (48 – 58 years) while ages between 37 and 47 come next (about 30%) while the youths structure interviewed between (for ages 26 – 36) is about 15% and 19% for 15 -25 years. The eldest of the study area stood at 11% (59 years upward).

5.2.13 Sex distribution

The male population dominates the number of respondents administered questionnaires amounting to 61.4% while the female counterpart is 38.6%. Generally among the people of Ogun state, according to tradition, the woman is usually expected to take a less prominent role either in the family or at a public meeting. In most instances, as keenly observed during meetings with the stakeholders, women were usually not forthcoming in expressing their views. They expect the head of the family (the man) to proffer answers to questions asked. The only instance where women freely respond to question is where either the head of the family is not at home at the time of the visit or that the woman is a widow. The outcome of this report corroborates that assertion.

Table 5.7: Sex Composition of Households

S/N	COMMUNITY	MALE	%	FEMALE	%

1	SAGAMU	13	68.4	6	31.6
2	IKENE	10	55.6	8	44.4
3	ILISAN	12	60.0	8	40.0
4	ODOGBOLU	13	65.0	7	35.0
5	OSOSA	11	55.0	9	45.0
6	IBEFUN	14	70.0	6	30.0
7	ILADO	10	62.5	6	37.5
8	IMODI-IJASI	8	57.1	6	42.9
9	KAJOLA	15	75.0	5	25.0
10	BARA	11	68.8	5	31.2
11	LOGBARA	12	85.7	2	14.3
12	ONILE-IMO	12	80.0	3	20.0
13	SIUN	12	60.0	8	40.0
	AVERAGE		**61.4**		**38.6**

5.2.14 Ethnic composition of population

The history of most of the settlements/communities in the proposed LDZ gas pipeline project reveals that the 'Egbas' from Abeokuta founded communities under Obafemi-owode local government while the Ijebus founded Sagamu upward part of the project area. The language spoken by indigenes is egba, remo and ijebu dialects while settlers/strangers speak different dialect. However, it is worth to note that the entire study area is a mix of many tribes comprising Ibos, Hausas, Igedes, Eguns, Niger Deltas among others. Surprisingly, the major agricultural activities are done by these settlers particularly the Igedes whose major work is farming. An indigene of a community gave a reason for this: "***since our old parents farming are getting old and the youths are no longer showing interest in farming, these settlers are the people doing the farming and providing food for us"***. It is also of note particularly that despite the complex mix of tribe concentration in the study area, the people have managed to live in peaceful coexistence for a long period of time.

5.2.15 Length of Residence in Community

Table 8 below shows the duration that residents have lived in the community for the past years. It reveals that 47.1% of the population had lived in the community for over 21 years while 30.3% resided in the community for between 11 and 20 years. About 16.4% of respondents claim to have lived between 5 and 10 years while only 5.4% population

have resided 1 – 4 years. The implication of this finding is that majority of the population administered questionnaires have stayed in the community for a long period of time and therefore know much about the community.

Table 5.8: Respondents' Length of Residence in Community

S/N	COMMUNITY	<1 yr	%	1-4 yr	%	5-10yr	%	11-20yr	%	21yrs or >	%
1	SAGAMU	2	10.5	2	10.5	6	31.6	6	31.6	3	15.8
2	IKENE	0	0.0	0	0.0	2	11.1	11	61.1	5	27.8
3	ILISAN	0	0.0	4	20.0	7	35.0	5	25.0	4	20.0
4	ODOGBO-LU	0	0.0	5	25.0	5	25.0	3	15.0	7	35.0
5	OSOSA	0	0.0	2	10.0	6	30.0	7	35.0	5	25.0
6	IBEFUN	0	0.0	0	0.0	4	20.0	7	35.0	9	45.0
7	ILADO	0	0.0	0	0.0	0	0.0	4	25.0	12	75.0
8	IMODI IJASI	0	0.0	0	0.0	0	0.0	0	0.0	14	100.0
9	KAJOLA	0	0.0	1	5.0	3	15.0	6	30.0	10	50.0
10	BARA	0	0.0	0	0.0	1	6.3	8	50.0	7	43.7
11	LOGBAR	0	0.0	0	0.0	4	28.6	2	14.3	8	57.1
12	ONILE-IMO	0	0.0	0	0.0	0	0.0	4	26.7	11	73.3
13	SIUN	0	0.0	0	0.0	2	10.0	9	45.0	9	45.0
	AVERAGE		**0.8**		**5.4**		**16.4**		**30.3**		**47.1**

5.3 Education

Education generally influences personal lifestyle and status in any given society. Several studies have reliably confirmed that educational attainment has a strong effect on health behaviours and attitudes. In no doubt, quiet a large proportion of the sampled population has received some formal education. The sample population that had the basic primary school leaving certificate is about 37.4 %. Those with secondary education are about 32.3%. About 9.2% of the sampled respondents acquired OND certificates while about 13.2% were HND holders. Just about 7.9% percent of the sampled population reported of having a degree certificate.

Table 5.9: Education Attainment of Respondents

S/N	COMMUNITY	PRY	%	SEC	%	OND	%	HND	%	B.SC	%
1	SAGAMU	0	0.0	13	68.4	1	5.3	2	10.5	3	15.8
2	IKENE	1	5.6	10	55.6	2	11.1	1	5.6	4	22.2
3	ILISAN	0	0.0	5	25.0	2	10.0	7	35.0	6	30.0
4	ODOGBO-LU	3	15.0	6	30.0	2	10.0	6	30.0	3	15.0
5	OSOSA	1	5.0	9	45.0	5	25.0	3	15.0	2	10.0
6	IBEFUN	8	40.0	5	25.0	2	10.0	4	20.0	1	5.0
7	ILADO	12	75.0	4	25.0	0	0.0	0	0.0	0	0.0
8	IMODI IJASI	9	64.3	2	14.3	0	0.0	3	21.4	0	0.0
9	KAJOLA	11	55.0	4	20.0	2	10.0	3	15.0	0	0.0
10	BARA	7	43.8	6	37.5	1	6.2	2	12.5	0	0.0
11	LOGBAR	8	57.1	2	14.3	3	21.4	1	7.2	0	0.0
12	ONILE-IMO	12	80.0	3	20.0	0	0.0	0	0.0	0	0.0
13	SIUN	9	45.0	8	40.0	2	10.0	0	0.0	1	5.0
	AVERAGE		**37.4**		**32.3**		**9.2**		**13.2**		**7.9**

5.3.1 Livelihood and Economic Systems in Project Area

5.3.2 Occupation and income generating activities

From Table 10, the modal source of income for the population under study is trading amounting to about 58.9%. Most of the traders are people in the middle age especially women and people with low cadre of education. Farming follows with a figure of 21.1%. Daily paid especially the artisans account for just 7.2% of the sampled population while teachers, civil servants and transporters represent 3.6%, 4.8% and 3.3% respectively.

Table 5.10: Primary Occupation of Respondents

S/N	COMMUNITY	FARMING	%	HUNTING	%	TEACHING	%	TRADING	%	TRANSPORTER	%	DAILY PAID	%	CIVIL	%
1	SAGAMU	0	0.0	0	0.0	2	10.5	12	63.2	1	5.2	1	5.2	3	15.8
2	IKENE	1	5.6	0	0.0	3	16.7	11	61.1	0	0.0	0	0.0	3	16.6
3	ILISAN	0	0.0	0	0.0	2	10.0	14	70.0	0	0.0	0	0.0	4	20.0
4	ODOGBOLU	3	15.0	0	0.0	1	5.0	15	75.0	1	5.0	0	0.0	0	0.0
5	OSOSA	2	10.0	0	0.0	1	5.0	12	60.0	2	10.0	2	10.0	1	5.0
6	IBEFUN	2	10.0	0	0.0	0	0.0	16	80.0	1	5.0	1	5.0	0	0.0
7	ILADO	6	37.5	0	0.0	0	0.0	9	56.3	1	6.2	0	0.0	0	0.0
8	IMODI-IJASI	4	28.6	1	7.1	0	0.0	8	57.1	1	7.1	0	0.0	0	0.0
9	KAJOLA	3	15.0	0	0.0	0	0.0	10	50.0	0	0.0	7	35.0	0	0.0
10	BARA	6	37.5	0	0.0	0	0.0	6	37.5	0	0.0	4	25.0	0	0.0
11	LOGBARA	7	50.0	0	0.0	0	0.0	6	42.8	0	0.0	2	14.2	0	0.0
12	ONILE-IMO	9	60.0	1	6.7	0	0.0	5	33.3	0	0.0	0	0.0	0	0.0
13	SIUN	1	5.0	0	0.0	0	0.0	16	80.0	2	10.0	0	0.0	1	5.0
	AVERAGE		**21.1**		**1.1**		**3.6**		**58.9**		**3.3**		**7.2**		**4.8**

5.3.3 Access to Land Ownership

According to NREH, ‘ since 1978, the major legislation regulating land acquisition within the country has been the Land Use Act of 1978 which states that all land in a State is to be held in trust by the State Governor for the benefit of all Nigerians. By law, foreigners may also acquire land wherever it is located in the country from either the State governments or from other holders. Since the Land Use Act confers all land to the respective State government, a prospective buyer can apply to the Governor of the State for a Certificate of Occupancy which is for a period of 99 years. Two classes of people are recognized by law as rightful owners of land. The first class, are people who have been granted rights of occupancy by the State, Local or Federal Government. The second class consists of those who held interests in land in Nigeria before the Act came into force. According to the Act, a person in this category continues to hold those interests in the land as if a right of occupancy had actually been granted to him by the Government ’.

Land is finite and scarce to get genuinely in most communities in Nigeria. Aside from the fact that land may be acquired through *individual, family, communal, and government* windows, it was observed that certain segments of people are involved in land grabbing and other fraudulent activities to unsuspecting buyers. In Onile-Imo for example, the ninety (90) year old Baale, Chief Ayinde Kujore accused certain elements of the community engaged in this practice. Prospective land buyers are advised to consult widely especially with the head of the community (Baale) before making payment for any piece of land. It is in this regard that both governments of Ogun and Lagos enacted laws through respective state of assemblies criminalizing land grabbing in their states.

5.3.4 Income levels of respondents

Incidentally, a man's status in the society is measured in terms of the income he earns and therefore contributes to his socioeconomic relevance in the society. As important as this socioeconomic variable is to any human study, it is however disturbing that most respondents are modest in divulging the real income of the family. A key reason is the fear of government taxation on their personal income. In the study area, most respondents generally believe that the taxation instrument employed by government is disproportionate to the money generated by an average household. Again, a major factor is the inability to keep good records of inflows by the self-employed. The sample population is majorly traders who don't keep daily sales record. It is no doubt that there are practical instances where some householders are involved in other income-generating activities that are not accounted for. It is important to note, however, that majority of the surveyed population earn their income from commerce activities like trading, and farming.

Therefore, information gathered from the sampled population as it relates to personal income cannot be confirmed to be the actual figure. However, it is important to comment in passing that about 10.6% respondents claim to earn well above N40, 000 yearly while just 8.1% earn between 30, 001 and 40, 000 yearly. Similarly, 27.3% earn between 25, 001 and 30, 000 annually while only 36.2% claim they earn in each year a figure between 10,000 and 25, 000.

Table 5.11: **Income Distribution of Population in Study Area**

S/N	COMMUNITY	< N10,000	%	N10,000 - 25,000	%	N25,100 – 30,000	%	N30,100 – 40,000	%	> N 40,000	%
1	SAGAMU	0	0.0	2	10.5	12	63.2	2	10.5	3	15.8
2	IKENE	0	0.0	3	16.7	11	61.1	1	5.6	3	16.6
3	ILISAN	0	0.0	2	10.0	14	70.0	0	0.0	4	20.0
4	ODOGBOLU	0	0.0	5	20.0	11	55.0	3	15.0	2	10.0
5	OSOSA	0	0.0	15	75.0	2	10.0	2	10.0	1	5.0
6	IBEFUN	0	0.0	13	65.0	6	30.0	1	5.0	0	0.0
7	ILADO	6	37.5	9	56.3	1	6.2	0	0.0	0	0.0
8	IMODI-IJASI	4	28.5	6	42.8	2	14.3	1	7.1	2	14.3
9	KAJOLA	3	15.0	11	55.0	1	5.0	2	10.0	3	15.0
10	BARA	6	37.5	5	31.3	2	12.5	1	6.2	2	12.5
11	LOGBARA	7	50.0	3	21.4	1	7.1	1	7.1	2	14.3
12	ONILE-IMO	9	60.0	5	33.3	1	6.7	0	0.0	0	0.0
13	SIUN	1	5.0	7	35.0	3	15.0	6	30.0	3	15.0
	AVERAGE		**17.9**		**36.2**		**27.3**		**8.1**		**10.6**

5.3.5 Infrastructures, utilities/services and quality of life

The value place of adequate and functional infrastructure and amenities in any society determines the quality of life and also the willingness of a large proportion of the people to live and remain there. In the gas pipeline project environment, the communities complain about the level of development, availability and access to basic social infrastructure in addition to employment. Many of the residents that have lived for over 15 years in the community lamented the state of infrastructure decay and neglect by successive governments. The security architecture of most communities are self-founded e,g, Oodua Peoples' Congress (OPC) and Vigilante Group of Nigeria (VGN).

5.3.6 Educational Facilities

In most of the impacted communities, apart from the town and urban settlements like Sagamu, Ikene, Ijebu-Ode, Ilisan, Odogbolu, among others, are in dire need of schools to send their wards to. Communities like Ilado, Kajola, Bara, Logbara, Imodi-Ijasi and the rest of them are clamouring for schools from government. In communities where there are schools, many are in bad shape and would need urgent government intervention. Many of the respondents express dissatisfaction that they have to send their wards to schools in community too far from where they reside. The extra cost spent on their wards transportation constitute additional burden to the already bad finance status of the household. Though some privately owned schools abound in some communities, residents complain of high school fees and incompetent teachers in some of these schools. For instance, many of these private schools do not have the financial capability to employ experienced hands and could only employ those at their disposal who are willing to teach with the poor salary they offer. So the quality of the education offered is in question. A particular young man with a secondary school certificate teaching in a private school confirmed to us that his monthly take home which is less than N20, 000 cannot keep him for the month with the economic reality of the present.

Plate 5.6: An International private school in Ibefun and the entrance gate of Babcock University at Ilisan

5.3.7 Water supply and waste management

Water is life as is popularly said among various folks across the world. In human nutrition, there is no suitable and perfect substitute for water in the human body. As a matter of fact, Nigeria concurs to the necessity of increasing access to improved drinking water as part of the Millennium Development Goals. The source of drinking water is an indicator of whether it is suitable for drinking. Lack of ready access to water may limit the quantity of suitable drinking water that is available to a household. In the study area, the whole sampled respondents claim to get their water from private wells though some segments of the communities still get their water source from boreholes either provided through community effort, by individual or again by a corporate social welfare package by an institution. Cases of benevolent efforts by individuals and corporate bodies in executing water project are found in communities like Ibefun, Kajola, Siun, Bara and some few others.

Table 5.12: Household Source of Water

S/N	COMMUNITY	PUBLIC WELL	%	RIVER	%	PRIVATE WELL	%	PIPED WATER	%
1	SAGAMU	0	0.0	0	0.0	15	79.0	4	21.0
2	IKENE	0	0.0	0	0.0	15	83.3	3	16.7
3	ILISAN	0	0.0	0	0.0	14	70.0	6	30.0
4	ODOGBOLU	1	5.0	0	0.0	17	85.0	2	10.0
5	OSOSA	1	5.0	0	0.0	16	80.0	3	15.0
6	IBEFUN	3	15.0	0	0.0	17	85.0	0	0.0
7	ILADO	2	12.5	0	0.0	14	87.5	0	0.0
8	IMODI-IJASI	2	14.3	0	0.0	12	85.7	0	0.0
9	KAJOLA	3	15.0	0	0.0	14	70.0	3	15.0
10	BARA	7	43.8	0	0.0	9	56.2	0	0.0
11	LOGBARA	4	28.6	0	0.0	10	71.4	0	0.0
12	ONILE-IMO	9	60.0	0	0.0	6	40.0	0	0.0
13	SIUN	3	15.0	0	0.0	16	80.0	1	5.0
	AVERAGE		**16.5**		**0.0**		**74.9**		**8.6**

Plate 5.7: A borehole provided for Siun located in front of the Olu of Siun land palace

Plate 5.8: A waste disposal dumpsite at Ososa

For any community, the importance of an effective waste management as a medium of guaranteeing good health for people and environmental safety can never be over narrated**.** Though every living thing on earth generates waste, but humans create far more waste than other species. To maintain a balanced ecosystem therefore, and as well sustain a high quality of life for the planet's inhabitants, humans must manage and store their waste efficiently and safely.

Historically, human beings have been practicing primitive waste management technique for thousands of years. In the early era of human evolvement, man simply dug a hole and buried his refuse and trash. This practice is understandable given the relatively small population and modest

activities. One will agree that burying the trash helps to prevent bugs and rodents from becoming a nuisance and spreading diseases. However, as the human population swells, such practice is no longer sustainable given the huge amount of waste generated daily in homes and the collective community. While primitive humans produced very little waste which are most cases biodegradable, modern humans produce large amounts of waste, much of which will take thousands if not millions of years to be biodegraded. Additionally, many types of garbage may be damaging to the soil, ground water and surrounding habitat. In technologically advanced society, modern waste management involves the placement of garbage in lined holes and the use of bacteria to help facilitate rapid decomposition of the garbage.

However, in the communities under study, it is unfortunate that proper waste management is poorly reflected as evidently observed. Most communities don't have a refuse collection centre where they can be picked and some only have a makeshift via paid cart pushers or dumping of the refuse in a nearby bush or again in the drainage when possible. This habit again, constitutes a major impediment to environmental sustainability.

5.3.8 Electricity and energy use

Generally speaking, there is no known community in Nigeria which is not connected to the 33KVA special line that do not complain of poor power supply. The hourage in most cases vary from three to five per day particularly in the urban settlements. The rural communities are even worse as some suffer years of power outage without immediate concern from the power provided to attend to their plight. Though all the impacted communities are connected to the national grid of the Power Holding Company of Nigeria (PHCN) nevertheless the communities are in dire need of public power supply.

Most residents interviewed complained of inadequate power supply to their community and as a result have negatively affected their businesses. One female respondent complained bitterly: '*since the government has not been able fix light for us, we have put everything in the hand of God my brother…the situation is frustrating as my business is seriously down'*. Even the community heads confirmed this inadequacy of government to provide regular light for the people of their communities.

However, it was observed that many respondents seek alternative supply of electricity through the use of power generators while some financially impoverished residents resided to the use the old-time kerosene lamp and candles as an alternative means of lighting. As majority of the settlements are profoundly urban, kerosene and gas are the main means used for their cooking.

Plate 5.9: IPP Electricity facility in Ilisan powering Babcok University

5.3.9 Transportation, Accessibility and Communication Facilities

Efficient transportation and access to reliable communication remains the vital life of any human environment. From an article, the author argued strongly that "Transport and communication occupy an important place in the economic and social development of a country. The proactive development of roads facilitates utilisation of natural resources lying unutilized in different hills, mountains, forests and mines. Transport system helps to send raw materials, fuel and machineries to different industries at right time and runs the industry and as well widens the size of the market. A developed transport system reduces regional industrial disparity by facilitating establishment of industries in backward areas, because the backward area is brought nearer to developed area with the help of a developed transport system by sending raw-materials to the backward industrial centre and by selling the products of industries in different areas.

Transport system helps to solve the problem of unemployment in rural areas by sending surplus labourers to the industries and it also solves the needs of industries. It also serves as a strong pillar to protect the people from the difficulties of war, natural calamities and other problems. A

developed transport system is necessary to send necessary helps to the affected people during the period of natural calamities. Except this, transport system helps to establish relationship among different parts of the people and strengthens the feeling of unity and brotherhood among the people".

In the study area, significant means of transportation includes motorcycle, tricycle, taxi and bus. The roads are peculiarly bad in many of the communities like Ibefun, and even some stretch of major road in Sagamu particularly the road running from Lafarge to link the Sagamu- Benin Expressway. There was no evidence of any tarred roads in most rural communities covered except the major road that leads to the community. In the cause of the field survey, the team's vehicle got stuck in Ibefun axis of Ikorodu-Ijebu-ode road and we had to engage the popularly referred 'area boys' to help rescue our vehicle from the flooded road. It was that bad.

Communication provides the medium through which information is exchanged and also the opportunity to get to know what is happening across the community and the nation at large. It also provides quick means of getting to know current market price for goods/produce and services. Communication, used effectively binds the community by allaying fears and dispelling rumours. The lifestyle of people could also be enhanced through provision of communication facilities. Quite a significant number if not all the surveyed population had the modern GSM phone with which they exchange information and keep the bond of togetherness.

Plate 5.10: A long stretch of bad and flooded road on Ikorodu-Ijebu-ode road

5.3.10 Civic Gathering Places, Recreational Facilities and Security

In any given society, human beings must have a time when they gather together to deliberate on issues or for celebrations. Town hall is an essential ingredient of a community to foster togetherness. Part of the benefits of a town hall is the opportunity provided for exchange of thoughts between the leadership and the stakeholders in the community to deliberate on issues affecting the people and how development opportunity could be tapped for the benefit of all concerned.

An undisputable outcome of this study is the proliferation of relaxation centres especially in the urban settlements. The entire communities possess restaurants and hotels for both lodging and relaxation. In such occasions, European football leagues are watched by customers while some take one or two bottles of beer to enjoy the matches. In one of the team visits in the weekend, the team noticed people gathering in restaurants taking beers and clustering totally disregarding social distancing despite the community spread of COVID-19 pandemic. One middle aged man response when approached by the team took us aback, he said: ***"which covid-19, my brother, there is nothing like that.. the people you see dying are the Abuja big men chopping our money…they would die one after the other… or have you seen poor people die of the disease in your area***? ***for us here, we no get covid***"

Again, another inadequate infrastructure profound in the communities is the lack of the presence of the Nigeria Police Force (NPF) in terms of security provision for all and sundry. Apart from the urban settlements, virtually every other community don't have the presence of the NPF except for vigilante group that provides security to the people. However, despite this security deficit, criminal activities are less evident.

5.3.11 Health Care Facilities

Before the advent of modern medicine or health care system, Africans manage their health through traditional medicine practitioners who claim to understand the cause of an ailment and the possible solution to it. In no doubt, orthodox medicine has recorded a very reasonable level of success in some disease conditions. However, it will also be a balanced argument that some lives have been equally lost through this practice. The advancement of science in providing practical and convincing explanation for the cause and cure of disease make modern medicine superior to orthodox practice. The WHO had defined health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'.

In the context of modern development, citizenry must have access to quality health facilities at all times. Truly, public health is an important element of national security to provide adequate and timely medical care and as well track, monitor, and control disease outbreak. In the study area, many of the communities surveyed lack access to government provided medical facilities. Communities like Imodi-Ijasi, Ilado, Kajola, Bara, Logbara, Onile-Imo, and Idofin were lacking in public primary health delivery neither were any private medical centres available. Where Primary Health Centres were established, medical doctors were not existent

It should be on the record that the primary health care centres in all of the privileged communities to have one are only able to provide general health care services. Major health issues brought to the centre include: malaria, typhoid, birth delivery, child stooling, general body pain, minor injury involving stitching, and vision impairment in need of glasses. Critical health issues requiring specialist attention are often referred to the general hospital for treatment including difficult birth delivery.

Plate 5.11: Public health facility in Odogbolu

5.3.12 Housing Type

There is no doubt that many of the communities in the study area are replica of urban settlement. There is a predominance of the modern housing types with better quality building materials.

The quality of housing in the communities measured by the quality of materials used for its construction indicates that majority of the respondents (about 80.4%) on the average live in bungalow houses constructed of concrete block and cement walls. Only 11.9% of the respondents live in houses constructed of mud wall. All the houses are roofed with corrugated zinc. In terms of the ownership/tenancy of accommodation, on the average, 11% live in rented apartment while 7.8% and 11.9% live in family compound and personal traditional houses respectively.

Table 5.13: Accommodation Pattern of Respondents

S / N	COMMUNITY	PERSONAL TRADITIONAL	%	BUNGALOW	%	STOREY BUILDING	%	RENTAL APARTMENT	%	FAMILY COMPOUND	%
1	SAGAMU	0	0.0	13	68.4	2	10.5	4	21.1		0.0
2	IKENE	0	0.0	12	66.7	3	16.7	3	16.6	0	0.0
3	ILISAN	0	0.0	16	80.0	2	10.0	2	10.0	0	0.0
4	ODOGBOLU	0	0.0	16	80.0	0	0.0	3	15.0	0	5.0
5	OSOSA	0	0.0	16	80.0	1	5.0	2	10.0	1	5.0
6	IBEFUN	2	10.0	14	70.0	0	0.0	1	5.0	1	15.0
7	ILADO	1	6.2	11	68.8	0	0.0	2	12.5	3	12.5
8	IMODI-IJASI	1	7.2	11	78.6	0	0.0	1	7.1	2	7.1
9	KAJOLA	1	5.0	14	70.0	0	0.0	4	20.0	1	5.0
10	BARA	2	12.5	8	50.0	0	0.0	3	18.7	1	18.7
11	LOGBARA	7	50.0	5	35.7	0	0.0	0	0.0	3	14.3
12	ONILE-IMO	8	53.3	3	20.0	0	0.0	1	6.7	2	20.0
13	SIUN	2	10.0	18	90.0	0	0.0	0	0.0	3	0.0
	AVERAGE		**11.9**		**66.0**		**3.2**		**11**	**0**	**7.8**

Table 5.14: Type and Quality of Housing

S / N	COMMUNITY	CEMENT BLOCK/PLASTERED	%	CEMENT BLOCK/UNPLASTER	%	MUD WALLS	%	BRICK WALLS	%	CONCRETE BRICK	%	PLYWOOD	%
1	SAGAMU	19	100	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	IKENE	17	94.4	1	5.6	0	0.0	0	0.0	0	0.0	0	0.0
3	ILISAN	20	100	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	ODOGBOLU	20	100	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	OSOSA	20	100	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	IBEFUN	17	85.0	1	5.0	2	10.0	0	0.0	0	0.0	0	0.0
7	ILADO	12	75.0	3	18.8	1	6.2	0	0.0	0	0.0	0	0.0
8	IMODI-IJASI	11	78.6	2	14.3	1	7.1	0	0.0	0	0.0	0	0.0
9	KAJOLA	16	80.0	3	15.0	1	5.0	0	0.0	0	0.0	0	0.0
10	BARA	13	81.3	1	6.2	2	12.5	0	0.0	0	0.0	0	0.0
11	LOGBARA	6	42.9	1	7.1	7	50.0	0	0.0	0	0.0	0	0.0
12	ONILE-IMO	5	33.3	2	13.3	8	53.3	0	0.0	0	0.0	0	0.0
13	SIUN	15	75.0	3	15.0	2	10.0	0	0.0	0	0.0	0	0.0
	AVERAGE		**80.4**		**7.7**		**11.9**		**0.0**		**0.0**		**0.0**

5.3.13 Market facility

A market place provides the opportunity for people to do commerce and interact with one another. Predominantly, the urban areas of Ososa, Ilisan, Odogbolu, Ikene, and Sagamu have many moderate to large markets where people can buy foodstuff, cosmetics, clothes and many other household items. These settlements also have shopping malls and retail shops providing more opportunities for the people to choose from. Rural communities like Ilado, Bara, Onile-Imo, and Logbara patronize markets available in nearby communities like Siun for their household needs usually opened on first and five other days.

5.3.14 Social/Communal Problems Confronting the Communities

In any human society, the likelihood of social problems is inevitable. The study area is no exemption to this ideal as there are many observed social challenges confronting the population. One major social problem observed is the indulgence of some youths in hemp smoking. The survey team witnessed some youths indulging in this deviant act in Onile-Imo community. As commonly said,' an idle hand is the devil's workshop', the earlier these youths are gainfully employed, the quickly the problem will be nipped.

This brings us to the problem of youth unemployment which is a reoccurring feature in all of the study area. These unemployed youths engage themselves in okada riding in order to make ends meet. Graduates are even not left out. Some youths ride tricycles and at most of the times, safety measures to secure their lives and commuters are totally neglected. Okada accident is common among those plying the expressway with passengers.

Another major social problem is the indulgence in alcoholism leading to drunkenness. This is common among the youths and do not spare even women.
Prostitution is least expressed by the respondents interviewed but information from a key informant suggest that this social problem remains a bad spot in the population. According to the key informant, he said: "*some lodgment houses harbour these prostitutes and they sometimes engage themselves in serious fighting because of customers palaver in the open…..you know ashewo people don't have shame".*

Chieftaincy title conflict and youth restiveness are agreed as nonexistent in the study area though a key informant claims that there was at a time when chieftaincy tussle was witnessed in their community. He doesn't want the community mentioned in this report. Generally, the study environment is peaceful and cooperative.

The issue of herdsmen attack has never been reported by any respondent though some residents fear that by allowing herdsmen cattle graze within their community poses a threat to their lives and peace to the community. For the record, the survey team came in contact with many of these cattle nomads grazing on farmland boundaries especially along the expressway.

5.3.15 Social Organizations

Man is a social animal. We need ourselves together to kill boredom and enjoy all that life brings to us to the fullest. There is a way in which social companionship contributes to longevity of life. Many social organizations abound in the surveyed population. Social organizations provide the means through which resident population come in contact with one another and provide the means for social exchange and improved relationship.

It also serves as a means through which conflicts/disputes are settled among members. This is common especially among trade related associations.

Social groups also contribute immensely towards the conservation of the culture of the community, engages in fund raising to provide essential services to members of the population as well as playing critical roles during celebrations and even in times of communal grief. Some social groups sometimes metamorphose into socio-cultural entity and help to sustain and conserve the community unique identity.

Profound among the social groups in the study environment include:

- Youth Social Organisations with diverse nomenclature but with the same objective
- Women Groups serving various purposes
- Oodua Socio-Cultural group providing community with security and conserving the cultural identity of the Yoruba race

Plate 5.12: A social organization house in Ilado

5.3.16 Perceptions and Attitudes toward the Project

In general, the perception of the pipeline project impacted communities is positive and encouraging. The expectations of the people are high and it is in line with this renew hope that the level of cooperation showed forth by the population should be taken advantage of by the proponent for the mutual good of the parties involved.

In every sense, a gas pipeline project like this is a practical step to reduce ‘’gas flaring through gas utilization for other beneficial purposes’’. In other words, this initiative will help address the menace of decades’ long gas flaring by converting otherwise ‘wasted gases’ to

usable domestic and commercial commodity for the benefit and development of the host community and its environment. This also will contribute to the preparedness and commitment of the government to the signed treaty on combating global warming through reduced gas flaring.

From all indications, the resident population is not opposed to the proposed gas pipeline project in the study area. Community members are of the opinion that the pipeline project have the capacity to impact them positively in terms of increased employment opportunities, provision of more public schools both primary and post primary and other educational programs and buildings, public primary health care services, improved electricity supply, boost business activities, and increased access to piped water. These were the expected benefits to be derived from the implementation of the project**.**

The only fear expressed by the community by some respondents is the possibility of pipeline vandalism. This particular fear was expressed by the Oba, Olu of Siun land. The issue of pipeline safety is paramount to the population. The Olu of Siun land, Oba Lawrence Olawale Adisa Odeyinka (JP) therefore suggested that it will be good if the proponent could come up with a group insurance policy to cover the closely impacted populace who are linearly settled along the pipeline route. The Baale of Kajola community also expresses this concern about the security and safety of the pipeline and recommends that community youths in the area should be employed to provide added security and safety of the pipeline.

In the context of a responsive corporate body like Transit Gas Nigeria Limited that is conscious of the expectations of the people with respect to a project of this nature, it is therefore expected that global best practice as duly profound in the industry will be followed especially that of the principles of corporate social responsibility (CSR). The goodwill of the population to cooperate and make peace should be reciprocated.

Table 5.15: Summary of Expectations/needs of the Communities

Community	**Expectations/needs**
Sagamu	• Improved security outfit of the NPF to ensure professionalism in policing • Employment opportunities for the unemployed youths • The completion of some government contracted roads in the town • Improvement in the power supply from the government • Adequate compensation to those whose properties would be negatively impacted by the pipeline right of way
Ikene	• The renovation and expansion of the exiting public schools. • Public pipe-borne water to combat high rate of health conditions associated with water-borne diseases • Improved electricity supply by PHCN was clamoured for.
Ilisan	• Building of a general hospital and improvement in the already established primary care system • Improved power supply and regular maintenance and provision of good roads in the inner town.
Odogbolu	• Establishment of more commercial banks to augment the financial system already provided by microfinance banks • Job opportunities for the unemployed youths through the establishment of more industries
Ososa	• Provision of an efficient waste disposal system and improvement in the road maintenance of the community • Community are also clamouring for a General Hospital as they complained of the inadequacy of the present public health centre • Public water system for the community will also be of great pleasure

	• Community wants employment opportunities and training of youths in skills and other vocational programmes.
Ibefun	• Community was particularly enraged by the poor state of the entire road network and therefore sought for quick government intervention. • Employment opportunities for the youths • Provision of piped water as well as a general hospital
Ilado	• Provision of public primary and secondary schools • Building of public health centre • Public water system for the community • The community also clamour for the provision of financial assistance from government
Imodi-Ijasi	• Employment opportunities for the youths • Building of public schools both primary and secondary • The return of the Obaship title to the community by government
Kajola	• Good road network and tarred surfaces in the community • Need of secondary school • Provision of more security architecture to build more on security of the environment due to influx of strangers into the community
Bara	• Building of public schools both primary and secondary • The community is in dire need of piped water and public toilet • Improved good road network
Logbara	• Good public water supply system • Provision of public toilet and good drainage network
Onile-Imo	• Provision of secondary school • Public water for the community • Improvement in electricity supply
Siun	• Engagement of youths as part of pipeline security • Festive gifts for community by the proponent • Building of secondary and pipe borne water for the community as well as public toilet

5.3.17 Impacts and mitigations

In a project like this, definitely some gray areas of the human environment will be impacted either positively or negatively. Mitigation measures are therefore necessary to address the negative impacts of the project while the positive impacts are enhanced. The measures are to a large extent a function of the adverse social impacts of project requiring mitigates. The human environment requiring mitigates will include the following:

- Demographic Impacts (redirection of labour, inflation)
- Impacts on Lifestyles (sexual laxity, alcoholism, youth militancy).
- Impacts on Cultural Properties (religious sites/shrines, etc).
- Impacts on Social Infrastructure (schools, health care facilities, water supply).
- Impacts on natural resources (land uptake).

One common approach to mitigation measures involves its differentiation for the purposes of analysis. However, in reality they tend to be closely interrelated. For example, an increase in population (demographic impact) can increase pressure on natural resources and social infrastructure. Transit Gas Nigeria Limted should continue to show interest in these communities after the construction phase for the maintenance of good community relations.

Table 5.16: Impacts Mitigation Measures

Human Environment	**Mitigations**
Population growth due to influx of workers	• The use of local labour as much as possible will help
Pressure on available infrastructure	• Using local labour will help reduce impact • Provision of additional facility
Sexual laxity disruption	• Step up public awareness on sexually transmitted diseases (STD) and related health issues
Inflation	• Use of local labour as much as possible to reduce influx of outside workers
Destruction/loss of land	• Adequate and commensurate compensation to those affected
Unemployment/youth militancy	• Use of youths to provide labour • Skill acquisition programme to engage youths

The use of local labour as mitigate for several of the impacts is found to be reoccurring as shown in Table 6. This reflects the significant role labour, as a factor of production, plays in project of this nature.

Health

The proposed mitigation/enhancement measures for the respective impacts on health are presented below:

Environmental Sanitation/Waste Management: The objective here is to achieve proper management of refuse, sewage and vectors of diseases. It is expected that the Environmental Health Unit of each local government area will be found useful to manage this aspect.

Refuse Management: Frankly speaking, the level of refuse management of the population under review is currently unsatisfactory and needs to be addressed urgently. The proffered solution to this will include: The use of polythene bags for refuse collection should be embraced. Also, an efficient protocol to gather the refuse using specialized vehicle like compactor should be provided by the government as well as a properly managed dumpsite.

Sewage: The findings from the survey reveal that most residents in the urban settlements of the project area have access to modern toilet facilities, some areas, especially the rural communities of the project area lack this facility and people engage in open field defecation. Public awareness should be enhanced and provision of adequate public toilets at designated locations in the community particularly the motor parks and markets should be made available.

Disease: One likely common infection/disease in camps and construction sites is malaria. This can be controlled to a reasonable extent by emphasizing the use of treated mosquito nets, insect repellants and insecticide sprays in rooms. This should be accompanied with proper sanitation measures and clearing of bushes around base camps.

Water Quality Impairment: The practice of boiling and filtering of water for drinking accompanied with good hygiene is a good practice but not feasible in a project like this. Hence, workers should be encouraged to drink water from certified manufacturers. These producers of table water are proliferated in the study area.

Noise: Some parts of the project area, no doubt produce excessive noise as a result of the location of some factories as well as their proximity to the expressway where the noise pollution from vehicles are inevitable. Mitigates for this will include: ear protection devices (muffs) should be provided and worn by construction staff within the working zone. And where possible, use of low noise type equipment should be encouraged.

Housing: The influx of people into the communities will definitely lead to housing deficit and this can be mitigated through use of base camps as a makeshift for the temporary workers.

5.3.18 Recommendation

From the findings gathered during the study exercise, the recommendations provided below are expected to ensure a seamless execution and smooth operations of the project:

- The study provided huge opportunity for the socioeconomic team to interact with the host communities especially the stakeholders including the community heads and youths. The line of communication should be left open to provide the opportunity for ongoing close relationship and peaceful coexistence.
- The head of each community should be carried along by the team leads of the project in the event of any change of plan to ensure that all relevant stakeholders are on the same page.
- The pipeline project expectedly will pass through a nonexistent right of way. In areas where there are infringements on the properties/structures of the people through errors in contour areas, such affected people should be approached in a decent and friendly manner and compensated commensurately.
- The population of the study area demonstrated high hope and expectation for the gas pipeline project in terms of the development it will bring to their communities: this window of opportunity should be seized to ensure its completion on time.
- Adequate community/local labour should be emphasized to further provide the opportunity for employment for the youths especially where they possess the required skill to do the job.

Field Interaction

The field work commenced from March 24th – July 11th 2020 and it provided the opportunity to interact with the host communities. Field interviews and consultation with the host communities, community heads (Baale/Oba), and other community representatives were carried out successfully without any hitch. Issues of concern raised by the communities during the meetings and interviews have been documented earlier. The community leaders interviewed included all the traditional heads of the communities accessible during the field exercise. Where they were absent during the exercise, a cabinet chieftain of the community was interviewed to ensure that the information contained in this report remain valid and truthful. It is important to note that all the traditional heads met gave the socioeconomic team a warm reception and their chiefs and subjects were found to be cooperative and helpful too.

Impending Consultation

The Transit Gas Nigeria Limited should ensure that the window of opportunity provided through consultation is sustained by ensuring that the process is left open-ended with all the key stakeholders identified during the field activities throughout the phases of the project. With this in place, adequate and prompt response on community concerns and suggestions will be enabled. This will also help the proponent to feed-in priorities that could affect the project smooth implementation in its Corporate Management Plan.

This report will not be complete without the mention of the excellent job done by the proponent team of this gas pipeline project who ensured that many of the impacted community heads (Baales/Obas) were contacted for consultation before the socioeconomic team went for a field survey. This is highly commendable and should be sustained throughout the lifespan of the project.

CHAPTER SIX

POTENTIAL AND ASSOCIATED IMPACTS

6.1 Introduction

This section presents an assessment and evaluation of the associated and potential environmental impacts that may result from the proposed 135km Natural gas pipeline network. The focus of the impact description is the determination of the project-associated and potential impacts whether positive or negative. The assessment covers all activities of the project from pre-construction, through construction and operations as well as the decommissioning phase.

6.2 Impact Assessment Methodology

The method employed in the impact analysis of the proposed 135km gas pipeline network involved three stages:

1) Impact identification;
2) Impact prediction; and
3) Impact evaluation.

6.2.1 Impact Identification Methodologies

Impact identification attempts to answer the question, ‘‘what will happen when a project commences or enters its operation’’. The type and sources of the impacts were identified at this stage. The impact identification was done using the methods described below:

- Ad hoc method which utilized expert opinions based on a similar gas Natural Gas Pipeline Network in the past, within Nigeria and subregion,
- Checklists: which involve a listing of potential environmental impacts. This method was used to assess the nature of the impacts, i.e. beneficial or adverse, short term or long term, no effect or significant impact, reversible or irreversible. The type of checklists methods used includes a simple list and questionnaire checklists.
- Matrices: Pioneered by Leopold et al (1971), now modified Leopold Matrix, is aimed at identification of impacts and the determination of their magnitude and importance (Leopold et al, 1971) For Leopold matrix, the actions/activities interact with the different environmental components or sensitivities

- Overlays: invented by Mc Harg (1968, 69) rely on a set of maps of the project area's environmental characteristics covering physical, social, ecological and aesthetic aspects. Geographical Information Systems (GIS) techniques were utilized.
- Networks: used to identify cause-effect linkages.
- Battelle Environmental Evaluation System (Dee et al., 1973).
- Peterson Matrix

6.2.1.1 Overlay Technique

The overlay technique uses a series of transparencies to identify, predict and assign relative significance to impacts in a geographical area. In using this technique, the study area was sub-divided into convenient geographical units, based on uniformly spaced grid points, topographic features or differing land uses. Within each unit, the assessor collected information on environmental factors, through aerial photography based on google maps, topography, land use maps, field observations, public meetings, and discussions with a multidisciplinary team of project and environmental experts.

6.2.1.2 Leopold Matrix

Leopold et al (1971) were the first to suggest the use of a matrix method for impact assessment. This method is useful because it highlights the fact that impacts result from the interaction of project activities and the environment. The Leopold matrix was also used to present the results of the experts' appraisal. Numbers representing magnitude and significance, expressed on a 10-point scale, are included in each cell indicating where likely impact is anticipated. Positive and negative impacts are identified with "+" or "-" sign, respectively.

6.2.1.3 Battelle Environmental Evaluation System (BEES)

This system involves separation of human concerns into four categories namely: ecology, physical/chemical, aesthetics and socio-economics, and health. The method translates the state of individual environmental parameters into arbitrary, environmental quality indices; all expressed on the same scale. For each component, this system develops an index of environmental quality, normalized to a scale ranging from 0-1, using a value-function method. Each impact indicator is given as the difference in environmental quality between the states and those without project actions/activities.

The environmental quality scores are multiplied by the appropriate weighing and added to give a total score of environmental quality for each option under consideration.

6.2.1.4 Peterson Matrix

Peterson Matrix is a modified version of Leopold matrix adopted for the screening and scoping exercise of any project. This method relies directly on the multiplication properties of matrices. An ordinal scale is used to evaluate individual impacts by a team of assessors, and separate matrix layers are produced for physical and human impacts. The matrices are also multiplied to find the effect of the causal elements on the human environment while the resulting product is weighed according to the significance of the human impact. The impact analysis technique addressed the following:

- Comprehensiveness
- Selectiveness
- Exclusiveness
- Confidence
- Objectivity

6.2.2 Preliminary Environmental Interaction Matrix

A summary of the preliminary environmental interaction matrix is presented in **Tables 6.1**. Based on the proposed project technical information, assessments of impacts were derived from the activities of the following project phases including pre-construction, construction, operation and decommissioning. The preliminary environmental interactions in relation to the project activities were assessed during a brainstorming session by the project environmental consulting team using available data on the baseline environmental and social conditions. Effects may vary in significance according to the sensitivity of the environmental and social features present, and the time of the year in which the activity is being carried out.

The individual activities may affect the biophysical and human environment in various ways, such as impacts to biodiversity, the impact to air quality/noise and potential impacts resulting from destruction of vegetation and potential condensate spill. Each of the main areas of impact is further discussed in the subsequent sections.

Table 6.1: Preliminary Impact Assessment

			Sources of Potential Impact																		
			Pre-Construction		Construction									Operation					Closure	
			Site Clearing and Preparation of ROW	Mobilization of Equipment and materials to the site	Trenching and Excavation for prefabricated structures	Laying of pipes	Assembling of prefabricated structures and facilities	Horizontal Directional Drilling	Landfilling and reclamation	Vehicular/Traffic Movement	Emission from Stationary Equipment	Wastes Generation	Maintenance of Construction Vehicles and machines	Hydro-testing of pipeline	Transportation of gas	Maintenance of onsite generators	Pipeline maintenance	Wastes generation and handling	Dismantling of Structures	Site Restoration
environmental attributes	***Biophysical***	***Vegetation***																		
		Surface water/Sediment																		
		Aquatic/Benthic species																		
		Groundwater																		
		Soil fauna																		
		Air Quality																		
		Noise																		
		Soil Structure																		
		Wildlife																		
	Human/Social	*Population Characteristics*																		
		• The influx of Temporary workers																		
		• Population Change																		
		Livelihoods																		
		• Artisanal Fishing																		
		• Labor displacement																		
		• Business/income																		
		• Local employment																		
		• Physical Properties (Houses etc.)																		

		• Erosion/Flooding																		
		• Sexually Transmitted Diseases/AIDS																		
		Socio/cultural institutions																		
		• Religious Institutions (Archaeology etc)																		
		• Formal(govt.) institutions																		
		Community infrastructure																		
		• Water Supply																		
		• Health																		
		• Recreation																		
		• Roads																		
		• Educational Institutions (Schools)																		
		• Electricity																		
		Conflicts																		
		• Interest Group Activities																		
		• Disturbance																		
		• Youth unrest due to unemployment																		
		• Communal clashes due to differences in youth employment																		
		Accident																		
		• Pipe rupture and leakage																		
		• Road accidents due to an increase in vehicular movements																		
		• Kidnapping																		

After Leopold Matrix

Green – Positive impact; Yellow – Minor impact; Purple – Moderate impact; Red – Major impact.

6.2.3 Impact Prediction and Evaluation

Based on experience, it is obvious that no single method can have all of the attributes described above. For the proposed Natural Gas Pipeline Network, a technique was developed that incorporated all of the positive aspects of the various methods, resulting in a 4-step impact assessment methodology. The various steps involved are described below:

- **Step 1:**

The first step of activities in terms of impact assessment for this project was to determine the various phases of the project and the associated activities. This is particularly critical, given that impacts are triggered by actions. For the purpose of simplicity, a table of various project phases and the associated activities was developed ***(Table 6.2)***.

Table 6.2: Project Phases and Associated Activities

PHASES	**ACTIVITIES**
Pre-Construction	Survey and acquisition of pipeline Right of Way (RoW)
	Site Clearing/preparation of RoW
	Mobilization of equipment and materials to the site
Construction	Excavation
	Thrust boring through pipeline crossings (such as a road)
	Laying of Pipes
	Backfilling and site reclamation
	Assembling and erection of prefabricated units (metering stations, etc.)
	Vehicular/traffic movement
	Use of diesel power equipment
	Maintenance of construction vehicles and machines
Commissioning	Hydro-testing of pipeline
Operation and Maintenance	Transportation of gas
	Maintenance of onsite generators/engines
	Pipeline maintenance and pigging

- ***Step 2:***

The next step of impact assessment is to determine the environmental attributes that are susceptible to generate effect(s) from the planned activities, based on a clear understanding of the project phases, as presented in ***Table 6.2***. Apart from identifying the environmental attributes, it is also necessary to determine the susceptible components and/or parameters of each attribute such as pH, Organic Carbon, Heavy Metals, etc. in case of effects on Soil. Therefore, in carrying out step two for this impact assessment, a table of susceptible attributes was developed and the components of each attribute that could potentially be affected listed as presented in ***Table 6.3***.

Table 6.3: Activity – Environment Interaction Categories and Environmental Components

Environment and Social	**Environmental and Social Components**	**Susceptible Parameters**
Biophysical	Climate and Weather	Changes in rainfall patterns, ambient temperature, and relative humidity.
	Surface water and groundwater	Changes to water quality indices (Physico-chemical properties, hydrocarbons, metals).
	Ambient air quality	Increase in the concentration of pollutant gases: NO_x, SO_x, CO, VOCs, and Total Suspended Particulate (TSP). Increase, in noise level.
	Vegetation and wildlife	Changes to species composition, diversity and abundance.
	Waste	Increase in volume of wastes and pressure on waste handling facilities.
Socio-economic/Human	Population Characteristics	Changes in population indices –Total population, gender ratio, age distribution.
	Livelihoods	Impact on artisanal fishing activities. Impact on farming, lumbering and hunting activities.
	Social and cultural institutions	Impact on religious and government institutions.
	Public infrastructure	Impact on traffic congestion, road structure, and health problems among neighboring communities/residences. Improvement or pressure on existing urban/rural infrastructure including waste handling

Environment and Social	Environmental and Social Components	Susceptible Parameters
		facilities.
	Conflicts	Communal strife and disagreement between project workers and neighboring communities.
	Land use	Land use alteration emanating from land acquisition and claim settlement. Community protests over compensation and wrong landowner identification.
	Occupational hazards	Work-related injuries from work-at-height, confined space entry, welding, excavation, exposure to electricity, fire, and explosion, just to mention a few
	Health	Incidents of sexually transmitted diseases (STD's) and HIV/AIDS due to increased social lifestyle and movement of a sizeable number of people including the project team members and contractors to the project area.

- **Step 3:**

An initial screening of the associated and potential impacts was then conducted to determine those impacts that are greater than negligible. The screening was based on some predetermined parameters (i.e. classification criteria as presented in Table 6.4 below) that facilitated easy segregation of impacts into negligible, minor, moderate and major, such that only minor to major impacts was considered for further evaluation. The classification used to determine the class of impacts is shown in ***Table 6.4***.

Table 6.4: Classification of Impacts

Impact Classification	Classification Criteria
Negligible	The impact is minimal, and the effect will hardly be felt. It will not affect more than 1% of the project area. For example, loud noise from construction activity is not likely to exceed the immediate 26m of the project area.
Minor	The impact will bring about a noticeable change in the environment however the change is well within accepted standards, and/or the receptor is of low sensitivity/value. It will not affect more than 6% of the project environment.
Moderate	The impact is substantial and beyond the acceptable standard. Up to 26% of the project area will be affected and the impact will persist for a while.

Impact Classification	Classification Criteria
Major	The impact is very large affecting environmental function and resource usability or productivity. Up to and probably larger than 60% of resources will be affected. Recovery will take a very long time if it happens at all. For instance, clearing of vegetation during site preparation will require about five (6) years for full recovery.

In order to do this effectively, a modified Leopold matrix was used to screen and remove negligible impacts. Although all efforts were made to minimize subjectivity, it may occur at this stage. Subjectivity was minimized by ensuring that initial screening is done by requiring a multidisciplinary group of experts to reach a consensus on each of the identified impacts, prior to further evaluation.

- ***Step 4:***

After undertaking the exercise above, a final evaluation of impacts was done, to provide an overview of the various impacts. This was done using a set of criteria. Four impact severity evaluation criteria were applied to this study: ***Magnitude***, ***Duration***, ***Frequency***, and ***Areal Extent***. Within these criteria, impacts were also evaluated with respect to whether they will result in cumulative effects, incremental changes, or indirect (secondary) effects. The overall impact evaluation considers not only the potential severity of the impact but also the likelihood of its occurrence.

Magnitude is defined as the quantitative intensity of the impact and can be measured as the percentage of a resource or a population within the area of influence, that may be affected by an impact. The definitions of ***"major," "moderate"*** and ***"minor/low"*** with respect to Magnitude may vary depending upon the specific receptor. The magnitude of an impact was characterized as follows:

- Major – large amount of the resource or population is affected; an easily observable and measurable effect.
- Moderate – moderate amount of the resource or population is affected; generally measurable and observable effect.

- Minor/Low – a small amount of the resource or population is affected; a low magnitude impact may be within the range of normal variation of background conditions.
- Negligible – the amount of resources or population affected is unnoticeable or immeasurably small.

Duration is defined as the time that is estimated for a population or resource to return to conditions present prior to the impact. The duration is calculated from the time the impact begins, which may coincide with the start of the activity that causes the impact. The Duration of an impact may be characterized as follows:

- **Major** – long-term impact (recovery would not occur within ten years)
- **Moderate/Medium** –moderate-term impact (recovery time between one year and ten years)
- **Minor/Short** –short-term impact (recovery time within less than one year)
- **Negligible** – impact or recovery is a very short-term or immediate

Characterization of the Duration of an impact is defined as a low, medium, or high includes consideration of the degree of Reversibility of the impact. Impacts for which the Duration is classified as major, as defined above, would be irreversible impacts.

Frequency is defined as the number of times an impact is expected to occur over the life of the project. The Frequency of an impact may be characterized as follows:

- **Major** – continuous impact: Impact will occur continuously throughout the life of the project. (impact associated with some operational phase activities)
- **Moderate** – intermittent impact: Impact will occur intermittently over the life of the project. (Impact associated with maintenance activities)
- **Minor/Low** – rarely occurring impact: Impact will occur for a very limited number of times (e.g., mobilization of construction machines to the site)
- There is no "negligible" category for frequency because impacts with no frequency would not occur and were screened out.

Areal Extent refers to the potential areal coverage of an impact and may be quantified in units of the area affected (e.g., square kilometers). The Areal Extent of an impact may be characterized as follows:

- **Major** – impact to the national, regional, or global environment (e.g., greenhouse gas emissions)
- **Moderate** – impact to the general vicinity of the project site or study area
- **Minor** – impact limited to the immediate vicinity of the activity or occurrence that results in the impact
- **Negligible** – impact limited to a very small part of the activity area

Likelihood

This is a measure of the probability of the environmental event occurring. The scale will include:

- **Never** occurred – This impact has not occurred but has some likelihood
- **Unlikely** – This impact rarely occurs
- **Likely –** This impact is a usual occurrence, most often on a regular basis
- **Most Likely –** This impact is expected frequently
- **Certain –** This is a normal impact

Cumulative impacts are changes to the environment that are caused by activity in combination with other past, present, and future human activities (GSI, 2003). The concept of cumulative effects is an important one. It holds that, while impacts may be small individually, the overall impact of all environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over. The objective of the cumulative impact assessment is to identify those environmental and/or socio-economic aspects that may not on their own constitute a significant impact but when combined with impacts from past, present or reasonably foreseeable future activities associated with this and/or other projects result in a larger and more significant impact(s).

Residual Impacts: The evaluation of the significance of impacts in this ESIA takes into consideration the mitigation measures that TGNL is already committed to and that are described in the report. One objective of the ESIA is to understand the significance of the residual impacts in the sense that there will be impacts that may remain after mitigation measures have been designed into the intended activity and applied. The residual impacts are described in terms of their significance and the nature of the impact is qualified, where appropriate, on the basis of the descriptors.

At the end of the effort, all impacts categorized to be above negligible are coalesced and discussed in detail. Mitigation measures are then devised for each of them. In order to facilitate easy comprehension of impact analyses, the impacts of the project activities/phases were discussed based on the various affected environmental attributes, such as socio-economics, soil and land use, vegetation and wildlife, etc. ***Tables 6.6*** and ***6.6*** show a simplified overview of the coalesced impacts.

Table 6.5: *Overall Impact Severity Rating Matrix*

IMPACT QUANTUM AND EFFECTS				
SENSITIVITY	**IMPACT QUANTUM AND TEMPORAL EFFECTS**			
	Negligible	Low	Moderate	Major
Major	Low	Medium	High	High
Moderate	Low	Low	Medium	High
Minor	Negligible	Negligible	Low	Medium
Negligible	Negligible	Negligible	Negligible	Low

Table 6.6: *Impact Ranking*

Colour code	Impact Significance
	Positive Impact
	Negligible
	Minor Impact
	Moderate Impact
	Major Impact

Table 6.7: Negative Impact Significance Levels and Criteria

Significance Criteria	Physicochemical Environment	Biological Environment	Socioeconomic Environment	Health and Safety (Personnel and Public)
Negligible (negative)				
Temporal	The very temporary effect, even less significant than periodic stress by nature. The duration of the effect is likely to be naturally reversible within a short period of time (less than One week). The frequency of The impact is extremely low (less than two times/year).	The duration of the effect is likely to be naturally reversible within a short period of time (less than one week). The frequency of the impact is extremely low (less than two times/year).	Temporary influence (impact discernable for less than one week). The effects are completely reversible and of extremely low frequency (less than two times/year).	No discernable health effects for any period of time.
Areal	The impact to the seabed, air, and water is localized, existing only within the pipeline RoW or facility boundary.	Some impact localized on a community or organism level, but not distinguishable from natural background perturbation.	Localized, isolated change in socioeconomic conditions or commercial activities; not affecting persons other than project personnel	No discernable health effects in any area.
Magnitude	Little or no change in physical environment, barely measurable Above background conditions (less than five percent change from the background). The concentration at receptor points is well below (e.g., no more than ten percent of) identified industry	Little or no change in biodiversity, habitat availability, Or community structure and Function in comparison to background levels.	Unlikely to have any measurable impact.	No discernable health Effects on any part of the population.

Significance Criteria	Physicochemical Environment	Biological Environment	Socioeconomic Environment	Health and Safety (Personnel and Public)
Minor (negative)				
Temporal	Measurable change lasting only a few days to a few months before recovery, with no observable residual effects. The duration of the impact is likely to be totally reversible, Naturally or by the intervention Within six months and have a moderate frequency of impact (from two to five times/year).	Short-term (less than a few months) local change of species or population abundance or distribution, habitat availability, or community structure and function. The duration of the effect is likely to be totally reversible, naturally or by intervention within six months and have a moderate frequency of impact (from two to five times/year).	For single events, the duration is One week to six months, with no observable residual effects outside of the duration of impact. Effects are reversible over time. For recurrent events, duration of each impact is brief (less than two weeks) with no observable residual effects outside of the duration of impact. The frequency of impact is moderate (from two to five times/year).	For single events, duration Is one week to six months, with no observable residual effects outside of the duration of impact. Effects are reversible over time. For recurrent events, duration of each impact is brief (less than two weeks) with no observable residual effects outside of the duration of impact. The frequency of impact is moderate (from twice to five times/year).
Areal	Localized, relatively isolated change in the physicochemical environment. Impact consequence is realized within 100m of RoW or facility boundary.	Local change of species or population abundance or distribution, habitat availability, or community structure and Function within100m of RoW or Facility boundary.	Localized relatively isolated Change in socioeconomic conditions or commercial activities affecting population immediately adjacent to the project boundaries.	The impact is localized to Project personnel and local population living within100m of RoW facility boundary

Significance Criteria	Physicochemical Environment	Biological Environment	Socioeconomic Environment	Health and Safety (Personnel and Public)
Magnitude	Some measurable change to the affected environment, up to 10 percent increase/ decrease over background conditions when Applicable (i.e., some factors do Not have associated existing background levels). The concentration at receptor points is generally well within (e.g., no more than 76 percent of) identified industry benchmark levels or established national standards.	No impact at species, population, or community level but the health of individual organisms is negatively impacted, including where organisms avoid project the area as habitat.	Some measurable change in Socioeconomic conditions, livelihood, living conditions, or social structure, likely to result in only minor hardships for a small minority of the populations of the affected communities. Effects can be largely overcome with existing individual or community resources.	Minor injury or illness affecting a small portion of the affected population (<16 percent) with some cases of very brief lost time from work (one to two days) .
Moderate (negative)				

Temporal	The duration of the effect is more than six months but less than five years and reversible within that period of time. The frequency of impact may occur from five to ten times per year.	The duration of the effect is more than six months but less than five years and reversible within that period of time. The frequency of impact may occur from five to ten times per year.	For single events, the duration of the effect is more than six Months but less than five years, and fully reversible after that period of time. For recurrent events, the duration of each event is no more than a month, impacts are reversible after each event, and the frequency of impact is from five to eight times per year.	For single events, the duration of the effect is more than six months but less than five years, and fully reversible after that period of time. For recurrent events, the duration of each event is no more than a month, and the frequency of impact is from five to eight times per year.

Significance Criteria	Physicochemical Environment	Biological Environment	Socioeconomic Environment	Health and Safety (Personnel and Public)
Areal	Localized, relatively isolated change in the physicochemical environment. Impact consequence is realized up to 600m from RoW or facility boundary.	Local to widespread change in habitat availability or quality, likely to modify abundance or distribution of species. Impact consequence is realized up to 600m from RoW or facility boundary.	Impacts affecting not only Project personnel but also surrounding population, local communities/public up to 600m from RoW or facility boundary.	Impacts affecting not only Project personnel but also surrounding population (public) up to 600m from RoW or facility boundary.
Magnitude	Local modification of considerable severity in atmospheric, surface, or subsurface conditions. Significant measurable change From baseline conditions (10 to 20 percent change from baseline). The concentration at receptor points is at, near, or periodically exceeds identified industry benchmark levels or established national standards.	Impact evident at the community or population level, a significant change in population density (e.g., the decline in fish species abundance), habitat quality, etc.	A pronounced change in socioeconomic conditions, livelihood, living conditions, or social structure, likely to result in significant hardships Or a reduction in living standards for a significant portion (but less than half) of the affected community population. Impacts too severe to be overcome or ameliorated with existing individual or community resources.	Injury or illness affecting Less than half of the affected population to a greater or lesser degree, with a few cases requiring hospitalization and/or resulting in long-term disability.

Significance Criteria	Physicochemical Environment	Biological Environment	Socioeconomic Environment	Health and Safety (Personnel and Public)
Major (negative)				
Temporal	The duration of the effect is long-term (greater than five years) or is not reversible (permanent). Frequency of the The impact may occur more than ten times/year.	Long-term (greater than five years). The modification will persist beyond the duration of the project or is not reversible. The frequency of the impact may occur more than ten times/year	The effect is long-term or Likely to last more than five years or is not reversible. For recurrent events, the duration of each event is greater than a month, impact frequency is high (more than eight times/year) and impact durations may overlap.	Effects are of long-term Duration (more than five years) or permanent, i.e., not reversible. For recurrent events, the duration of each event is greater than a month, impact frequency is high (more than eight times/year) and impact durations may overlap.
Areal	Widespread modification of considerable severity in atmospheric, surface, or subsurface conditions. The areal extent of impact consequence is realized beyond 600m of RoW or facility boundary.	Widespread change in habitat availability or quality, which Would likely modify natural Abundance or distribution of species beyond 600m of RoW or facility boundary.	Widespread (possibly even Beyond study area communities).	Impacts affecting not only Project personnel but also surrounding population (public) more than 600m from RoW or facility boundary; may cause regional effects.

Significance Criteria	Physicochemical Environment	Biological Environment	Socioeconomic Environment	Health and Safety (Personnel and Public)
Magnitude	Modification of considerable severity in atmospheric, surface, or subsurface conditions. Significant, Measurable change from Baseline conditions (more than 20 percent change from baseline when applicable). The concentration at receptor points exceeds identified industry benchmark levels or established national standards.	Impact to affect organisms at or above the ecosystem level.	A very pronounced change in socioeconomic conditions, livelihood, living conditions, or social structure, likely to Affect the majority of people In the affected communities and result in serious hardships, reduction in living standards, or impoverishment. Impacts overwhelm the ability of individuals or communities to recover or overcome.	Impacts affect a large a portion or even the majority of the affected population to a greater or lesser degree, with some cases of permanently disabling injury/illness; chronic and irreversible health impacts that may shorten life expectancy or immediate fatalities.

[a]Physico-chemical and Biological Impacts are considered "localized" if they are likely to occur only within 100m of the impact source (pipeline or construction equipment).

6.2.4 Assessment Methodology

The impact identification process uses a project environment interaction approach where various project activities that are likely to interact with environmental and social attributes at different phases of the proposed project irrespective of the level of significance are highlighted. The essence is to provide a broad-based knowledge of the project impacts, with a view to recommending cost-effective mitigation measures.

For the purpose of this assessment, potential positive impacts associated with the proposed 135km Natural Gas Pipeline Network are highlighted differently from the negative impacts.

6.2.4.1 Potential Positive Impacts

Most of the identified potential positive impacts associated with the 135km Natural Gas Pipeline Network are socioeconomic in nature. Potential positive impacts for the various phases of the proposed project implementation are presented in ***Table 6.8***.

Table 6.8: Potential positive impacts associated with the TGNL project

Project Phase	**Potential Positive Impact**
Pre-Construction	Improved access to project location, which is presently unkempt and may harbor dangerous reptiles such as snakes and scorpions.
	Clearing and removal of vegetation and stumps will improve the aesthetic value of the project area.
	Provision of local labor especially from residents of Lekki and Epe and nearby communities will lead to improved personal income and living standard.
Construction	Increased sales and income for food vendors due to increased patronage from local labor who will be engaged during this phase.
	Potential provision of labor youths thereby leading to improved income and standard of living especially around Ibeju-Lekki, Epe, and other neighboring communities.

	Improved social life and economic standard especially around the host communities.
Operation and Maintenance	Improved utilization of gas that has hitherto been locked up.
	Gas transportation will lead to increased income for both investors and government through payment of taxes and other statutory levies.
	Technology transfer and increased generation of employment.
	Improved security especially around the project area due to better and uninterrupted illumination of the area at night.
	The project is designed to reduce gas flare, thereby contributing to Climate Change mitigation objectives while enhancing revenue from effective gas utilization.
	Return on investment for Rite Foods industries

6.2.4.2 Potential Negative Impacts

Tables 6.9 and ***6.10*** present the potential and associated negative environmental and social impacts respectively of the proposed 135km TGNL Natural Gas Pipeline Network.

***Table 6.9**: Negative Environmental Impacts Associated with the135km Natural Gas Pipeline Network*

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
Pre-Construction	RoW Clearing and Site Preparation.	• Use of equipment that can cause **air emissions** and associated **air pollution**: Clearing and site preparation may lead to the emission of particulate matter (dust) into the ambient air. Thereby deteriorating the air quality condition of the area especially if this activity is carried out during the dry season;	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • The public interest is not significant Therefore, the overall impact significance is Minor.	Minor
		• **Water pollution**: an increase in sediment load and turbidity of pockets of inland waters within the project area. This may arise as a result of land and vegetation disturbance creating particulates and subsequent washing into surface water bodies	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is minor. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low • The public interest is not significant Therefore, the overall	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			impact significance is Minor.	
		• **<u>Change in ecological characteristics</u>:** The introduction of film materials such as laterite, sand and gravel for access, operational building construction activities could lead to contamination of the soil and groundwater of the area, especially if the fill materials are contaminated.	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is minor. • Likelihood: unlikely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	Minor
		• **<u>Loss of biodiversity:</u>** The clearing of vegetation from the site may lead to v egetation loss and subsequent exposure of the soil surface to agents of denudation (Rain and wind). Trees, shrubs and lower class vegetation will be a loss. Fauna components will be forcefully	• Duration of this activity is moderate as habitat restoration time could be between one year and ten years • Magnitude is moderate as the impact will occur at population and community level of biodiversity. • Frequency is moderate as the impact will occur intermittently over the project	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		evicted from their natural habitats such as earth burrows and bird nests on trees. These impacts are only during pre-construction and construction phases, but revegetation and habitat restoration could occur afterward.	life and; • Areal extent is major (about 135km). • Likelihood: unlikely • Regulated: Yes • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Moderate.	
		• The process of re-vegetation could lead to the **introduction of exotic species of plants**, which could out-compete native species leading to an alteration of species composition and abundance.	• Duration of this activity is moderate, • Magnitude is moderate, • Frequency is moderate and; • Areal extent is major. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low Public interest is minor Therefore, the overall Impact is Moderate.	Moderate
	Mobilization of personnel, equipment, and materials to the site	• **The influx of people** to the area in search of employment leading to a change in demographic	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		characteristics of the area. Other associated impacts include social vices and pressure on available utilities	minor. • Likelihood: Likely • Regulated: No • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor.	
		• Movement of earthmoving equipment, payloaders, gravel, sand, cement, rods, levelers, crane, pipes, etc. To the project site may engender a temporary **increase in noise levels** and **vibration** from the movement of vehicles and machines to site;	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low Public interest is minor Therefore, the overall Impact is Minor.	Minor
		• **Air pollution**: a potential increase in gaseous emissions from vehicles used to convey the construction equipment to the site.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood:	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			Unlikely • Regulated: Yes • Importance of environmental component is low Public interest is minor Therefore, the overall Impact is Minor.	
		• **<u>Climate change potential</u>**: emission of greenhouse gases (NOx, CHx, CO, and CO_2) from vehicles	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: unlikely • Regulated: Yes • Importance of environmental component is medium • Public interest is medium Therefore, the overall Impact is Minor.	Minor
		• **<u>Displacement of wildlife species even flora species</u>**: potential migration of noise-sensitive wildlife and aquatic species from the project area as a result of possible excessive noise	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		generated by the movement of mobilization vehicles.	• Importance of environmental component is low public interest is minor Therefore, the overall Impact is Minor.	
		• **Alteration of soil structure and landscape**: potential alteration of soil structure especially on the project location, which could also lead to soil erosion. However, on completion of the mobilization activities, altered soil structures can recover its components without any modification.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is Minor.	Minor
Construction	Clearing, Landscaping, Excavation and Trenching of portions to be used for construction camps, operational buildings/metering station/ manifold, and pipeline trenches and horizontal directional	• **Loss of vegetation**: the potential loss of vegetation and important plant species.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor • Likelihood: Likely • Regulated: Yes • Importance of environmental	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
	drilling/thrust boring.		component is low Public interest is minor Therefore, the overall impact is Minor.	
		• **Noise:** Potential increase in ambient noise from earth moving equipment.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor.	
		• **Loss of fauna:** potential migration and loss of soil fauna especially on the excavated portion;	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low Public interest is	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			minor Therefore, the overall Impact is Minor.	
		• **<u>Air pollution:</u>** Potential dust generation during the excavation may temporarily increase the Total Suspended Particulate (TSP) level in and dust the ambient air of the environment especially if this activity is carried out in the dry season. Gaseous pollutants such as NOx, SOx, COx, and CHx can also be emitted from equipment	• Duration of this activity is short. • Magnitude is small, • Frequency is medium and, • Areal extent is localized. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor.	Minor
		• The potential change in the local topography of the area	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: No • Importance of environmental component is low	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			• Public interest is minor Therefore, the overall Impact is Minor.	
		• **<u>Water pollution:</u>** a potential increase in turbidity of available shallow waters especially in the rainy season as a result of run-offs. This can negatively affect the aquatic species within the surface water bodies. In addition, due to disturbance of the waterbed, toxic waste that has solidified on materials will be loosed and spread to the water column thereby contaminating it.	• Duration of this activity is short. • Magnitude is moderate, • Frequency is moderate and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low Public interest is medium Therefore, the overall Impact is Moderate.	Moderate
		• **<u>Increase in ambient Noise level and vibration</u>**: Noise and vibration from heavy machinery used for excavation and.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor.	
		• **<u>Loss of biodiversity</u>**: the potential loss of aquatic fauna and flora/benthic organisms.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall impact is Minor.	Minor
		• Loss of wildlife habitat: earth burrow for mammals will be damaged during excavation. On completion of excavation and backfilling, some of the wildlife species may return to the original	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		environment.	component is low • Public interest is • minor Therefore, the overall Impact is Minor.	
		• **Potential alteration of soil structure**, which may lead to soil erosion around the excavated portions.	• Duration of this activity is short. • Magnitude is high, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is minor Therefore, the overall Impact is Moderate.	Moderate
		• **Potential damage to/loss archaeological artifacts**. Although the project area does not have a record of such buried features, any of such buried cultural and geological features	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is moderate. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		encountered during excavation that can be used for study and research work can be lost and or destroyed as a result of excavation work.	component is low • Public interest is • minor Therefore, the overall Impact is Minor.	
		• **<u>Land pollution:</u>** Potential waste generation from construction workers due to indiscriminate defecation and disposal of waste such as food and water containers within the project area. Other sources of pollution include potential diesel spill.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low • Public interest is • Moderate Therefore, the overall Impact is Minor.	Minor
	Laying of Pipes - Stringing, Bending, Welding, and Lowering	• **<u>Air pollution</u>**: during the welding process of the pipes, there may be a temporal increase of NO_2 in the ambient air. Other notable pollutants	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		include CO and CO_2.	• Regulated: Yes • Importance of environmental component is moderate • Public interest is • minor Therefore, the overall Impact is Minor.	
		• Potential temporal increase in ambient **noise level** as a result of the cutting, scraping and shaping of the pipes during welding.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor	Minor
		• Potential **vibration** from machinery. Machinery to be used include an excavator, compactors, etc. which are potential sources of vibration	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			• Regulated: No • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor	
		• The potential **<u>loss of aquatic fauna and alteration of benthic ecology.</u>** During pipe laying, the benthic, as well as pelagic aquatic organisms, will be demobilized from their natural habitat.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor	Minor
		• **<u>Displacement of wildlife species even flora species:</u>** Potential migration of noise-sensitive mammals and reptiles from the natural habitat due to the increased	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		noise level caused by machinery.	• Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor	
	Installation of Metering station, manifold, and other surface units.	• Potential increase in ambient **noise** from equipment and other human activities. The potential impact is similar to those caused by previous activities.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is ranked, Minor.	Minor
	Nondestructive testing (NDT) and hydro-testing	• Land and surface water pollution: the release of hydro-test fluid containing chemicals such as inhibitor into land and surface water	• Duration of this activity is short. • Magnitude is high, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			• Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is ranked Moderate.	
		• Radiations (X-Ray) from NDT activities	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is ranked Minor.	Minor
	Backfilling, Clean-Up, Restoration and Reclamation	• **<u>Loss of biodiversity:</u>** Sand filling during the dry season may bury important aquatic and benthic flora and fauna that presently inhabit the swampy portions of the	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		project area.	• Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is ranked Moderate.	
		• Potential **introduction of foreign and contaminated materials** into the project area especially if the filling materials are contaminated.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is ranked, Minor.	Minor
		• Potential increase in **soil erosion** due to continuous loosening of soil as a result of increased movement of vehicles on untarred primary roads in the area.	• Areal extent will be moderate • Duration is short • The frequency of this activity is low • Magnitude is small • Likelihood: unlikely	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			• Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is Minor	
		• **<u>Increase in noise levels</u>** from construction vehicles may distort the current serenity of the project area.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low Public interest is minor Therefore, the overall Impact is Minor	Minor
		• **<u>The potential loss of wildlife species</u>** from the project area due to the sudden introduction of noise in the project area.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			low • Public interest is minor Therefore, the overall Impact is Minor	
		• **<u>Air pollution</u>**: Use of stationary emission sources such as diesel-powered generators are potential sources of air pollution due to emissions pollutants gases.	• Areal extent will be moderate • Duration is short as this phase is expected to be short-lived. • The frequency of this activity is low • Magnitude is small • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall impact is minor	Minor
		• Potential increase in ambient noise around the project area.	• Areal extent will be moderate • Duration is short as this phase is expected to be short-lived. • The frequency of this activity is low • Magnitude is small • Likelihood:	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			Likely • Regulated: Yes • Importance of environmental component is low Public interest is minor Therefore, the overall impact is minor	
		• **<u>Waste generation</u>**: Various waste materials are always generated in most construction site and in camps/communities where construction workers are accommodated. In most cases, improper disposal of these wastes pose some problems, especially if appropriate mitigation is not put in place during this phase of the proposed project.	• Areal extent is minor • Construction duration is short relative to the project lifecycle • The frequency of this activity is low • Magnitude is small • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low Public interest is minor Therefore, the overall impact is minor	Minor
	Maintenance of Construction Vehicles and machines	• Potential contamination of soil, surface, and groundwater as a result of the indiscriminate disposal of spent lube oil and used serviced parts.	• Duration is minor • Frequency is minor • Magnitude is minor • Areal extent is minor • Likelihood: Unlikely	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			• Regulated: Yes • Importance of environmental component is low Public interest is minor Therefore, the overall impact is minor	
	Hydro-testing of the pipeline	• Indiscriminate discharge of the hydro-test water could lead to acute toxicity of aquatic organisms, low dissolved oxygen levels in the immediate surrounds of the discharge.	• The areal extent of the portion that will be impacted is small. • The frequency of this activity is low as the activity will not be continuous. • Magnitude is small. • Duration of this activity is small • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall impact is Minor	Minor
Operation and Maintenance As previously elucidated in Chapter Three of this report TGNL intends	**Transportation of gas**	• **<u>Land and groundwater pollution</u>**: potential gas leak leading to fire and explosion may result in contamination of soil and aquatic	• Areal extent is small • Duration is low • The frequency of this activity is low • Magnitude is moderate • Likelihood:	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
to construct a135km pipeline and in order to capture the associated and potential impacts during the operational phase of the proposed project, it is essential to discuss the impacts of the various activities of this phase on the different environmental attributes.		environment and life forms. The potential destruction of assets and properties from pipeline blow-out.	Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall impact is Minor	
		• **<u>Air pollution</u>**: Continuous operation of pressure reduction engines may lead to CH_4 emissions and deterioration of the ambient air quality. The emission of methane, a major GHG will lead to global warming impact	• Areal extent is expected to be high. • The frequency of this activity is high, though the likelihood of the impact is moderate. • Magnitude is medium. Duration of this activity is long • Likelihood: Likely • Regulated: Yes • Importance of environmental component is high • The public interest is moderate Therefore, the overall impact is Major	Major
		• **<u>Climate change:</u>** Predominant pollutant is known to be methane (CH_4)	• Areal extent is high. • The frequency of this activity is high, though the likelihood	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
		which is one of the high global warming potentials for climate change.	of the impact is high. • Magnitude is moderate • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low • Public interest is • Moderate. Duration of this activity is long Therefore, the overall impact is high	
		• **<u>Vibration</u>** impacts from the pressure reduction engines could impact on the land physical (geological) characteristics as well as human health	• Areal extent is expected to be small. • The frequency of this activity is high, though the likelihood of the impact is low. • Magnitude is small. Duration of this activity is long • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall impact is	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			minor.	
		• Sanitary and domestic was tes generated from the operational building and kitchen can pose danger to the immediate environment if not adequately treated before discharge.	• Areal extent is expected to be moderate. • The frequency of this activity is high, though the likelihood is low. • Magnitude is moderate. Duration of this activity is long • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • The public interest is moderate Therefore, the overall impact is moderate	Moderate
		• **<u>Noise:</u>** Potential increase in noise, particulate and gaseous emissions. Power generation and evacuation from a small independent power facility is identified as potential sources of noise especially at the PRMF	• Duration of this activity is long. • Magnitude is small, • Frequency is high and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			• Moderate Therefore, the overall impact is Moderate.	
	Maintenance (pigging activities, maintenance, compressor, power plant, and pumps)	• **<u>Land pollution</u>**: Indiscriminate disposal of spent lube oil during routine maintenance of the generators may alter the biophysical characteristics of the soil or water in the immediate environment.	• Duration of this activity is short. • Magnitude is small, • Frequency is low and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor	Minor
		• **<u>Nuisance</u>**: Potential solid waste generation from used parts, packages, accessories, etc.	• Areal extent is expected to be small. • The frequency of this activity is low, • Magnitude is small. • Duration of this activity is small. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact Significance
			• Public interest is minor Therefore, the overall impact is minor	
		• **Waste generation:** Indiscriminate discharge of the condensate and disposal of spent oil may lead to the alteration of the ecology of soil or surface water;	• Duration of this activity is short. • Magnitude is small, • Frequency is moderate and, • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is Minor.	Minor

Table 6.10: Potential Negative Social Impacts Associated with the TGNL Project

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
Pre-Construction This is the planning phase of the project where designs, construction details, acquisition of RoW, claim settlements and project implementation strategies will be finalized. A very important component of this phase that might also impact the general	**Land acquisition and Claim settlement**	• **<u>Third party agitation:</u>** Communities located along the pipeline RoW and land grabbers/swindlers popularly known as *Omo onile* in Lagos are	• Areal extent is expected to be moderate. • The frequency of this activity is low, though the likelihood of the impact is high. • Magnitude is moderate. • Duration of this activity is	Major

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
acceptability and overall success of the project is the site preparation and mobilization of equipment/materials to project location.		identified as potential sources of agitation. However, currently, the Lagos State government with its Lagos State Property Protection Law, 2016 has put land related agitation under control.	short. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is Moderate Therefore, the overall impact is Major.	
		• **<u>Land take</u>**: Land take for the RoW will be permanent, however, the project is sub-surface therefore it will not create landscape problems. The sensitivity of the project area is high considering land value in Lagos state. However, the right of	• The duration permanent • Magnitude is low • Areal extent is large • Frequency is long • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • The public interest is Major	Major

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		way is just 26m and access		
		• Potential reduction of access to land and its resources.	• Magnitude is minor, • Duration of this activity is long. • Frequency is low and, • Areal extent is minor. Therefore, the overall Impact is Minor	Minor
		• Potential encroachment on culturally sensitive sites. • Site selection avoided grave sites and shrines	• Magnitude is minor, • Duration of this activity is long. • Frequency is low and, • Areal extent is minor. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is Minor	Minor
	RoW Clearing and Site Preparation.	• Clearing and site preparati	Duration of this activity is short,	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		on may lead to displacement of hunters who may presently rely on the project area for hunting.	• Magnitude is small, • Frequency is low and; Areal extent is small. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	
		• The potential loss of hunting activities may also lead to loss of income and important source of family protein;	Duration of this activity is short, • Magnitude is small, • Frequency is low and; A real extent is small. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is Minor.	Minor
		• Farmers who have	• Magnitude is high,	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		hitherto used the project area for subsistence and semi-commercial farming activities may lose their farmlands and income or food.	• Duration of this activity is short. • Frequency is low and, • Areal extent is minor. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low Public interest is minor Therefore, the overall Impact is Moderate.	
		• Clearing of vegetation may result to potential loss of medicinal and commercial crops, which may lead to prevalence and protraction of some ailments that have hitherto been treated	Duration of this activity is short, • Magnitude is small, • Frequency is low and; Areal extent is small. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor.	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		with some of these important plants as well as loss of income, especially on the commercial crops.		
		• Potential injury and exposure of workers to wildlife attack.	• Duration of this activity is short, • Magnitude is moderate, • Frequency is low and; • Areal extent is low. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor.	Minor
	Mobilization of personnel, equipment, and materials to the site	• Movement of materials to the project site, which will be primarily	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		by road may lead to a potential increase in vehicular traffic especially in adjoining roads during this period may engender traffic build-up especially on such roads as Lekki Epe expressway;	minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is Minor.	
		• Temporary increase in noise levels from the movement of earth moving and construction vehicles could lead to psychological stress in nearby communities.	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is minor. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
			overall Impact is Minor.	
		• Cases of armed bandit attacks/ kidnappings may arise during mobilization.	• Duration of this activity is short, • Magnitude is high, • Frequency is low and; • Areal extent is high. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • Public interest is • Moderate Therefore, the overall Impact is moderate.	Moderate
		• Potential third-party agitation	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is minor. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is low • Public interest is	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
			minor Therefore, the overall Impact is Minor.	
Construction	**Clearing, Landscaping, Excavation, and Trenching of portions to be used for construction camps, operational buildings and pipeline trenches and Horizontal Directional Drilling.**	• The influx o	• This activity is of short duration, • Magnitude is small, • Frequency is low and; • Areal extent is moderate. • Likelihood: Likely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	Minor
		• Potential deterioration of ambient air quality as a result of emissions from stationary equipment could lead to health-related issues among construction workers and	• This activity is of short duration, • Magnitude is small, • Frequency is low and; • Areal extent is moderate. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		residents of the host community.	low • Public interest is moderate Therefore, the overall Impact is Minor	
		• The influx of construction workers may lead to a potential increase in the rate of pregnancies and unwanted abortion	• This activity is of short duration, • Magnitude is high, • Frequency is low and; • Areal extent is high. • Likelihood: Likely • Regulated: No • Importance of environmental component is low • Public interest is moderate Therefore, the overall Impact is Moderate	Moderate
		• Potential proliferation of diseases such as sexually transmitted diseases and HIV/AIDS especially among	• This activity is of short duration, • Magnitude is high, • Frequency is low and; • Areal extent is high. • Likelihood: Likely • Regulated: No	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		females in nearby communities as a result of the influx of temporary construction workers;	• Importance of environmental component is low • Public interest is Moderate Therefore, the overall Impact is Moderate	
		• Cases of armed bandit attacks/ kidnappings may arise during this activity	• This activity is of short duration, • Magnitude is high, • Frequency is low and; • Areal extent is high. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is Moderate Therefore, the overall Impact is Moderate	Moderate
		• Potential accident and bodily injuries especially to pedestrians (farmers)	• This activity is of short duration, • Magnitude is high, • Frequency is low and;	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		who may not be aware of this activity especially in the dark early morning hours while going to the farm.	• Areal extent is high. • Likelihood: Likely • Regulated: No • Importance of environmental component is low • Public interest is moderate Therefore, the overall Impact is Moderate	
		• Potential influx of migrant workers to the project area may put pressure on the limited social infrastructures in the host communities.	• This activity is of short duration, • Magnitude is small, • Frequency is low and; • Areal extent is small. • Likelihood: Likely • Regulated: No • Importance of environmental component is low • Public interest is minor Therefore, the overall Impact is Minor	Minor
		• Increase in noise level and vibrations	• This activity is of short duration, • Magnitude is	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		from heavy machinery could lead to psychological stress to residents of nearby communities	small, • Frequency is low and; • Areal extent is small. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor	
		• Potential youth unrest resulting from unemployment of some youths who may have considered themselves more qualified but were denied temporary employment opportunity;	• This activity is of short duration, • Magnitude is small, • Frequency is low and; • Areal extent is small. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor	Minor
	Laying	• Potential	• This activity is	Major

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
	Pipes – Stringing, Bending, Welding and Lowering	accident and bodily injuries especially to pedestrians, users of the waterway who may not be aware of this activity	of short duration, • Magnitude is high, • Frequency is moderate; • Areal extent is high. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • The public interest is a major • Therefore, the overall Impact is Major	
		• Potential accidents injuries from work-related activities	• This activity is of short duration, • Magnitude is moderate, • Frequency is low; • Areal extent is high. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is moderate Therefore, the	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
			overall Impact is Moderate	
		• Potentially increased pressure on limited infrastructure in nearby communities Especially around Ibeju-lekki and Epe LGA where some of these workers may secure temporary accommodation.	This activity is of short duration, • Magnitude is moderate, • Frequency is low and; Areal extent is moderate. • Likelihood: Likely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	Minor
	Vehicular/Traffic Movement	• Potential increase in noise around the project area that may lead to psychological Stress to workers and residents of nearby host communities due to the blaring of vehicle horns and continuous movement of constructio	• Duration of this activity is short, • Magnitude is moderate, • Frequency is low and, • Areal extent is small. • Likelihood: Likely • Regulated: No • Importance of environmental component is low • The public interest is a minor	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		n vehicles;	Therefore, the overall Impact is Minor.	
		• Potential traffic congestion around the project area, especially along Lekki Epe express road, may lead to loss of valuable hours on the road as well as psychological stress on commuters.	• Duration of this activity is short, • Magnitude is moderate, • Frequency is low and, • Areal extent is small. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is moderate Therefore, the overall Impact is Minor.	Moderate
		• Potential road accident as a result of road crossing of errant pedestrians	• This activity is of short duration, • Magnitude is high, • Frequency is low and; • Areal extent is high. • Likelihood: Likely • Regulated: Yes • Importance of environmental	Major

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
			component is moderate • Public interest is major Therefore, the overall Impact is Major.	
	Emission from Stationary Equipment	• Potential health impact such as bronchitis, and other respiratory problems due to inhalation of noxious emissions from vehicle exhaust pipes.	This activity is of short duration, • Magnitude is moderate, • Frequency is low and; Areal extent is moderate. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is • minor Therefore, the overall Impact is Minor.	Minor
		• Increased noise may engender discomfort in social milieu.	• Duration of this activity is short, • Magnitude is moderate, • Frequency is low and, • Areal extent is small. • Likelihood: Likely • Regulated: Yes	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
			• Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	
	Wastes Generation Various waste materials are always generated in most construction site and in camps/communities where construction workers are accommodated. In most cases, improper disposal of these wastes pose some problems, especially if appropriate mitigation is not put in place during this phase of the proposed project.	• Generation of domestic wastes such as food and other organic materials may engender odor and fouling of the ambient air.	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is small. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is moderate Therefore, the overall Impact is Moderate.	Moderate
		• Potential health-related problems from decomposing waste materials	This activity is of short duration, • Magnitude is moderate, • Frequency is low and; Areal extent is moderate. • Likelihood:	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		indiscriminately disposed of by construction workers.	Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is Moderate Therefore, the overall Impact is Moderate.	
		• Reduction of the aesthetic value of the project area as a result of indiscriminate waste Disposal.	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is small. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	Minor
		• Potential agitation among youths for increased job opportunity quota	This activity is of short duration, • Magnitude is moderate, • Frequency is low and; Areal extent is moderate.	Minor

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		and privileges.	• Likelihood: unlikely • Regulated: No • Importance of environmental component is low Public interest is minor Therefore, the overall Impact is Minor.	
		• Increased pressure on limited social infrastructures i n nearby communities including nearby host communities.	• Duration of this activity is short, • Magnitude is small, • Frequency is low and; • Areal extent is small. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	Minor
	Hydro-testing of pipeline	• The potential for surface water degradation may	This activity is of short duration, • Magnitude is moderate, • Frequency is low and; Areal extent is	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		prevent domestic use.	moderate. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Moderate.	
	Maintenance of Construction Vehicles and machines	• Indiscriminate disposal of spend lube oil used to service construction vehicles and machines on available surface water bodies may lead to a loss in fishing catch and income for the artisanal fishermen.	This activity is of short duration, • Magnitude is minor, • Frequency is low and; Areal extent is minor. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is low • The public interest is a minor Therefore, the overall Impact is Minor.	Minor
Operation and Maintenance As previously discussed in Chapter Three of this ESIA report, this project	**Transportation of gas**	• Potential pipe rupture and condensat	• Duration of this activity is long. • Magnitude is high,	Major

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
is intended to construct a 135km pipeline from the ELPS KP292 tie-in point at Mojoda to Lekki Free Zone and in order to capture the associated and potential impacts during the operational phase of the proposed project, it is essential to discuss the impacts of the various activities of this phase on the different environmental attributes.		e spill could lead to a fire, pollution of soil, surface/underground water, sediment and poisoning of aquatic life, which may engender communal unrest and agitations.	• The frequency of activity is high and, • Areal extent is large. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • The public interest is a major Therefore, the overall Impact is Major.	
		• Cases of armed bandit attacks/ kidnappings may arise during transportation of gas	• Duration of this activity is long. • Magnitude is high, • The frequency of activity is high and, • Areal extent is large. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • The public interest is a major Therefore, the	Major

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
			overall Impact is Major.	
	Maintenance of onsite generators/engines/power plant	• Potential bodily injuries to maintenance engineers;	• Duration of this activity is short. • Magnitude is high, • The frequency of activity is low and, • Areal extent is large. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is low • Public interest is moderate Therefore, the overall Impact is Moderate	Moderate
		• Potential indiscriminate disposal of waste e.g. spent oil and service materials may reduce the aesthetics of the project area and contaminates soil	• Duration of this activity is short. • Magnitude is high, • The frequency of activity is low and, • Areal extent is large. • Likelihood: Unlikely • Regulated: Yes • Importance of environmental component is	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		and groundwater	low • The public interest is a minor Therefore, the overall Impact is Moderate	
	Pipeline maintenance and pigging	• Potential condensate spill during pipeline maintenance and pigging may engender agitation from stakeholders	• Duration of this activity is short. • Magnitude is high, • The frequency of activity is low and, • Areal extent is large. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is moderate Therefore, the overall Impact is Moderate	Moderate
		• Potential line rupture if appropriate precautions are not taken during regular maintenance.	• Duration is moderate. • Magnitude is high, • The frequency of activity is low and, • Areal extent is large. • Likelihood: Likely	Major

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
			• Regulated: Yes • Importance of environmental component is moderate • The public interest is a major Therefore, the overall Impact is Major.	
	Waste handling and generation	• Indiscriminate treatment and disposal of wastes will engender odor, which may lead to an outbreak of disease around the host communities.	• Duration of this activity is long. • Magnitude is high, • The frequency of activity is low and, • Areal extent is large. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is moderate Therefore, the overall Impact is Moderate	Moderate
		• Potential indiscriminate disposal c May reduce the aesthetics	• Duration of this activity is long. • Magnitude is high, • The frequency of activity is	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		of the project area	low and, • Areal extent is large. • Likelihood: Likely • Regulated: Yes • Importance of environmental component is moderate • Public interest is moderate Therefore, the overall Impact is Moderate	
		• The potential loss of employment and income to workers especially those still in their productive ages;	• Duration of this activity is short. • Magnitude is high, • The frequency of activity is low and, • Areal extent is large. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is moderate • Public interest is moderate Therefore, the overall Impact is Moderate	Moderate

Project Phase	Activity/Source of Impact/Issue	Potential Negative Impact	Impact Ranking	Impact significance
		• The potential loss of revenue by the proponent.	• Duration of this activity is short. • Magnitude is high, • The frequency of activity is low and, • Areal extent is large. • Likelihood: Unlikely • Regulated: No • Importance of environmental component is moderate • The public interest is a minor Therefore, the overall Impact is Moderate	Moderate

6.3 Impact Description

Sources of the associated and potential impact of the proposed GPL project are highlighted in this section. Identified environmental issues associated with a gas distribution system that will or may occur during the construction and operations phases are classified into four groups as described below:

1) Environmental impacts,
2) Occupational health and safety impacts,
3) Community health and safety impacts, and
4) Economic impacts

6.3.1 Environmental Impacts

Environmental impacts related to effects on biological and physicochemical resources such as vegetation, wildlife, crops, and aquatic life. It also includes interaction with physical elements such as air, water, soil, land, and climate. The proposed TGNL gas pipeline construction impacts will greatly depend on the location of the pipeline installation as it cut across communities of different settings. In already developed areas, environmental impacts are considerably different than in suburban or mixed-use areas. Environmental issues that may occur during the gas distribution projects are grouped into habitat alteration and air emissions.

Common impacts include:

a) Noise and vibration caused by the operation of earth moving and excavation equipment, and materials transport and delivery; dust emissions generated by a combination of on-site excavation and movement of earth materials,
b) Contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind; mobile emissions from the exhaust of diesel engines for earth moving equipment; and hazardous materials and waste handling, including oil spills associated with heavy equipment operation and fueling activities.
c) In newly developed areas, impacts may also include soil erosion resulting from excavated areas prior to the reestablishment of vegetation. In developed areas, impacts may include noise, traffic interruption, disposal of contaminated soil, and presence of archeological artifacts.

- ***Habitat Alteration***

Habitat alteration is only considered a relevant potential impact during construction of the gas distribution pipeline systems in rural or peri-urban and built-up areas. These impacts may be associated with excavation, trenching, pipe laying, backfilling, and the establishment of infrastructures such as regulating stations, which may create temporary or permanent terrestrial habitat alteration depending on the characteristics of existing vegetation and topographic features along the proposed Right of Way (RoW). The potential for impacts depends on the level of existing development, and will likely be less of an issue in rural areas.

Depending on the level of existing urbanization in the proposed project area, examples of habitat alteration from these activities may include

- Landscape fragmentation;
- Loss of wildlife habitat, including for nesting;
- Establishment of non-native invasive plant species; and
- Crossing aquatic habitats may disrupt watercourses and wetlands and require the removal of riparian vegetation. Sediment and erosion from construction activities and stormwater runoff may increase the turbidity of surface watercourses or inland waters.

➢ ***Air Emissions***

The proposed gas distribution systems may generate gas leaks as a result of normal operations, equipment venting for maintenance, and aging. Natural gas is primarily composed of methane. Methane emission from natural gas distribution sector is 26% of the total methane emissions in the US (United States Environment Protection Agency (US EPA) 1999).

Gas leakage, principally consisting of methane (CH_4), a greenhouse gas, may result from corrosion and degradation of pipelines and related components over time and from fugitive emissions from pipelines and regulating stations.

6.3.2 Occupational Health and Safety

Occupational Health and Safety (OHS) issues in the construction phase include potential exposures to dust, noise, physical strain, and trenching excavation hazards. Occupational health and safety hazards associated with the construction and operation of gas distribution systems may also include:

- Occupational exposure to gas leaks and explosions,
- Confined spaces,
- Electrocution,

➢ ***Occupational exposure to gas leaks and explosions***

Excavation, construction, and repair of gas distribution systems may result in accidental pipeline rupture or leakage and consequent exposure of workers to harmful gases and an explosive gas atmosphere. In addition, excavation by non-gas utility personnel (saboteurs) may result in accidental ruptures and exposure of the untrained persons and communities to explosion hazards.

- ***Confined Spaces***

Accumulation of natural gas in a confined space is a potentially fatal condition. Entry by workers into confined spaces and the associated potential for accidents may vary among the gas distribution project phases and facilities. Specific and unique areas for confined space entry may include excavation trenches during construction and regulating stations and vaults, both above and below ground, which may also contain equipment (e.g. safety valves, filters) that may emit fugitive emissions of gas and create a potential for oxygen deficient and explosive atmospheres.

- ***Electrocution***

Excavation, construction, and repair of gas distribution systems may result in workers' exposure to existing aboveground or underground utilities, including aerial or buried electric transmission lines. Cranes or other talk equipment could have contact with high tension cables during lifting operations causing electrocution.

6.3.3 Community (Health and Safety)

Community health and safety hazards associated with the construction and operation of gas distribution systems include public exposure to gas leaks and explosions. Others may include movement of heavy lifting and material delivery equipment.

- ***Health and safety (public exposure to gas leaks and explosions)***

The presence of gas distribution systems within populated areas may expose the public to hazards from gas leaks and explosions. Gas leakage may result from accidental rupture of pipelines during installation and repair or from contact during excavation unrelated to the gas system. The act of pipeline saboteurs by third parties and improper operation of natural gas-fueled appliances and equipment may expose the user and the public to gas leakage and explosion hazards.

- ***Social Impacts***

Potential impacts on the social components may include:

1) Demography – Displacement and relocation effects and changes in population characteristics. Residential and commercial buildings that are currently located or encroaching on the Federal highway setback (also the RoW) may be demolished and the

affected residents displaced. Highway encroachment is more prominent in urban (or peri-urban) areas.

2) Cultural – Traditional patterns, family structure, religion, archeological features, social networks. During construction, community nonmembers engaged as part of the workforce may bring new cultural behaviors having the potential to erode the existing cultures and norms of the community.
3) Gender – Implication of the project on the roles of women in society, employment opportunity, and equity. Construction work will require the engagement of local labor, mostly male and working class. This may cause gender inequality in a job offer.
4) Institutional – Few number of housing, schools, health welfare, marketplace, etc. used by communities may be partly affected.

➢ ***Economic impacts***

Economic parts are POSITIVE impacts and they include the following amongst others:

- Workforce requirements for all the project phases
- Skills requirements (local availability)
- Raw material and other inputs purchase from communities
- Capital investment: TGNL Natural Gas Pipeline Network is a capital project with the potential to boost the economy of the affected communities. In a similar vein, it will bring a return to TGNL, the investor.
- Outputs: Natural gas for cleaner power generation, less carbon emission (a major climate change culprit).
- Characteristics of the local economy: the benefiting parties: company (Rite Foods) and other industries will be transformed into gas-based industries.

CHAPTER SEVEN

MITIGATION MEASURES

7.1 Introduction

Mitigation measures for the identified associated and potential environmental, social and health impacts of the proposed project are presented in this chapter. The mitigation measures have been proffered to prevent, eliminate or minimize the impacts and their effects on levels that are considered As Low As Reasonably Practicable (ALARP). The rationale for impact quantification and significance has earlier been discussed in the previous chapter. The results indicate that various components would be impacted positively or negatively. In order to preserve the present integrity of the environment, certain measures have been recommended to mitigate or control the major negative impacts identified in this study.

The control/mitigation measures are based on the baseline conditions with regards to the biophysical environment, socio-economic and health status of the host communities. Also considered were the project activities and their envisaged impacts and concerns of stakeholders during consultation meetings, scoping workshops and socio-economic/health status of the host communities. In proffering mitigation measures, the primary objectives were:

- ***Prevention*** - ensuring that significant and adverse potential impacts and risks do not occur.
- ***Reduction*** - ensuring that the effects or consequences of those significant associated and potential impacts that cannot be prevented are reduced to as low as reasonably practicable. Reasonable practicability was determined in reference to best industry practice and to economic, environmental, technical, health and safety considerations.
- ***Control*** – ensuring that residual associated impacts are reduced to a level as low as reasonably practicable.

7.2 Considerations for the Mitigation Measures

The residual impacts that can arise despite these mitigation measures were also noted. Impacts shall be mitigated through effective implementation of the Environmental Management Plan (EMP) articulated forth project. The mitigation measures proposed are in keeping with the following:

- Environmental laws in Nigeria, with emphasis on permissible limits for waste streams FMEnv (formerly FEPA,1991)
- Department of Petroleum Resources Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN) 1992.
- Best Available Technology for Sustainable Development
- International best practices such as IFC and the World Bank environmental standards
- Social well-being requirements; and
- Concerns of stakeholders

7.3 Selected Control Measures

A summary of the mitigation measures is presented in ***Table 7.1***. These measures are recommended to ameliorate the potential high, moderate and minor impacts identified with the proposed Project. Mitigation measures for socioeconomic parameters are shown in Table 7.2 below.

Table 7.1: Recommended Mitigation Measures for Negative Environmental Impacts Associated with the TGNL 135km pipeline Project

Activity/Source of Impact/Issue	Potential Negative Impact	Impact Rating Before Mitigation	Mitigation Measure	Impact Rating after Mitigation
Pre- Construction				
RoW Clearing and Site Preparation.	• Use of equipment that can cause **air emissions** and associated **air pollution**: Clearing and site preparation may lead to the emission of particulate matter (dust) into the ambient air thereby deteriorating the air quality condition of the area especially if this activity is carried out during the dry season;	Minor	TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions • wet the area to be cleared by spraying water to reduce dust generation	Negligible

	• **<u>Water pollution</u>**: an increase in sediment load and turbidity of pockets of inland waters within the project area. This may arise as a result of land and vegetation disturbance creating particulates and subsequent washing into surface water bodies	Minor	TGNL shall: • plan to carry out activity during the dry season • disposed spoils and overburden from site clearing in such a way as to reduce turbidity-generating run-offs	Negligible
	• **<u>Change in ecological characteristics</u>:** The introduction of fill materials such as laterite, sand, and gravel for access, operational building construction activities could lead to contamination of the soil and groundwater of the area, especially if the fill materials are contaminated.	Minor	TGNL shall ensure that: • fill materials are free from possible contamination and where available, source materials around the project area.	Negligible
	<u>Loss of biodiversity:</u> The clearing of vegetation from the site may lead to v egetation loss and subsequent exposure of the soil surface to agents of denudation (Rain and wind). Trees, shrubs and lower class vegetation will be a loss. Fauna components will be forcefully evicted from their natural habitats such as earth burrows and bird nests on trees. However, subsequent upon completion of construction work, the RoW will be re-vegetated with grass to prevent erosion and keep the site green	Moderate	TGNL shall • use existing access/right of way if available • ensure minimum land clearing and clearing shall be restricted to the acquired area • ensure re-planting of riparian plants in areas outside the RoW corridor • ensure the RoW is re-vegetated with lower class vegetation cover such as grass for cover	Minor
	• The process of re-vegetation could lead to the **<u>introduction of exotic species of plants</u>**,	Moderate	TGNL shall • restrict clearance to the required portion of	Negligible

	which could out-compete native species leading to an alteration of species composition and abundance.		the project area. • properly clean all clearing materials before deployment for use.	
	• **Loss of wildlife habitat**: Clearing of the vegetation will deprive the wildlife species within the project site of their natural habitats. However, on completion of construction and re-vegetation, some of the displaced wildlife species will come back and inhabit the area.	Minor	TGNL shall • minimize land take and restrict clearance to the required portion of the project area. • re-vegetate cleared area outside the pipeline RoW at the end of construction • enforce no hunting ban during clearing	Negligible
obilization of personnel, equipment, and materials to the site	• **The influx of people** to the area in search of employment leading to a change in demographic characteristics of the area. Other associated impacts include social vices and pressure on available utilities	Minor	TGNL shall • Ensure the recruitment of community-based people for unskilled labours. • Ensure 3rd party contractors carry out a fair recruitment process for personnel to use for the project and have necessary to have a work camp to minimize potential interference with the community lifestyle.	Negligible
	• Movement of earth moving equipment, payloaders, gravel, sand, cement, rods, levelers, crane, pipes, etc. to the project site may engender a temporary **increase in noise levels** and **vibration** from the movement of vehicles and machines to the site;	Minor	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Negligible
	• **Air pollution**: a potential increase in gaseous	Minor	TGNL shall • pre-mob construction	Negligible

	emissions from vehicles used to convey the construction equipment to the site.		equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions	
	• **Climate change potential**: emission of greenhouse gases (NOx, CHx, CO, and CO_2) from vehicles	Minor	TGNL shall • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions	Negligible
	• **The forced eviction of wildlife species**: potential migration of noise-sensitive wildlife and aquatic species from the project area as a result of possible excessive noise generated by the movement of mobilization vehicles.	Minor	TGNL shall: • as much as possible, restrict movement of equipment during the day to only approved areas; In addition, service machines and vehicles used for mobilization and ensure lubrication of friction parts to reduce possible noise impact.	Negligible
	Alteration of soil structure and landscape: potential alteration of soil structure especially on the project location, which could also lead to soil erosion. However, on completion of the mobilization activities, altered soil structures can recover its components without any modification.	Minor	TGNL shall: • make sure it is a temporary activity and the project shall be immediately cleared and filled and reinforced. • reduce timeframe between clearing, excavation and trenching through proper project planning	Negligible
Construction				
Clearing, Landscaping,	• **Loss of vegetation**: the potenti	Minor	TGNL shall: • carry out tree pulling	Negligible

Excavation and Trenching of portions to be used for construction camps, operational buildings/ metering station/ manifold, and pipeline trenches and horizontal directional drilling/thrust boring.	al loss of vegetation and important plant species.		where possible • restrict excavation to the required portion of the project area. • carry out replacement of lost trees within or near the pipeline RoW	
	• **Noise:** Potential increase in ambient noise from earth moving equipment.	Minor	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Negligible
	• **Loss of flora:** potential migration and loss of soil fauna especially on the excavated portion;	Minor	TGNL shall: • carry out tree pulling where possible • restrict excavation to the required portion of the project area. • carry out replacement of lost trees within or near the pipeline RoW	Negligible
	• **Air pollution:** Potential dust generation during the excavation may temporarily increase the Total Suspended Particulate (TSP) leveling and dust the ambient air of the environment especially. The impact is more pronounced during the dry season. Gaseous pollutants such as NOx, SOx, COx, and CHx can also be emitted from equipment	Moderate	TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions • spray water on the access road that is not tarred and on construction site prior to during the dusty season	Negligible

	• The potential change in the local topography of the area	Minor	NGPC shall ensure the site is rehabilitated after completion of construction work	Negligible
	• **Water pollution:** a potential increase in turbidity of available shallow waters especially in the rainy season as a result of run-offs. This can negatively affect the aquatic species within the surface water bodies. In addition, due to disturbance of the waterbed, toxic waste that has solidified on materials will be loosed and spread to the water column thereby contaminating it.	Moderate	TGNL shall: • implement a run-off management program and install silt curtains to control the suspended particles in the runoffs especially during the rainy season • prevent water contamination from fueling activities by using drip trays • enforce proper waste management practices and good in-house sanitary practices for base camp personnel	Minor
	• **Increase in ambient Noise level and vibration**: Noise and vibration from heavy machinery used for excavation and.	Minor	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Negligible
	• **Loss of biodiversity**: the potential loss of aquatic fauna and flora/benthic organisms along the lagoon crossing sections of the pipeline ROW.	Minor	TGNL shall carry out site restoration after completion of construction activities. Affected riparian and mangroves shall be re-vegetated except along the ROW where only lower class vegetation shall be replanted.	Negligible
	• **Loss of wildlife habitat**: earth burrow for mammals will be	Minor	TGNL shall: • ensure site rehabilitation after	Negligible

	damaged during excavation. On completion of excavation and backfilling, some of the wildlife species may return to the original environment.		construction/ pipe-laying activities. • No poaching policy shall be adopted to protect wildlife encountered during construction work.	
	• **Potential alteration of soil structure**, which may lead to soil erosion around the excavated portions.	Moderate	TGNL shall: • make sure it is a temporary activity and the project shall be immediately cleared and filled and reinforced. • reduce timeframe between clearing, excavation and trenching through proper project planning	Negligible
	• **Potential damage to/loss archaeological artifacts**. Although the project area does not have a record of such buried features, any of such buried cultural and geological features encountered during excavation that can be used for study and research work can be lost and or destroyed as a result of excavation work.	Minor	TGNL shall: • keep intact any archaeological artifact encountered during excavation from damage and loss • keep a record of all recovered artifacts • move artifacts recovered to location acceptable to the community.	Negligible
	• **Land pollution:** Potential waste generation from construction workers due to indiscriminate defecation and disposal of waste such as food and water containers within the project area. Other sources of pollution include potential diesel spill arising from accidental contact with underground infrastructure.	Minor	TGNL shall: • provide mobile toilet on site • prevent water contamination from fueling activities by using drip trays • enforce proper waste management practices and good in-house sanitary practices for base camp personnel • provide appropriate waste bins with lids and strictly enforce	Negligible

			use. • employ the principle of waste segregation and waste reduction • engage the services of accredited waste contractors to collect and dispose of waste	
Laying of Pipes – Stringing, Bending, Welding and Lowering	• **<u>Air pollution</u>**: during the welding process of the pipes, there may be a temporal increase of NO_2 in the ambient air. Other notable pollutants include CO and CO_2.	Minor	TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions • wet the area to be cleared by spraying water to reduce dust generation	Negligible
	• Potential temporal increase in ambient **<u>noise level</u>** as a result of the cutting, scraping and shaping of the pipes during welding.	Minor	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Negligible
	• Potential **<u>vibration</u>** from machinery. Machinery to be used include an excavator, compactors, etc. which are potential sources of vibration	Minor	TGNL shall: • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels	Negligible
	• The potential **<u>loss of aquatic fauna and alteration of benthic ecology.</u>** During pipe laying, the benthic, as	Minor	TGNL shall limit all activities to the site of interest.	Negligible

	well as pelagic aquatic organisms, will be demobilized from their natural habitat.			
	• **The forced eviction of wildlife:** Potential migration of noise-sensitive mammals and reptiles from the pipeline sections with natural habitat status due to the increased noise level caused by machinery.	Minor	TGNL shall ensure the protection of wildlife during activities. Partnership with wildlife conservation institution such as Nigeria Conservation Foundation (NCF) to ensure protection and rescue of vulnerable and endangered species following local and international guidelines.	Negligible
Installation of Metering station, manifold, and other surface units.	• Potential increase in ambient **noise** from equipment and other human activities. The potential impact is similar to those caused by previous activities.	Minor	TGNL shall: • carry out the installation of the unit during the day when the impact of noise will have less impact on people. • dampers shall also be used where applicable to reduce noise from pipes movement. • workers are to use hear muffs to the reduced impact of noise.	Negligible
Non Destructive Testing (NDT) and hydro-testing	• The potential for land pollution and surface water degradation may prevent domestic use.	Moderate	TGNL shall: • carry out discharge as to prevent erosion and maintain discharge water quality • control run-off using silt curtains	Negligible
	• Radiations (X-Ray) from NDT activities	Minor	TGNL shall: • ensure adequate setback is maintained during x-ray shooting to ensure personnel protection • prevent intruders/inquisitive on-lookers from the work site to protect them against welding	Negligible

			radiation. • protect integrity testers from exposure to X-ray. • ensure x-ray expert use appropriate clothing for protections	
Backfilling, Clean-Up, Restoration and Reclamation	• **Loss of biodiversity: Backfilling** may bury important aquatic and benthic flora and fauna that presently inhabit the freshwater swampy portions; Sections B (Ejirin) and D of the pipeline ROW.	Moderate	TGNL shall • ensure that excavated materials are themselves backfilled. Original materials may be containing eggs, lavas or young organisms that may reproduce to replace lost ones. • minimal extraneous materials shall be used for backfilling • undertake proper reinstatement procedure after backfilling	Minor
	• Potential **introduction of foreign and contaminated materials** into the project area especially if the filling materials are contaminated.	Minor	TGNL shall ensure minimal extraneous materials are used for backfilling. Backfilling shall rely more on the original materials removed from the site to prevent contamination and introduction of exotic plant species	Negligible
	• **Water pollution**: an increase in sediment load and turbidity of pockets of inland waters within the lagoon crossing sections along the pipeline ROW during backfilling.		TGNL shall: • implement a run-off management program and install silt curtains to control the suspended particles in the runoffs especially during the rainy season	Negligible
	• Potential increase in **soil erosion** due to continuous loosening of soil as a result of increased movement of vehicles on un-tarred	Minor	TGNL shall • restrict the movement of vehicles to compacted and properly reinforced	Negligible

	primary roads in the area.		portions. • reduce timeframe between clearing, excavation and trenching through proper project planning	
	• Potential **increase in noise levels** from construction vehicles may distort the current serenity of the project area.	Minor	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Negligible
	• **The potential loss of wildlife species** from the sections with natural habitat status due to the sudden introduction of noise in the project area.	Minor	TGNL shall: • enforce no hunting ban around the project area during construction • ensure noise abatement measures such as the controlled use of vehicle horns are put in place. • other noise abatement measures as discussed before shall also be adopted.	Negligible
Vehicular Movement	• **Traffic Congestion:** The movement of materials and personnel will lead to traffic congestion along the Sagamu Ibefun Ososa Ogun State.	Moderate	TGNL shall: • liaise with traffic regulation agency at the Federal, State and Local Government level namely FRSC and LASTMA to ensure the free flow of traffic especially during material and personnel movement • use trained and DDC compliant driver • ensure proper planning and timing of transport	Minor

			activities to avoid busy or rush hours especially during transport of heavy duty equipment • liaise with and provide necessary information to other transport service providers and stakeholders	
	• Movement of earthmoving equipment, payloaders, gravel, sand, cement, rods, levelers, crane, pipes, etc. To the project site may engender a temporary **increase in noise levels** and **vibration** from the movement of vehicles and machines to site;	Minor	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Negligible
	• **Air Pollution:** Vehicular emission will lead to a change in air quality.		TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions	Negligible
Power Generation	• **Air pollution**: Use of stationary emission sources such as diesel-powered generators are potential sources of air pollution due to emissions. Pollutants gases.	Minor	TGNL shall: • ensure use of diesel-powered engines that are well maintained and at optimum performance. • install scrubbers and filters are fitted on the exhausts to machines to minimize emissions.	Negligible
	• **Noise:** Potential increase in ambient noise around the project area.	Minor	TGNL shall: • install mufflers and dampers on noise generating equipment	Negligible

			• use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	
Waste Disposal	• **<u>Waste generation</u>**: Various waste materials are always generated in most construction site and in camps/communities where construction workers are accommodated. In most cases, improper disposal of these wastes pose some problems, especially if appropriate mitigation is not put in place during this phase of the proposed project.	Moderate	TGNL shall: • adopt sound waste management practice giving priority to waste reduction and recycling. • implement a comprehensive waste tracking program • engage registered and approved waste management service providers/contractors for hazardous and non-hazardous waste by the Federal Ministry of Environment and Ogun State Waste Management Authority Other waste management approaches discussed above shall also be adopted	Low
Maintenance of Construction Vehicles and machines	• Potential contamination of soil, surface, and groundwater as a result of the indiscriminate disposal of spent lube oil and used serviced parts.	Minor	TGNL shall: • prevent the spillage of oil and lubricant during maintenance by applying standard operating procedures (SOP) • use drip trays to prevent oil spillage • Ensure that all hazardous waste including used oil is stored and transported to waste dumpsite and disposed of by a DPR licensed vendor.	Negligible

			• reuse or recycling of waste oil or dispose of by third parties.	
Pressure Testing and Hydro-testing of the pipeline	• **Sagamu Ibefun Lagoon Water Contamination**: Indiscriminate discharge of the hydro-test water could lead to acute toxicity of aquatic organisms, low dissolved oxygen levels in the immediate surrounds of the discharge.	Minor	TGNL shall: • install filter or screen during abstraction to prevent entry of fish or entrapment • carry out discharge as to prevent erosion and maintain discharge water quality • control run-off using silt curtains • reduce the need for chemicals by reducing the retention time for hydro-test • treat hydro-test water and dispose of responsibly	Negligible
Operation/ Maintenance				
Transportation of gas	• **<u>Land and groundwater pollution</u>**: potential gas leak and pipeline blowout may result in contamination of soil and aquatic environment and life forms. The potential destruction of assets and properties from pipeline blow-out.	Moderate	TGNL shall: • ensure schedule monitoring and testing of the pipeline to check for leaks • carry out pressure monitoring to monitor pressure decline along the pipeline that can help detect leaks • maintain the pipeline RoW • provide security to prevent vandalization of pipeline • contain condensate spill and remediate spill-affected areas • consider the installation telemetry pipeline monitoring system • carry out environmental monitoring to track any emission that is connected to pipeline leaks.	Negligible

	• **<u>Air pollution</u>**: Continuous operation of pressure reduction engines may lead to emissions and deterioration of the ambient air quality.	Major	• ensure schedule monitoring and testing of the pipeline to check for leaks • odourize the gas stream • carry out pilot flaring instead of continuous cold flaring • dry pipeline with nitrogen (nitrogen purging) • carry out pressure monitoring to monitor pressure decline along the pipeline that can help detect leaks • maintain the pipeline RoW • provide security to prevent vandalization of pipeline • consider the installation telemetry pipeline monitoring system • carry out environmental monitoring to track any emission that is connected to pipeline leaks.	Minor
	• **<u>Climate change:</u>** Predominant pollutant is known to be methane (CH_4) which is one of the culprits for climate change. There is also the possibility of gas flaring at the Pressure Reducing and Monitoring Facility (PRMF) unit which will lead to the release of methane	Major	TGNL shall ensure that loss of methane to the atmosphere is minimized, introduce methane recovery and utilization program as part of the energy sustainability programs.	Minor
	• **<u>Vibration</u>** impacts from the pressure reduction engines could impact on the land physical (geological) characteristics as well as human health	Minor	TGNL shall: • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection	Negligible

			and enforce usage compliance by contractors and staffs	
	• Potential flaring of associated gas, sanitary and domestic wastes generated from the operational building and kitchen can pose danger to the immediate environment if not adequately treated before discharge.	Moderate	TGNL shall • ensure flaring is carried out in conformance with standards requirement stipulated by EGASPIN. • install knock-out pots to prevent the escape of oil to the flare tip which will generate sooth • carry out pilot flaring instead of cold flaring • provide an adequate setback for the flare stack	Major
	• **Noise:** Potential increase in noise, particulate and gaseous emissions. Power generation and evacuation from a small independent power facility is identified as potential sources of noise	Moderate	TGNL shall: • Ensure regular and scheduled maintenance of power generators Other noise abatement procedures described above shall also be used	Negligible
Maintenance (pigging activities, maintenance, compressor, power plant, and pumps)	• **Land pollution**: Indiscriminate disposal of spent lube oil during routine maintenance of the generators may alter the biophysical characteristics of the soil or water in the immediate environment.	Minor	TGNL shall: • ensure waste oil and other hazardous liquid wastes like sludge are contained, transported, treated and disposed in line with best practice.	Negligible
	• **Nuisance**: Potential solid waste generation from used parts, packages, accessories, etc.	Minor	TGNL shall ensure that wastes are handled in line with the company's waste management plan to prevent nuisance	Negligible
	• **Waste generation:** Indiscriminate discharge of the condensate and disposal of spent oil may lead to the alteration of the ecology of soil or	Minor	TGNL shall: • adopt sound waste management practice giving priority to waste reduction and recycling.	Negligible

	surface water;		• implement a comprehensive waste tracking program • engage registered and approved waste management service providers/contractors for hazardous and non-hazardous waste by the Federal Ministry of Environment and Ogun State Waste Management Authority Other waste management approaches discussed above shall also be adopted	

Table 7.2: Recommended Mitigation Measures for Negative Social Impacts Associated with the 135km TGNL pipeline

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
Pre-construction				
Land acquisition and Claim settlement	• **<u>Third party agitation:</u>** Communities located along the pipeline RoW and land grabbers/swindlers popularly known as *Omo onile* in Ogun are identified as potential sources of agitation. However, currently, the Ogun State government with its Ogun State Property Protection Law, 2017 has put land related agitation under control.	Major	TGNL shall: • Pay utmost attention to minimize alteration of land use, only areas required for administrative building in addition to other projects appurtenant land use shall be acquired. • Ensure proper identification of landowners is carried out, and adequate compensation is paid to all concerned parties. • Ensure thorough assessment of land requirements before an additional land take. • Ensure appropriate	Minor

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			compensation is paid for any additional land take; • Provide and encourage adoption of alternative means of livelihood, e.g. microcredit scheme.	
	• **<u>Land take</u>**: Land take for the RoW will be permanent, however, the project is sub-surface therefore it will not create landscape problems. The sensitivity of the project area is high considering land value in Ogun State.	Major	TGNL shall Ensure the pipeline RoW is protected from encroachment from third parties from developing the RoW or changing the land use pattern. Regular surveillance of the RoW using the host communities and landmarks or sign-post to create awareness.	Minor
	• Potential encroachment on culturally sensitive sites	Minor	TGNL shall: • Ensure thorough assessment of and requirements before an additional land take.	Negligible
Clearing and Site Preparation. Mobilization of Equipment and materials to the site	• Clearing and site preparation may lead to displacement of hunters who may presently rely on the project area for hunting;	Minor	TGNL shall: • Duly consult with the host community on the project objectives as well as the sensitivity/dangers to possible farming and hunting activities.	Negligible
	• The potential loss of hunting activities may also lead to loss of income and important source of family protein;	Minor	TGNL shall: • Encourage possible few hunters around the project area to consider other business areas such as fishing.	Negligible
	• Farmers who have hitherto used the project	Moderate	TGNL shall: • Educate farmers on	Minor

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	area for subsistence and semi-commercial farming activities may lose their farmlands and income or food.		improved methods of farming such as the use of high yield species.	
	• Clearing of vegetation may result to potential loss of medicinal and commercial crops, which may lead to prevalence and protraction of some ailments that have hitherto been treated with some of these important plants as well as loss of income, especially on the commercial crops.	Minor	TGNL shall: • Develop a sustainable programme of Corporate Social Responsibility (CSR) for the host community especially as it relates to health care delivery.	Negligible
	• Potential injury and exposure of workers to wildlife attack.	Moderate	TGNL shall: • Provide and enforce usage of PPE by field workers. • Provide First aid/Anti-venom and insect repellent on site. • Create awareness among site workers and nearby communities on the likelihood of exposure to wildlife/insect attack.	Minor
	• Movement of materials to the project site, which will primarily by road may lead to a potential increase in vehicular traffic especially in adjoining roads during this period may engender traffic build-up	Minor	TGNL shall: • Engage the services of road traffic managers to manage traffic along the affected road especially during the movement of equipment and materials to the project site.	Negligible
	• Temporary increase in noise levels from the movement of earth moving	Minor	TGNL shall: • Ensure that all machines and	Negligible

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	and construction vehicles could lead to psychological stress in nearby communities.		vehicles are properly serviced and friction parts oiled to reduce possible noise;	
	• Cases of Pirates/armed bandit attacks/kidnappings may arise during mobilization	Moderate	TGNL shall: • Make adequate security arrangements for the mobilization phase.	Minor
	• Potential third-party agitation	Minor	TGNL shall: • Shall carry out due and exhaustive consultations with all stakeholders and third-party groups.	
Construction				
Excavation of portions to be used for construction camps, operational buildings and pipeline trenching.	• The influx of migrant workers for this construction activity results to alterations and adulteration in values and customs of the people around the project area especially Sagamu Ibefun, Ogun LGA and nearby communities where a sizeable number of construction workers may likely be drawn from.	Minor	TGNL shall: • Ensure the services of significant numbers of the local laborers are engaged from nearby communities.	Negligible
	• The influx of construction workers may lead to a potential increase in the rate of pregnancies as a result of unsafe sex.	Moderate	• Educate workers on safe sex and possible abstinence. • Regular distribution of condoms among construction workers.	Minor
	• Potential influx of migrant workers to the project area may put pressure on the limited social infrastructures in the host communities.	Minor	TGNL shall: • Ensure the recruitment of a large proportion of the workforce from the locality to reduce the migrant population. • Provide alternative	Negligible

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			accommodation with relevant facilities for construction workers.	
	• Potential youth unrest resulting from unemployment of some youths who may have considered themselves more qualified but were denied a temporary employment opportunity.	Minor	TGNL shall: • Liaise with community and youth leaders in the engagement of local labors from nearby communities.	Negligible
	• Potential proliferation of diseases such as sexually transmitted diseases and HIV/AIDS especially among young females in nearby communities as a result of the influx of temporary construction workers;	Moderate	TGNL shall: • Educate workers on safe sex and possible abstinence. • Carry out HIV/AIDS education campaign in line with the National Prevention Program • Regular distribution of condoms among construction workers. • Enforce strict Access control within workers campsites.	Minor
	• Potential deterioration of ambient air quality as a result of emissions from stationary equipment could lead to health-related issues among construction workers and residents of the host community	Minor	TGNL shall: • Ensure equipment is regularly serviced and well maintained and carry out regular routine health surveillance.	Negligible
	• Increase in noise level and vibrations from heavy machinery could lead to psychological stress to residents of nearby communities.	Minor	TGNL shall: • Ensure that there is controlled the use of all equipment and that equipment engines are turned off when not in use.	Negligible

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			Combustion engines are fitted with effective silencers.	
	• Cases of Pirates/ armed bandit attacks/ kidnappings may arise during mobilization	Moderate	TGNL shall: • Make adequate security arrangements for the construction phase and partner with local communities for security intelligence.	Minor
	• Potential accident and bodily injuries especially to pedestrians (farmers) who may not be aware of this activity especially in the dark early morning hours while going to farm	Moderate	TGNL shall: • Ensure staff members are sensitized to the peculiarity of the project environment. • Carry out awareness program per community on the project activities weekly.	Minor
Construction (Horizontal Directional Drilling Works)	• The influx of laborers and followers (dependants, bounty seekers, CSWs, etc.)	Minor	TGNL 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. TGNL shall support skill acquisition and empowerment schemes for the community.	Negligible
	• Increased risk of prevalence of HIV	Minor	TGNL shall • Liaise with the appropriate health agencies to provide health awareness	Negligible

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			campaign and seminars for the community on STIs. • Engage health personnel in educating workers on HIV/AIDS	
	• Increased risk of malaria, dysentery, and other diseases	Minor	• TGNL shall Periodic health education for the host communities and the TGNL workers on use prevent and eliminating breeding ground for mosquitoes and other disease-carrying vectors • TGNL shall carry out the campaign on malaria awareness and support in the provision of mosquito nets during the campaign • TGNL shall provide site clinic for workers • TGNL shall provide potable water for the site workers and at the accommodation • TGNL shall discourage indiscriminate defecation into the area by providing mobile toilet to its worker on site	Negligible
	• The potential for Socio-cultural conflict	Moderate	• TGNL shall ensure the adoption of appropriate community entry strategies;	Minor

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			• TGNL shall manage Socio–cultural conflict inline its SOP on Cultural Heritage Management Procedure.	
	• Increased pressure on existing social amenities/infrastructure.	Minor	TGNL shall • Make adequate accommodation agreement prior to mobilization of the workforce to reduce pressure on local housing	Negligible
aying Pipes	• Potential accident and bodily injuries especially to pedestrians (farmers) who may not be aware of this activity especially in the dark early morning hours while going to farm or crossing the waterway	Major	TGNL shall: • Ensure total barricade of the project area with color-coded safety indicators to avoid a possible accident.	Minor
	• Potential injuries from work-related accidents. • Workers may sustain burns from welding sparks.	Moderate	TGNL shall: • Ensure provision/use of adequate PPEs such as hand gloves, goggles, etc. by construction workers.	Minor
	• Potential visual impairment from high-intensity welding flash	Minor	TGNL shall: • Ensure that workers use appropriate radiation protection clothing and do not have high exposure time.	Negligible
Assembling of the prefabricated operational building structure.	• The potential increase of psychological stress of workers as a result of noise associated with this activity.	Minor	TGNL shall: • Ensure and enforce the use of appropriate Personal Protective Equipment (PPE) such as helmets, safety boots eye goggles, etc.	Negligible

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			by all construction workers.	
	• Potential injuries from a crane and other installation gadgets on workers	Major	TGNL shall: • Carry out first aid training of workers including casual workers and locals. • Provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) • Ensure work area is cordoned off as restricted areas. Ensure use of Hardhats, eye goggles, etc. are enforced • Ensure that health talks and awareness and job hazard analysis are carried out prior to work activities. • Provide On-site/Referral health care (including MEDEVAC).	Minor
	• The potential decrease in school attendance especially among male teenagers who may opt for quick paid construction work to the detriment of their secondary education.	Moderate	TGNL shall: • Completely discourage engagement of youths of school age by liaising with community youth leaders in the temporary employment process.	Minor
	• Potentially increased pressure on limited	Moderate	TGNL shall: • Consider the	Minor

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	infrastructure in nearby communities especially around Sagamu Ibefun Ogun LGA where some of these workers may secure temporary accommodation		provision of alternative accommodation for construction workers.	
Sand filling and Reclamation	• The potential loss of farmland and crops;	Moderate	TGNL shall: • Encourage and educate farmers on improved farming operations to help increase farm yield.	Minor
Vehicular/ Traffic Movement	• Potential increase in noise around the project area that may lead to psychological stress on workers and residents of nearby communities due to the blaring of vehicle horns and continuous movement of construction vehicles;	Minor	TGNL shall: • Ensure that construction vehicles are duly serviced and all friction Parts oiled and greased to reduce possible noise impact;	Negligible
	• Potential traffic congestion around the project area may lead to loss of valuable hours on the road as well as psychological stress on commuters.	Minor	TGNL shall: • Liaise and engage the services of road traffic managers/police to control traffic on the affected area.	Negligible
Emission from Stationary Equipment.	• Potential health impact such as bronchitis, and other respiratory problems due to inhalation of noxious emissions from vehicle exhaust pipes; • Reduced visibility as a result of suspended gaseous and particulate emissions;	Moderate	TGNL shall: • Ensure that construction vehicles are duly serviced.	Minor
	• Increased noise may engender discomfort in	Minor	TGNL shall: • Ensure that all	Negligible

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	the social milieu.		construction vehicles are duly serviced and all friction parts oiled and greased to reduce possible noise impact	
Wastes Generation Various waste materials are always generated in most construction site and in camps/communities where construction workers are accommodated. In most cases, improper disposal of these wastes pose some problems, especially if appropriate mitigation is not put in place during this phase of the proposed project.	• Generation of domestic wastes such as food and other organic materials may engender odour and fouling of the ambient air; • Potential epidemic and other health-related problems from decomposing waste materials indiscriminately disposed of by construction workers; • Reduction of the aesthetic value of the project area as a result of indiscriminate waste disposal.	Moderate	TGNL shall: • Provide waste bins with lids in strategic locations within Construction site and ensure regular and proper disposal by an accredited waste manager as at when due.	Minor
Maintenance of Construction Vehicles and machines	• Indiscriminate disposal of spent lube oil used to service construction vehicles and machines on available surface water bodies may lead to a loss in fishing catch	Minor	TGNL shall: • Provide appropriate waste bins with lids at strategic locations around the facility and strictly	Negligible

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
	and income for the artisanal fishermen.		enforce use. • Educate workers and maintenance contractor of the recommended waste management plan.	
Operations/maintenance				
Operation/ Maintenance As previously discussed in Chapter Three of this EIA report, this project is intended to construct a 135km pipeline from the ELPS KP312 tie-in point at Sagamu Ibefun to Ososa Free Trade Zone and in order to capture the associated and potential impacts during the operational phase of the proposed project, it is essential to discuss the impacts of the various activities of	• Potential pipe rupture and condensate spill could lead to pollution of soil, surface/underground water, sediment and poisoning of aquatic life, which may engender communal unrest and agitations.	Major	TGNL shall: • Ensure that gas transportation through a well-fortified three- layer polyethylene pipes with improved corrosion integrity. • Ensure sustained consultation with community stakeholders to avoid vandalization. • Provide a robust emergency response plan for gas transportation.	Minor
	• Potential cases of Pirates/armed bandit attacks/kidnappings may arise during transportation of crude products via shuttle tankers	Major	TGNL shall: • Make adequate security arrangements for the mobilization Ensure staff are sensitized to the peculiarity of the project environment.	Minor

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
this phase on the different environmental attributes.				
Power generation and evacuation	• Potential Electrocution and injuries.	Major	TGNL shall: • Ensure provision and appropriate use of relevant PPEs such as insulated hand gloves and tools. • Provide Earth-mating high voltage installations and substations.	Minor
Maintenance of onsite generators/ engines	• Potential body injuries to maintenance engineers;	Moderate	TGNL shall: • Provide and strictly enforce proper use of relevant personal protective equipment (PPE). • Put in place a well-equipped sickbay and Emergency Medical Evacuation (MEDIVAC) for injured or ill personnel.	Minor
	• Potential indiscriminate disposal of waste e.g. spent oil and service materials may reduce t Groundwater	Moderate	TGNL shall: • Provide waste bins with well-fitted lids at strategic places around the facility. • Provide modern technology for managing waste oil generated in your facility. • Provide a comprehensive waste management plan and ensure strict	Minor

Activity	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating after Mitigation (Residual)
			implementation.	
Pipeline maintenance	• Potential condensate spill during pipeline maintenance may engender agitation from stakeholders.	Moderate	TGNL shall: • Provide a robust emergency response plan for facility maintenance. • Ensure that well-trained engineers are engaged to carry out maintenance work.	Minor
	• Potential blowout of the pipeline if appropriate precautions are not taken during regular maintenance.	Major	TGNL shall: • Ensure that well-trained engineers are engaged to carry out maintenance work. • Organize toolbox meeting sand job hazard analysis before every maintenance operation.	Minor
Waste generation and handling	• Indiscriminate treatment and disposal of wastes will engender odour, which may lead to an outbreak of disease around the host communities. • Potential indiscriminate disposal of waste e.g. spent oil and service materials may reduce the aesthetics of the project area	Moderate	TGNL shall: • Provide a comprehensive waste management plan and ensure strict implementation.	Minor

7.4 Summary

In summary, the mitigation measures recommended in this section may not be exhaustive. However, they are considered adequate to effectively ameliorate or in some cases, eliminate the negative impacts that may attend this proposed pipeline project. From the assessment undertaken, TGNL management is committed to ensuring these measures are judiciously applied. As a result, most of the negative impacts will be reduced significantly in most cases to negligible and minor residual impacts.

In order to verify these assertions, and to ensure that the measures are effective, it is necessary to have in place a practical and cost-effective Environmental Management Plan (EMP), which is presented in the next section of this report.

CHAPTER EIGHT

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1 Introduction

This chapter presents the Environmental and Social Management Plan (ESMP) specific to the project through its lifecycle. The plan is one of the key reference documents for ensuring that environmental issues are addressed and would be fully communicated to all project and operations staff, contractors and subcontractor personnel involved in the project. In essence, the Environmental Management Plan (EMP) will be used as a tool by Nigeria Gas Company Limited (TGNL) for managing the predicted environmental impacts of the project. It provides the means in which the mitigation measures recommended for reducing the effects of moderate and major impacts to *as* low as reasonably practicable (ALARP) are implemented and monitored throughout the project lifecycle.

The plan will include the following sub-plans:

- Social Management Plan
- Health Management Plan
- Waste Management Plan
- Contingency plan
- Audit Plan
- Safety Plan
- Training Plan
- Traffic Plan

Detailed environmental and social procedures will be developed as the project progresses. The plan and procedures would be coordinated by the project Environmental Advisor/Coordinator. Best practices to protect the environment would be adopted during the construction, operational and decommissioning phases of the project.

The plan will form the basis against which audits will be conducted in the field. The Health Safety and Environmental Management System (HSE–MS) and the Project HSE Plan will supplement the EMP in managing the project environment issues. Highlights of the HSE – MS elements are presented below.

- **Demonstrable Management Leadership, Planning, Commitment and Review**

Senior Management leadership and commitment is key to the successful management of Health, Safety, and Environment. This is clearly evident in the provision of adequate resources to manage HSE and personal involvement of the Chief Operating Officer (COO) in the project planning phase. Project Management and Supervisors are responsible for ensuring Health Safety and Environment is managed in accordance with company policy and standards. They are to be seen as providing a leading role towards constant improvement through leadership and action planning. Management shall regularly review the suitability and effectiveness of the system.

- **Policy and Strategic Objectives**

Contractors involved in the project shall have a written HSE policy, in line with the TGNL HSE Policy elements as a minimum. HSE objectives shall be challenging, and understood by all and consistently incorporated into the policy.

In setting HSE objectives, the project management shall consider the overall risk levels of its activities and identify those critical activities and operational issues of the project which require a fully documented demonstration that risks have been reduced to as low as reasonably practicable (ALARP).

- **Organization and Responsibilities**

HSE Superintendent of Nigeria Gas Company Limited at all times shall ensure that a properly resourced and functional project organization is in place to manage the 135km TGNL Gas Pipeline Project and resources shall be adequate and timely available. Responsibilities at all levels shall be clearly described, communicated and understood. Staff shall be developed following structured competency assessment and training systems. The HSE Organogram of TGNL is as indicated in Figure 8-1.

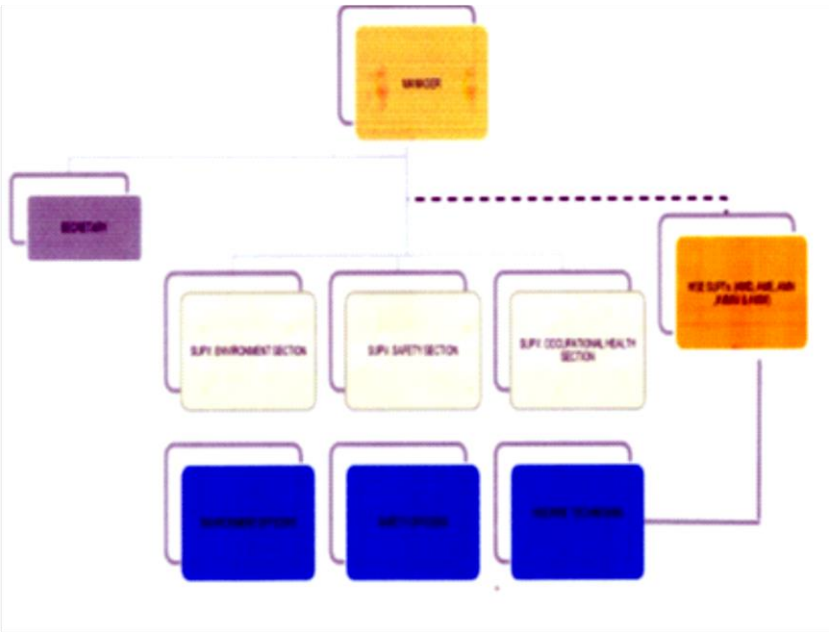


Figure 8-1: HSE Organogram of TGNL

- Hazards and Effects Management Process

The process for project critical activities and operations shall include:

- An inventory of the major hazards to the environment and to health and safety of people of all the activities, materials, products and services.
- An assessment of the related risks, implementation of measures to control these risks and to recover in case of control failure.

The health risk assessment shall address the physical, chemical, biological, ergonomic and psychological health hazards associated with work.

Environmental Management Plan (including a consideration of social impacts) from this ESIA shall be strictly implemented to manage all project identified impacts to ALARP.

Product stewardship shall be applied at all stages of the product life cycle relevant to the company's activities.

- Standards, Procedures, and Document Control

Adequate standards and procedures shall be in place and understood at the appropriate project levels. Preparation, review, and distribution of all key reference documentation shall be

adequately controlled. Emergency response procedures (including medical emergencies) shall be regularly tested.

- Environmental Management Plan

The objectives of the Project Environmental Management Plan are to:

- Address concerns and issues raised in the EIA's stakeholder engagement process and those that will likely continue to arise during the project's lifetime;
- Serve as an action plan for environmental management for the Project;
- Ensure that all workers, contractors, subcontractors, and others involved in the project meet legal and other requirements with regard to environmental management;
- Provide a framework for implementing project environmental commitments (i.e. mitigation measures identified in the EIA); and
- Prepare and maintain records of project environmental performance (i.e. monitoring, audits, and non-compliance tracking).

The EMP will form one of the key reference document for the environmental management of the project and it incorporates the following sub-plans:

8.2.1 Waste Management Plan

Effective and responsible handling and disposal of wastes are key elements in the environmental management system. It is, therefore important that an effective waste management scheme or plan be in place to avoid contravening the above regulations and the NGPTC HSE policy.

Waste management for the project shall be carried out in consultation and in line with the waste management guidelines of Ogun State Waste Management Board.

The operation team shall take all practical and cost-effective measures to minimize the generation of wastes, by employing the five R's (Reduce, Reuse, Recycle, Recovery and Responsible disposal) through the process of optimization or redesign, efficient procedures, and good housekeeping.

Waste shall be managed by applying the below management principles:

- Inventorisation
- Classification

- Segregation
- Wastes quantification
- Wastes tracking, and
- Wastes disposal

Wastes disposal shall be carried out in consultation with Ogun State wastes management. A comprehensive waste management plan is articulated in Section 8.5

8.2.2 Social Management Plan

This is essentially concerned with the social action plan (SAP) for the project-affected communities. SAP consists of measures designed to mitigate the adverse social impacts of projects. Among other things, SAP lists mitigation measures, the means by which the measures will be implemented, the time schedule for the implementation, as well as the implementing parties. The SAP is therefore based on clearly identified mitigation measures. These measures were designed in collaboration with stakeholders notably communities in order to engender a sense of ownership. This was achieved by holding wide-ranging discussions with cross sections of the stakeholders. SAP will be disseminated as part of future engagements and revised based on feedback from communities and stakeholders.

Mitigation

It is clear from literature and from experience that development projects do generate some adverse social impacts, in addition to other positive effects. Mitigation measures are therefore designed to address the adverse impacts. The mitigation measures for the respective adverse social impacts were spelled out in the previous chapter (Chapter Six). On the basis of the proposed mitigation measures, a proposed SAP is provided in Table 8.1 below.

Monitoring and Auditing

The monitoring and auditing of the activities can be handled by the same team. The auditing functions should consist of examining the number, state, and efficiency of the activities while they are being put in place. On the other hand, the monitoring function will involve periodical checks to ensure that the activities/facilities are working properly. The monitoring and auditing programmes should involve visits to activity sites/host communities, in conjunction with local/community leaders from the MOU implementation committee.

Monitoring is particularly necessary in the case of youth militancy and disruptive activities. The experience has shown that militancy and the associated disruption of activities usually emerge gradually. The implication is that with effective monitoring any discontent could be effectively addressed before it becomes disruptive.

Table 8-1: Tentative Social Action Plan

Goals	Actions	Implementing Agency	Time Frame/Phase
1.Manage population growth due to immigration	(a). Recruit community people for unskilled jobs (b). Where possible recruit and train communities' youths for project jobs.	Project office, contractors and community leaders	Site preparation, construction and pipe laying
2. Minimize the depletion of the farming population and agricultural production	(a). Meet with farmers or farmers' groups. (b). Assist with agricultural extension service.	Corporate Social Responsibility (CSR) Department	Land Acquisition Site preparation, construction and pipe laying
4. Minimize pressure on communities infrastructure	(a). 1 a and b above (c). Provide infrastructure for project staff	Project Manager	Construction & Operational Project phases
5. Minimize disruption of means of livelihood	(a). Take the minimum required land for right of way	Project Manager	Land Acquisition Site preparation, construction and pipe

Goals	Actions	Implementing Agency	Time Frame/Phase
	(b). Carry out strategic compensation and resettlement of farmers where land is acquired for right of way occupation.		laying and HDD Operations at river closings
6. Reduce the potential for youth militancy and disruptive activities	(a.) Facilitate continuous engagements with relevant stakeholders (b). Ensure employment of communities' youths in line with agreed employment quotas and ensure wages paid are fair, employment contracts properly documented and disengagement process and plan are fair and clearly communicated. • Initiate/support skill acquisition programmes to engage youths as part of improving means of livelihoods • Develop and disseminate and implement Project Grievance Redress Mechanism	Corporate Social Responsibility (CSR) Department Human Resource (HR) Human Resource (HR) Corporate Social Responsibility (CSR) Department	Construction, Operations and Decommissioning

Goals	**Actions**	**Implementing Agency**	**Time Frame/Phase**
8. Minimize negative impact on Culture and Archaeological Materials.	• Disseminate and implement TGNL Cultural Heritage Management Procedure • Manage and communicate Chance Find of Archaeological materials to the relevant stakeholders	Corporate Social Responsibility (CSR) Department	Construction and decommissioning phase

8.2.3 Health Management Plan

To address the health impacts identified in Chapter 5 for which mitigation measures were proffered in Chapter 6, the proposed Health Management Plan will be a vehicle to be used during project implementation phase to achieve the health-related mitigation measures for the project. Table 8.2 presents a summary of the plan.

Table 8-2: Recommended Health intervention activities and performance indicators

Health intervention Activity	**Phase**	**Performance indicators**	**Timeframe**	**Action party**
Formation and meeting of Community Health Development Committees	All	Activities of community-Health Dev Committees	Quarterly	Community Leaders Environment Advisor
Provision and equipment of Health facilities	All	Number of Health facilities with adequate infrastructures	At inception	Ogun State Govt TGNL Personnel (Project Manager)
Health education on common health problems especially	All	Number of community-Based on Health Education	Quarterly	Ogun State Govt TGNL Personnel (HSE Coordinator)
Provision of safe water (Boreholes)	All	Number of communities with the	Yearly	-TGNL Personnel CSR Manager
Provision of toilet facilities for project Workers (Mobile toilets at work	All	Number of toilets facilities at work location for use	As may be necessary	CSR Manager TGNL (Personnel)
Train and equip Community selected Volunteer Health Workers (VHWs)	Operational	Number of communities with functional VHWs	Quarterly	Ogun State Govt TGNL Personnel (HSE Coordinator)

8.2.4 Contingency Plan

A contingency plan for prompt and effective response to emergency situations that may occur in the course of construction and operations of the proposed pipeline would be established prior to the site preparation and construction phase. The Contingency Plan would detail possible emergency scenarios that could affect the pipeline in course of construction and operations detailing actions required from key personnel and the public).

Pipeline surveillance shall be maintained through regular patrols. The first indication of an emergency may come from one or several sources, depending on the type of emergency. It may come from within the Company or from outside – from employees, customers, the public, civil authorities such as Police or fire services.

No matter what the source, an indication that an emergency exists shall be evaluated (verified as true or proven false) without delay. If an emergency involving Company facilities is verified, a course of corrective action shall be pursued with the utmost diligence.

Pipeline emergencies (whether a notice is received, or discovered directly, by field personnel) will immediately be reported to the Pressure Reduction and Metering Station Control Room, which shall become the "clearing house" for information and plans regarding appropriate responses. The control room shall be staffed to receive and record all internal and external reports 24 hours per day, 8 days a week. The Supervisors of Control Room shall be administratively responsible for reviewing all emergency notifications and actions taken each day. Each notification of a pipeline emergency shall be recorded on the "Notice and Disposition of reported Happening" form, using all available details and information. The Control Room Supervisor shall be notified of the following emergency situations within a nominal 15 minutes (i.e., "as soon as possible") after discovery.

For this purpose, "emergency situation" is defined as any of the following events:

- Rapture or leak in a pipeline or related facility.
- Other pipeline or related facility event which causes a public evacuation or closes a public road;
- A serious injury to an employee or contractor that requires medical attention (or a fatality);
- An "environmental" event that involves a reportable (or potentially reportable) release of hydrocarbons or other chemicals;
- Any accident that has the potential to involve local, state or national media attention.

When a possible emergency is initially identified in the Control Room Office, the Control room supervisor on duty will immediately notify the appropriate Operators/supervisors for field evaluation, response and for taking the necessary steps to effect the immediate implementation of the emergency action that applies to the situation. The names of essential Company personnel (and means of contacting them) shall be listed on a "Key Employee emergency action telephone List".
Each Area Operations Engineer (and a higher level of management) shall be responsible for reviewing the Emergency Call Lists affecting their area of operations and reporting needed changes

to names or contact numbers to the HSE Coordinator, who shall administratively be responsible for issuing updates to the lists as needed.

The contingency plans for the envisaged emergencies shall include:

- Maintenance of functional firefighting equipment and firefighting team with an "on-scene commander" on duty 24 hours daily.
- Presence of portable fire extinguishers on the premises of all consumers and training of firefighters/wardens for all consumers. Occasional activation of fire drills to keep fire wardens/consumers alert.
- Telecommunication facilities to inform Control room, Federal and Ogun State Fire Service (serious fires), the exact location of the fire and to mobilize assistance from TGNL and/or state fire service authority for serious/major fires.
- Purchase and maintenance of ambulance vehicle or prompt assess to ambulance services with medical facilities for first aid and evacuation of wounded personnel during fire outbreaks/injury to employee or contractor.
- Provision for closing blow down valve that vented gas could be ignited.

8.2.5 Audit Plan

An internal and external audit programme shall be in place to review and verify the effectiveness of the EMP and Environmental Management System (EMS) in general. As a follow up of internal audit, TGNL shall carry out internal Audit using company resource personnel to ensure that identified impacts are managed in line with approved EMP use. Audit follow- up shall be timely, thorough and auditable. A schedule of environmental audits/reviews will be developed for all phases of the project to monitor site activities and the effectiveness of the EMP. Reviews and audits will be carried out including reviews of design drawings, specifications and other documents to verify that environmental objectives and requirements will be satisfied. Audits of site operations at key stages and during the construction phase will be conducted to ensure procedures are carried out in the field. Particular emphasis will be placed on reviewing activities carried out in any environmentally sensitive areas.

External Audits by regulators shall be facilitated by TGNL in line with regulatory requirement once or twice yearly as part of Impact Mitigation Monitoring (IMM). Actions from the audit and monitoring shall be promptly closed out.

8.2.6 Training Plan

A training program is an essential part of an Environmental Management System. Environmental Training will be given to key personnel, construction and operation teams to ensure that all personnel on site shall be competent to at least awareness level on environmental matters. Topics will include pertinent environmental legislation, health and safety procedures, environmental awareness, and identification of environmental risks, and the contingency plans, waste management and key actions to which the project is committed to carrying out as part of the EMP.

8.3 Environmental Compliance Monitoring Plan

The FEPA (FMEnv) interim guidelines and DPR EGASPIN (2002) Provisions require environmental monitoring for Transportation of gas by pipeline. Monitoring may require the installation of boreholes or wells within and on the margins of the site with facilities for a sampling of groundwater (or leachate in the waste) and sampling and analysis of emissions and effluents to the environment. This entails sinking of monitoring wells along the pipeline RoW.

Monitoring will be for two purposes:

- To verify the company's compliance with the approved EMP and Regulatory requirements;
- To identify, early, any sign of environmental degradation within the project area, resulting from the project activities.
- Monitoring reports will be submitted to regulators quarterly for review and acceptance. Meanwhile, anomalies/non-compliance will receive immediate attention for immediate mitigation and amelioration.

Table 8-3: Proposed Monitoring Programme (Schedules, Indicators, and Scope).

Environmental components	*Parameters/indicators*	Monitoring frequency (scope)	Number of samples/site	Action Party
Atmospheric Emissions	**Air Quality**: SOX, NOX, SPM, CH_4 **Meteorological Data**: Air temperature, Atmospheric pressure, Relative humidity, wind velocity and Direction	24 hours each time venting is carried out during the first six months of operation and bi-annually during operation	3 1	TGNL, FMEnv, Consultant
Noise	Noise amplitude in decibels	Weekly (during site preparation)	3	TGNL/Consultant
Socio-Economics/ Health	Income levels, Disease prevalence, Changes in lifestyle, Pressure on resources, Damage to infrastructure	Quarterly after construction in affected communities to monitor socio-economic baseline changes and damaged infrastructure reconstruction plans	Communities within 5km (as at the time of presenting this report, 9 communities were identified (see chapter four)) corridor of pipeline and reconstruction project implementation	TGNL
Waste Management	Waste arising from construction activity	Quarterly after construction along RoW of pipeline surroundings and at base camp	Inventory of waste to include type, quantity, and management strategy	TGNL

8.4 Project Management Team

The management structure of the TGNL Pipeline Project will change as it moves from the Design/Procurement phase, via Construction/Commissioning phase to Operation phase. The respective teams will be responsible for the implementation of the environmental management plan associated with each phase of the project.

The task of executing the TGNL Pipeline Project in a sustainable manner and ensuring the protection and conservation of the environment are vested in the Project Team Manager. This is to guarantee management commitment to all environmental issues concerning the project including:

- Ensuring compliance with the project EMP by all staff and contractors involved in the project.
- Interfacing with TGNL and Authorities (FMEnv and DPR) and other stakeholders on project related environmental matters;
- Overall coordination of project related environmental matters;
- Further development, implementation, and revision of the Environmental Management Plan and procedures;

The project team manager may delegate some or all of these responsibilities to other staff in the TGNL organization but he will ultimately remain accountable for the successful implementation of the EMP.

Resources and Responsibilities

For the project, the Environmental Advisor/Coordinator will be appointed to the project team. During the detailed design phase, Advisor/Coordinator has the responsibility to liaise with all parties involved in the project, especially the engineering team and environmental consultants. He shall provide advice on environmental matters in conformity with TGNL HSE – MS and EMS policies.

However, to adequately cover the monitoring, inspection and reporting requirements of the construction and operations phase, greater resources will need to be deployed. Two options are apparent:

Establish within TGNL an environment-monitoring group as indicated in Table 8.4

Table 8-4 Environmental Monitoring Group

Position	**Requirement**
Manager HSE Projects	Permanent
Inspector (HSE Supervisor)	Permanent in construction
	Part time during operational and RoW maintenance
Environmental Consultants (Noise, Air Quality, Water Quality, Soil, wildlife, and Vegetation Experts and Socioeconomics and health	Part-time
Laboratory support	As required with QA/QC back up support
Specialist technical support	As required, production chemistry laboratory or Accredited Laboratory
Environmental Regulatory Authorities (FMEnv, DPR and OGSEPA)	Permanent

(ii) Contract

The alternative to an internal environmental monitoring group is to contract out the job to an appropriately qualified group. TGNL has established schedules for responsibility to which all levels of staff owe accountability.

The responsibility of environmental issues lies with the management through a specialist whose role is advisory.

TGNL management, however, affirms a total commitment to ensuring that all environmental considerations are integrated into related activities. Induction and training courses for staff are part of an effective environmental management scheme which TGNL holds in high regard.

Table 8-5: Summary of Commitments/Responsibilities for the project

S/N	Commitment/issue	Action	Action Party
1.	Project planning and Scheduling	Setting up an environmental focal Point	TGNL
2.	Project mobilization	Supervision of the process	TGNL
3	Construction phase Supervision	Supervision including inspection, monitoring and auditing of activities	TGNL /Project Contractor/ FMEnv/ DPR, LMOE
4.	Construction demobilization	Supervision of the process	TGNL
5.	Post pipe laying and maintenance phase supervision	Supervision including inspection, monitoring and auditing of activities	TGNL
6.	Contingency Planning	Training plan development and Implementation	TGNL
8.	Project decommissioning	Post project monitoring and auditing	TGNL

Table 8.6: Environmental Management Plan for the 135 Kilometre Nigeria Gas Processing and Transportation Company Limited Pipeline Project

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
Pre-Construction					
Land acquisition for the pipeline RoW	• **Third party agitation:** Communities located along the pipeline RoW and land grabbers/swindlers popularly known as *Omoonile* in Lagos are identified as potential sources of agitation. However, currently, the Ogun State government with its Ogun State Property Protection Law, 2016 has put land related agitation under control.	TGNL shall • ensure robust and continual community consultation. A community grievance mechanism shall be instituted by the company to redress community issues throughout the project life	Social acceptance of the project	Yearly	TGNL, FMEnv, DPR, and OGSEPA
	• **Land take**: Land take for the RoW will be permanent, however, the project is sub-surface therefore it will not create landscape problems. The sensitivity of the project area is high considering land value in Ogun State.	TGNL shall • ensure the pipeline RoW is protected from encroachment from third parties from developing the RoW or changing the land use pattern • return the land area to community members for other land use where possible	Social acceptance of the project	Monthly	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	• **Loss of Access to farmland and facility:** Loss of livelihood by farmers and business owners due to inability to access their farmland and businesses as a result of the acquisition of land for pipeline Right of Way (RoW)	TGNL shall • provide adequate compensation, resettlement (economic or physical), and • provide for support to the change introduced • Implement a resettlement program	Social acceptance of the project/ alternative source of income provided	Annually during community engagement sessions	TGNL, FMEnv, DPR, and OGSEPA
RoW Clearing and Site Preparation.	• Use of equipment that can cause **air emissions** and associated **air pollution**: Clearing and site preparation may lead to the emission of particulate matter (dust) into the ambient air. Thereby deteriorating the air quality condition of the area especially if this activity is carried out during the dry season;	TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions • wet the area to be cleared by spraying water to reduce dust generation	No exceedance in FMEnv, DPR and World Health Organisation (WHO) Standards and Minimizing air emissions	Prior to the pre-mob operation and weekly during clearing and site preparation	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	• **Water pollution**: an increase in sediment load and turbidity of pockets of inland waters within the project area. This may arise as a result of land and vegetation disturbance creating particulates and subsequent washing into surface water bodies	TGNL shall: • plan to carry out activity during the dry season • disposed spoils and overburden from site clearing in such a way as to reduce turbidity-generating run-offs	No exceedance in FMEnv, DPR and World Health Organisation (WHO) Standards and Minimizing wastewater discharges	Prior to the pre-mob operation and daily during clearing and site preparation	TGNL, FMEnv, DPR, and OGSEPA
	• Movement of earth moving equipment, pay loaders, gravel, sand, cement, rods, levelers, crane, pipes, etc. to the project site may engender a temporary **increase in noise levels** and **vibration** from the movement of vehicles and machines to the site;	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Zero noise and vibration disturbance complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	Daily during the mobilization period	TGNL, FMEnv, DPR, and OGSEPA
	• **Air pollution**: a potential increase in gaseous emissions from vehicles used to convey the construction equipment to the site.	TGNL shall • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications	No exceedance in FMEnv, DPR and World Bank Standards and Minimizing air emissions	Weekly during the mobilization period	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		• maintain equipment used on site to reduce the number of emissions			
	• **Climate change potential**: emission of greenhouse gases (NOx, CHx, CO, and CO_2) from vehicles	TGNL shall • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions	No exceedance in FMEnv and DPR Standards, compliance with United Nations Framework Convention on Climate Change and Minimizing air emissions	Weekly during the mobilization period	TGNL, FMEnv, DPR, and OGSEPA
	Alteration of soil structure and landscape: potential alteration of soil structure especially on the project location, which could also lead to soil erosion. However, on completion of the mobilization activities, altered soil structures can recover its components without any modification.	TGNL shall: • make sure it is a temporary activity and the project shall be immediately cleared and filled and reinforced. • reduce timeframe between clearing, excavation and trenching through proper project planning	Limited/minimization in Land use/land cover change	Continuous during landscaping	TGNL, FMEnv, DPR, and OGSEPA
Construction					
Clearing, Landscaping, Excavation and Trenching of	• **Loss of vegetation**: the potential loss of vegetation and important plant species.	TGNL shall: • carry out tree pulling	Minimization of the impact of Fauna/Flora population during earthwork activity	Continuous during earth-	TGNL, FMEnv, DPR, and

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
portions to be used for construction camps, operational buildings/ metering station/ manifold, and pipeline trenches and horizontal directional drilling/thrust boring.		where possible • restrict excavation to the required portion of the project area. • carry out replacement of lost trees within or near the pipeline RoW		working	OGSEPA
	• **Noise:** Potential increase in ambient noise from earth moving equipment.	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Zero noise and vibration disturbance complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	Weekly during earthwork period	TGNL, FMEnv, DPR, and OGSEPA
	• **Air pollution:** Potential dust generation during the excavation may temporarily increase the Total Suspended Particulate (TSP) leveling and dust the ambient air of the environment especially. The impact is more	TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and	No exceedance in FMEnv, DPR and World Bank Standards and Minimizing air emissions	Weekly during earthwork period	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	pronounced during the dry season. Gaseous pollutants such as NOx, SOx, COx, and CHx can also be emitted from equipment	specifications • maintain equipment used on site to reduce the number of emissions • spray water on the access road that is not tarred and on construction site prior to during the dusty season			
	• The potential change in the local topography of the area	TGNL shall ensure the site is rehabilitated after completion of construction work	No visual impact complain recorded	Once after the earthwork period	TGNL, FMEnv, DPR, and OGSEPA
	• **Water pollution:** a potential increase in turbidity of available shallow waters especially in the rainy season as a result of run-offs. This can negatively affect the aquatic species within the surface water bodies. In addition, due to disturbance of the waterbed, toxic waste that has solidified on materials will be loosed and spread to the water column thereby contaminating it.	TGNL shall: • implement a run-off management program and install silt curtains to control the suspended particles in the runoffs especially during the rainy season • prevent water contamination from fueling activities by using drip trays • enforce proper waste management practices and good in-house sanitary practices for base camp	No visible turbidity plume recorded and No exceedance in FMEnv, DPR and World Health Organisation (WHO) Standards and Minimizing wastewater discharges	Daily monitoring of silt curtains effectiveness and monthly monitoring recipient water during earthwork activity	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		personnel			
	• **Increase in ambient Noise level and vibration**: Noise and vibration from heavy machinery used for excavation and.	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Zero noise and vibration disturbance complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	Weekly during earthwork period	TGNL, FMEnv, DPR, and OGSEPA
	• **Loss of biodiversity**: the potential loss of aquatic fauna and flora/benthic organisms along the lagoon crossing sections of the pipeline ROW.	TGNL shall carry out site restoration after completion of construction activities. Affected riparian and mangroves shall be re-vegetated except along the ROW where only lower class vegetation shall be replanted.	Minimization of the impact of Fauna/Flora population during earthwork activity	Continuous during earth-working	TGNL, FMEnv, DPR, and OGSEPA
	• **Loss of wildlife habitat**: earth burrow for mammals will be damaged during excavation. On completion of excavation and	TGNL shall: • ensure site rehabilitation after construction/ pipe-	Minimization of the impact of Fauna/Flora population during earthwork activity	Continuous during earth-working	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	backfilling, some of the wildlife species may return to the original environment.	laying activities. • No poaching policy shall be adopted to protect wildlife encountered during construction work.			
	• **Land pollution:** Potential waste generation from construction workers due to indiscriminate defecation and disposal of waste such as food and water containers within the project area. Other sources of pollution include potential diesel spill arising from accidental contact with underground infrastructure.	TGNL shall: • provide mobile toilet on site • prevent water contamination from fueling activities by using drip trays • enforce proper waste management practices and good in-house sanitary practices for base camp personnel • provide appropriate waste bins with lids and strictly enforce use. • employ the principle of waste segregation and waste reduction • engage the services of accredited waste contractors to collect and dispose of waste	No soil contamination recorded	Weekly during earth-working	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
Laying of Pipes – Stringing, Bending, Welding and Lowering	• **Air pollution**: during the welding process of the pipes, there may be a temporal increase of NO_2 in the ambient air. Other notable pollutants include CO and CO_2.	TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions • wet the area to be cleared by spraying water to reduce dust generation	No exceedance in FMEnv, DPR and World Bank Standards and Minimizing air emissions	Weekly during pipes laying	TGNL, FMEnv, DPR, and OGSEPA
	• Potential temporal increase in ambient **noise level** as a result of the cutting, scraping and shaping of the pipes during welding.	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Zero noise complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	Weekly during pipe laying	TGNL, FMEnv, DPR, and OGSEPA
	• Potential **vibration** from machinery. Machinery to be used include an excavator,	TGNL shall: • install mufflers and	Zero vibration complain recorded;	Weekly during pipe	TGNL, FMEnv, DPR, and

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	compactors, etc. which are potential sources of vibration	dampers on noise generating equipment • use noise defenders at high noise levels	Compliance with FMEnv and DPR Criteria	laying	OGSEPA
	• The potential **loss of aquatic fauna and alteration of benthic ecology.** During pipe laying, the benthic, as well as pelagic aquatic organisms, will be demobilized from their natural habitat.	TGNL shall limit all activities to the site of interest.	Minimization of the impact of Aquatic Fauna/Flora population during pipes laying	Continuous during pipes laying	TGNL, FMEnv, DPR, and OGSEPA
	• **The forced eviction of wildlife:** Potential migration of noise-sensitive mammals and reptiles from the pipeline sections with natural habitat status due to the increased noise level caused by machinery.	TGNL shall ensure the protection of wildlife during activities. Partnership with wildlife conservation institution such as Nigeria Conservation Foundation (NCF) to ensure protection and rescue of vulnerable and endangered species following local and international guidelines.	Minimization of the impact of Fauna/Flora population during pipes laying	Continuous during pipes laying	TGNL, FMEnv, DPR, and OGSEPA
Installation of Metering station, manifold, and other surface units.	• Potential increase in ambient **noise** from equipment and other human activities. The potential impact is similar to those caused by previous activities.	TGNL shall: • carry out the installation of the unit during the day when the impact of noise	Zero noise complain recorded; Compliance with World Bank, FMEnv	Weekly during pipe laying	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		will have less impact on people. • dampers shall also be used where applicable to reduce noise from pipes movement. • workers are to use ear muffs to reduced impact of noise.	and DPR Criteria		
Non Destructive Testing (NDT) and hydro-testing	• The potential for land pollution and surface water degradation may prevent domestic use.	TGNL shall: • carry out discharge as to prevent erosion and maintain discharge water quality • control run-off using silt curtains	No soil contamination recorded. No exceedance in FMEnv, DPR and World Health Organisation (WHO) Standards and Minimizing wastewater discharges from NDT activities	Monthly monitoring of soil and recipient water during NDT	TGNL, FMEnv, DPR, and OGSEPA
Backfilling, Clean Up and Restoration	• **Water pollution**: an increase in sediment load and turbidity of pockets of inland waters within the lagoon crossing sections along the pipeline ROW during backfilling.	TGNL shall: • implement a run-off management program and install silt curtains to control the suspended particles in the runoffs especially during the rainy	No visible turbidity plume recorded and No exceedance in FMEnv, DPR and World Health Organisation (WHO) Standards and	Daily monitoring of silt curtains effectiveness and monthly monitoring	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		season	Minimizing wastewater discharges	recipient water	
	• Potential increase in **soil erosion** due to continuous loosening of soil as a result of increased movement of vehicles on un-tarred primary roads in the area.	TGNL shall • restrict the movement of vehicles to compacted and properly reinforced portions. • reduce timeframe between clearing, excavation and trenching through proper project planning	Zero land lost to erosion	Monthly after backfilling and reclamation for at least two season cycle	TGNL, FMEnv, DPR, and OGSEPA
	• Potential **increase in noise levels** from construction vehicles may distort the current serenity of the project area.	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Zero noise complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	Weekly during backfilling and reclamation	TGNL, FMEnv, DPR, and OGSEPA
Vehicular Movement	• **Traffic Congestion:** The movement of materials and personnel will lead to traffic	TGNL shall: • liaise with traffic regulation	Zero traffic congestion complain recorded;	Daily during heavy vehicular	TGNL, FMEnv, DPR,

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	congestion along the Sagamu - Ibefun Ogun State	agency at the Federal, State and Local Government level such as FRSC to ensure a free flow of traffic especially during material and personnel movement • use trained and DDC compliant driver • ensure proper planning and timing of transport activities to avoid busy or rush hours especially during transport of heavy duty equipment • liaise with and provide necessary information to other transport service providers and stakeholders	Compliance with relevant traffic codes and pre-arranged agreement with traffic regulation agency at the Federal, State and Local Government level such as FRSC.	movement	OGSEPA and FRSC.
	• Movement of earthmoving equipment, pay loaders, gravel, sand, cement, rods, levelers, crane, pipes, etc. To the project site may engender a temporary **increase in noise levels** and **vibration** from the movement of vehicles and machines to site;	TGNL shall: • ensure equipment are regularly maintained to put them in optimum efficiency • install mufflers and dampers on noise generating equipment	Zero noise and vibration disturbance complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	Weekly during heavy vehicular movement	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		• use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs			
	• **Air Pollution:** Vehicular emission will lead to a change in air quality.	TGNL shall: • pre-mob construction equipment to meet an acceptable level of emission to conform with national standard and specifications • maintain equipment used on site to reduce the number of emissions	No exceedance in FMEnv, DPR and World Bank Standards and Minimizing air emissions	Weekly during vehicular movement	TGNL, FMEnv, DPR, and OGSEPA
Power Generation	• **Air pollution**: Use of stationary emission sources such as diesel-powered generators are potential sources of air pollution due to emissions. Pollutants gases.	TGNL shall: • ensure use of diesel-powered engines that are well maintained and at optimum performance. • install scrubbers and filters are fitted on the exhausts to machines to minimize emissions.	No exceedance in FMEnv, DPR and World Bank Standards and Minimizing air emissions	Weekly during power generation	TGNL, FMEnv, DPR, and OGSEPA
		TGNL shall:	Zero noise and	Weekly	TGNL,

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	• **Noise:** Potential increase in ambient noise around the project area.	• install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	vibration disturbance complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	during power generation	FMEnv, DPR, and OGSEPA
Waste Disposal	• **<u>Waste generation</u>**: Various waste materials are always generated in most construction site and in camps/communities where construction workers are accommodated. In most cases, improper disposal of these wastes pose some problems, especially if appropriate mitigation is not put in place during this phase of the proposed project.	TGNL shall: • adopt sound waste management practice giving priority to waste reduction and recycling. • implement a comprehensive waste tracking program • engage registered and approved waste management service providers/contractors for hazardous and non-hazardous waste by the Federal Ministry of Environment and Ogun State Waste Management Authority	Wastes are adequately handled and contained	Monthly	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		Other waste management approaches discussed above shall also be adopted			
Maintenance of Construction Vehicles and machines	• Potential contamination of soil, surface, and groundwater as a result of the indiscriminate disposal of spent lube oil and used serviced parts.	TGNL shall: • prevent the spillage of oil and lubricant during maintenance by applying standard operating procedures (SOP) • use drip trays to prevent oil spillage • Ensure that all hazardous waste including used oil is stored and transported to waste dumpsite and disposed of by a DPR licensed vendor. • reuse or recycling of waste oil or dispose of by third parties.	No soil, surface water, and groundwater contamination recorded	Random Inspection, Monthly	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
Pressure Testing and Hydro-testing of the pipeline	• **Sagamu Lagoon Water Contamination**: Indiscriminate discharge of the hydro-test water could lead to acute toxicity of aquatic organisms, low dissolved oxygen levels in the immediate surrounds of the discharge.	TGNL shall: • install filter or screen during abstraction to prevent entry of fish or entrapment • carry out discharge as to prevent erosion and maintain discharge water quality • control run-off using silt curtains • reduce the need for chemicals by reducing the retention time for hydro-test • treat hydro-test water and dispose of responsibly	No exceedance in FMEnv, DPR and World Health Organisation (WHO) Standards and Minimizing wastewater discharges	Prior to discharge of Hydro test water	TGNL, FMEnv, DPR, and OGSEPA
Operation/ Maintenance					
	• **Air pollution**: Continuous operation of pressure reduction engines may lead to emissions and deterioration of the ambient	TGNL shall • ensure schedule monitoring and testing of the pipeline	No exceedance in FMEnv, DPR and World Bank Standards and Minimizing air	Annually	TGNL, FMEnv, DPR, and

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	air quality.	to check for leaks • odourize the gas stream • carry out pilot flaring instead of continuous cold flaring • dry pipeline with nitrogen (nitrogen purging) • carry out pressure monitoring to monitor pressure decline along the pipeline that can help detect leaks • maintain the pipeline RoW • provide security to prevent vandalization of pipeline • consider the installation telemetry pipeline monitoring system • carry out environmental monitoring to track any emission that is connected	emissions		OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		to pipeline leaks.			
	• **Climate change:** Predominant pollutant is known to be methane (CH_4) which is one of the culprits for climate change. There is also the possibility of gas flaring at the Pressure Reducing and Monitoring Facility (PRMF) unit which will lead to the release of methane	TGNL shall ensure that loss of methane to the atmosphere is minimized, introduce methane recovery and utilization program as part of the energy sustainability programs.	No exceedance in FMEnv and DPR Standards, compliance with United Nations Framework Convention on Climate Change and Minimizing air emissions	Biannually	TGNL, FMEnv, DPR, and OGSEPA
	• **Vibration** impacts from the pressure reduction engines could impact on the land physical (geological) characteristics as well as human health	TGNL shall: • install mufflers and dampers on noise generating equipment • use noise defenders at high noise levels • provide ear protection and enforce usage compliance by contractors and staffs	Zero vibration disturbance complain recorded; Compliance with World Bank, FMEnv and DPR Criteria	Biannually	TGNL, FMEnv, DPR, and OGSEPA
	• **Noise:** Potential increase in noise, particulate and gaseous emissions. Power generation and evacuation from a small independent power facility is identified as potential sources	TGNL shall: • Ensure regular and scheduled maintenance of power generators	Zero noise complain recorded; Compliance with World Bank, FMEnv		TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
	of noise	Other noise abatement procedures described above shall also be used	and DPR Criteria		
Maintenance (pigging activities, maintenance, compressor, power plant, and pumps)	• **Land pollution**: Indiscriminate disposal of spent lube oil during routine maintenance of the generators may alter the biophysical characteristics of the soil or water in the immediate environment.	TGNL shall: • ensure waste oil and other hazardous liquid wastes like sludge are contained, transported, treated and disposed in line with best practice.	No soil, surface water, and groundwater contamination recorded	Once after each pigging activity	TGNL, FMEnv, DPR, and OGSEPA
	• **Nuisance**: Potential solid waste generation from used parts, packages, accessories, etc.	TGNL shall ensure that wastes are handled in line with the company's waste management plan to prevent nuisance	Wastes are adequately handled and contained	Once after each pigging activity	TGNL, FMEnv, DPR, and OGSEPA
	• **Waste generation:** Indiscriminate discharge of the condensate and disposal of spent oil may lead to the alteration of the ecology of soil or surface water;	TGNL shall: • adopt sound waste management practice giving priority to waste reduction and recycling. • implement a comprehensive waste tracking program • engage registered and	Wastes are adequately handled and contained	Once after each pigging activity	TGNL, FMEnv, DPR, and OGSEPA

Activity/Source of Impact/Issue	Potential Negative Impact	Mitigation Measure	Indicator Parameters	Frequency of Monitoring	Responsible Action Party
		approved waste management service providers/contractors for hazardous and non-hazardous waste by the Federal Ministry of Environment and Ogun State Waste Management Authority Other waste management approaches discussed above shall also be adopted.			

PROJECT WASTE MANAGEMENT PLAN

FOR

THE PROPOSED SAGAMU LDZ NATURAL GAS PIPELINE NETWORK CONSTRUCTION PROJECT

BY

TRANSIT GAS NIGERIA LIMITED

Waste Management Principle

The awareness and concern for the environment is on a phenomenal rise worldwide. the current thinking that of ‘’zero discharge’’ of waste.

In view of this growing concern, especially with the ever-increasing environmental pollution problem in Nigeria, several decrees on the environment have been promulgated by government e.g. the FEPA decree no. 58 of 1988.

These decrees, which are enforced by regulatory bodies, like the Federal Ministry of Environment (FMEnv) and the Directorate of Petroleum Resources (DPR) make it mandatory for all operating companies and institution to effectively manage their emissions and waste stream.

The need to maintain good field practice, good corporate image as well as complying with national environmental guidelines and standards in Nigeria, makes it pertinent to reduce overall emissions and pollution to the barest minimum.

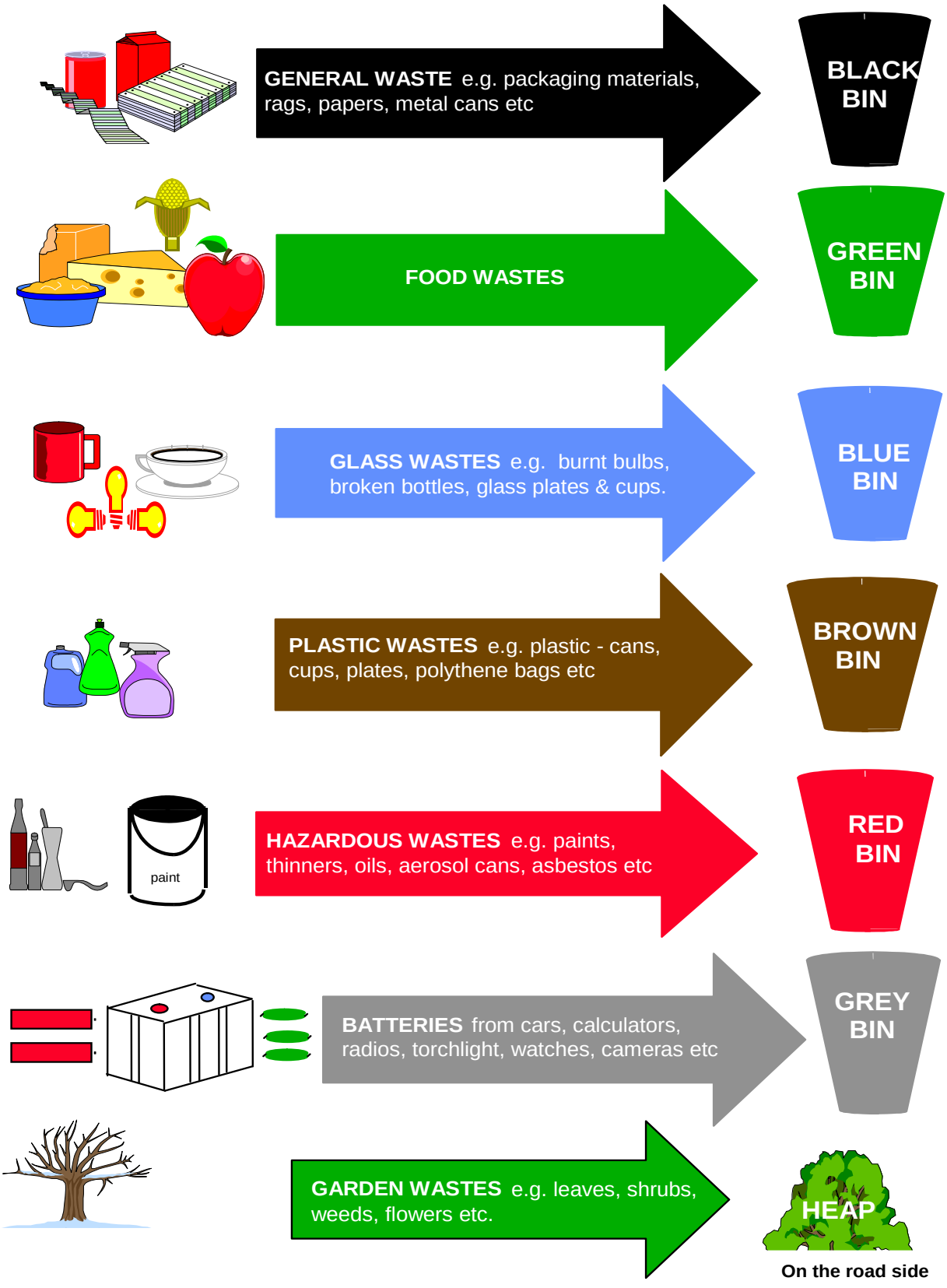
In recognition of the above, **Nigerian Gas Company** strives to meet the quality objectives of her clients in waste management aspects.

Waste Management methods applied to the waste streams include:

Inventorisation: this is the systematic recording of waste based on type and characteristics

Segregation: this is the systematic separation of waste based on type and quality. It entails the use of colour-coded bins for collection of wastes. These codes vary according to client’s standards or other existing standards.

Adopted in this project is the TGNL Colour-code as depicted below:


GENERAL WASTE e.g. packaging materials, rags, papers, metal cans etc
BLACK BIN
FOOD WASTES
GREEN BIN
GLASS WASTES e.g. burnt bulbs, broken bottles, glass plates & cups.
BLUE BIN
PLASTIC WASTES e.g. plastic - cans, cups, plates, polythene bags etc
BROWN BIN
paint
HAZARDOUS WASTES e.g. paints, thinners, oils, aerosol cans, asbestos etc
RED BIN
BATTERIES from cars, calculators, radios, torchlight, watches, cameras etc
GREY BIN
GARDEN WASTES e.g. leaves, shrubs, weeds, flowers etc.
HEAP
On the road side

Segregation and characterisation is required to determine which wastes are similar and may be combined to simplify storage, treatment, recycling and / or disposal. Asset / process owners shall be responsible for the maintenance of the Waste Segregation Scheme in their facilities. The recommended segregation scheme is given in Appendix

Characterisation: the characteristics of waste important for the development of management solutions include:

- moisture concentration
- practical size
- chemical make up (lab-analysis if necessary)
- density and composition

Minimisation (reduce, reuse, recycle, recover): this is the application of techniques causing absolute reduction in the waste volume generated reusing of waste in their original form recycling of waste into other useful products recovering of useful substances from waste materials

Treatment: the treatment techniques applicable to various waste streams include:

- Reprocessing
- Neutralization
- Gravity separation and
- Solid washing e.g. the recovery of silver from x-ray processing waste etc
- Stabilisation
- Quicklime/binding agent
- Incineration
- Direct burning

- Portable incineration
- Domestic/industrial incinerators
- Biodegradation
- Composting
- Bioremediation

Disposal

The residual disposal is done after treatment: shall be dispose of as in Table below that shows the Waste Treatment / Handling and Disposal Facilities in our facilities

A specific waste management plan based on project phases is as overleaf.

Pre-Construction Phase Waste Stream and Management Strategy

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
RoW Preparation and Surveying	**Solid** Green waste	NA	-	Y	- Packing - Shredding - Weighing - Baling - Storing	Contractors Tipper	-	- Mulched or chipped for recycling or disposal (once after site preparation activity)	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved composting facility where practicable or another recycling facility for recycling or dumpsite/landfill facility for disposal	By a Nominated contractor
Mobilisation of equipment, personnel and	Solid Food waste	- 200kg per day at the rate of 2kg per person for 100	-	- Y	- Collection in bins - Packing - Shredding - Weighing - Baling	Contractors Tipper	-	- Non-recyclable waste shall be segregated and stored in a wheelie bin at	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
materials		personnel			- Storing			offices and lidded. - Compost waste where possible - Waste shall be collected on a weekly basis and removed by an FMEnv licensed contractor	composting or Material Recovery Facility (MRF) for recycling, or dumpsite/landfill facility for disposal	
	Solid Sanitary Sewage	- 100kg/day at the rate of 1 kg per personnel per day		- Y	- Collection with Onsite Mobile Toilet	Contractor Evacuation System		- Use mobile toilet on site for collection -	- Collect and transport to the Ogun State Waste Management Agency or DPR licensed Waste Management consultant.	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
	Gases/Emission: - Sulphate Oxides - SO_x *Hydrogen Sulphide -H_2S* *Hydrocarbons - (HC)** ***Methane -*** *(CH4,* *Nitrogen Oxides - NO_X,* *Carbon Monoxi*	- **8500kg** of gaseous emission at the rate of 3kg/ltr of diesel consumed for 50 vehicles /truck consuming 50 liter of diesel/per day						Engine turn-off policy Regular Maintenance of construction vehicles ensuring that emission are within limit. SO_2 -830ug/l H_2S- 30ug/l CO- 5000ug/m^3 NO_X – 500ug/m^3 CH_4 – 500ug/m^3 VOCug/m^3 Particulates 5000ug/m^3		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
	de- CO, *Carbon Dioxides - CO_2,* *Volatile Organic compounds - VOC,* - *Suspended Particulate Matter* - *Exhaust smoke*							Emission/gas discharge should meet all regulatory standard- DPR, FMENV and OGSEPA for air quality		

Construction Phase Waste Stream and Management Strategy

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
Site Clearing, Landscaping and grading	**Solid** Soils and stones	NA		N	- Packing - Storing - Wetting - Covering			- Excavated materials will be stockpiled and re-used on site where feasible - Where not feasible waste will be disposed at permitted dumpsite/ landfill facility	- Re-use on-site or off-site through a commercial soil and stone contractor - Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal	By a Nominated contractor
Mobilisation of equipment, personnel and	**Solid** Green waste	NA	-	Y	- Packing - Shredding - Weighing - Baling - Storing	Contractors Tipper	-	- Mulched or chipped for recycling or disposal (once after site	- Collect and transport to Ogun State Ministry of Environment and FMEnv	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
material/Pipeline lay down,								preparation activity)	approved composting facility where practicable or another recycling facility for recycling or dumpsite/landfill facility for disposal	
Excavation and Trenching	**Solid** Earthings waste	Estimated at about 1,500 tonnes at 15 meter by 1.5 meters by approximately 40km		N	- Reduction - Reuse of over 90% of excavated material for backfilling	Contractors Tippers		- Care shall be ensured so that waste is minimized during this process. Investigations will be undertaken to identify if any excess concrete can be re-used for	- Re-use onsite - Collect and transport to the supplier (return) - Recycle on site - Recover off-site where feasible (some backfilling operations) - Residual	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								new batches. Awareness shall be raised about the importance of effective handling. - A take-back scheme shall be established for excess concrete with suppliers. - Investigations will also be undertaken to determine whether the concrete can be crushed on site for use as aggregate or fill material	waste to landfill (Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal)	

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								where it is not possible to re-use it in its current form		
Construction- civil, mechanical and structural	Solid Concrete	NA		N				- There is a possibility that concrete will be batched on site. Care shall be ensured so that waste is minimized during this process. Investigations will be undertaken to identify if any excess concrete can be re-used for	- Re-use onsite - Collect and transport to the supplier (return) - Recycle on site - Recover off-site where feasible (some backfilling operations) - Residual waste to landfill (Collect and transport to Ogun State Ministry of	

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								new batches. Awareness shall be raised about the importance of effective handling. - A take-back scheme shall be established for excess concrete with suppliers. - Investigations will also be undertaken to determine whether the concrete can be crushed on site for use as aggregate or fill material	Environment and FMEnv approved dumpsite/landfill facility for disposal)	

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								where it is not possible to re-use it in its current form - Where this is not feasible the concrete waste shall be recovered off-site - Residual waste to permitted dumpsite/land fill		
Construction- civil, mechanical and structural	**Liquid** Stormwater	NA		Y	- Reuse - Recycle - Recovery of sediment in a sedimentatio	Contractor Tipper		Good Housekeeping to prevent contamination the site from contamination from waste.	Residual waste to landfill (Collect and transport to Ogun State Ministry of Environment and	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
					n tank -			Treatment of contaminated storm water within regulatory before discharge to the public drain through - Sedimentation - Collection	FMEnv approved dumpsite/landfill facility for disposal)	
Directional Drilling	**Solid** Spent bentonite slurry	NA		Y	- Coagulation - Flocculation - Reuse - Recycle - Recovery of sediment in a mud pit	Contractor Tipper		- If bentonite slurry is used it shall be well contained in a bentonite slurry tank. The optimum recycling of the bentonite shall be ensured with	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
					or sedimentation tank -			solid control equipment and other adequate treatment such as vibrating screens, desanding and desilting hydro-cyclones before returning to the mixing/succion tank for use in the next pile or another location; If feasible, the slurry will be solidified with fibbers or		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								cement to build embankment or diaphragm walls (on site) - Return to original supplier for treatment to separate the solid phase (bentonite and cuttings) and the liquid fraction (water) - Evacuate for disposal after an adequate physicochemical process (coagulation, flocculation,		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								and dewatering). The liquid phase will be dumped in the adjoining ocean after confirmatory analysis and the solid phase will be disposed at a permitted dumpsite/land fill facility - Recycle where possible -		
Lowering and Backfilling	**Solid** Earthings waste	NA		N	- Reduction - Reuse of over 90% of excavated	Contractors Tippers		- Care shall be ensured so that waste is minimized	- Re-use onsite - Collect and transport to the supplier	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
					material for backfilling			during this process. Investigations will be undertaken to identify if any excess concrete can be re-used for new batches. Awareness shall be raised about the importance of effective handling. - A take-back scheme shall be established for excess concrete with suppliers. - Investigations	(return) - Recycle on site - Recover off-site where feasible (some backfilling operations) - Residual waste to landfill (Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal)	

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								will also be undertaken to determine whether the concrete can be crushed on site for use as aggregate or fill material where it is not possible to re-use it in its current form		
Pipe Stringing	**Solid** Metals	NA		Y	Segregation	Recycler Collection		- All metals shall be segregated for off-site recycling	- Collect and transport to an approved Ogun State Ministry of Environment, FMEnv and SON certified metal recycling	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									facility through an approved FMEnv waste management contractor for recycling.	
Worksite activities	**Solid** Glass	NA		Y	Segregation	Recycler Collection		- Glass will be segregated into a separate container so that off-site recycling can occur	- Collect and transport to an approved Ogun State Ministry of Environment, FMEnv and SON certified glass recycling facility through an approved FMEnv waste management contractor	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									for recycling	
Worksite activities	**Solid** Plastics	NA		Y	Segregation	Recycler Collection		- Plastics shall be segregated for off-site recycling.	- Collect and transport to an approved Ogun State Ministry of Environment, FMEnv and SON certified plastic recycling facility through an approved FMEnv waste management contractor for recycling	By a Nominated contractor
Worksite activities	**Solid** Paper and cardboard	NA		Y	Segregation	Recycler Collection		- Paper and cardboard shall be segregated for off-site	- Collect and transport to Ogun State Ministry of Environment and FMEnv	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								recycling	approved composting facility or other paper recycling facility through an approved FMEnv waste management contractor for recycling	
Vehicle Maintenance	**Solid** Tyres	NA		Y	Segregation	Recycler Collection		- Stored in a dedicated waste management area until there is sufficient quantity for an FMEnv licensed waste contractor to transport	- Collect and transport to an approved Ogun State Ministry of Environment, FMEnv and SON certified tyre (tyre-retreading) recycling	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									facility through an approved FMEnv waste management contractor for recycling - Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal	
Medical	**All** Medical	NA		Y	Segregation			- Improved HSE management	- Dispose waste USING	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								will reduces accidents and hence reduction of first aid application and the production of wastes.	approved LAWMA service provider	
Vehicle Maintenance	**All** Batteries (wet cell and alkaline	NA		Y	Segregation	Recycler Collection	Batteries (wet cell and alkaline	- Alkaline batteries to be stored separately from wet cell batteries in lidded and sealed containers in a bunded area	- Collect and transport to an approved Ogun State Ministry of Environment, FMEnv and SON certified battery recycling facility through an approved	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									FMEnv waste management contractor for recycling - Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal	
Painting	**Liquid** Paint and adhesive waste	NA		Y	- Collection in drums onsite - Segregation	Contractors Collection /pick up		- Waste paints and adhesives will be stored in bunded areas on site (clearly	- Empty paint tins arising on site will be segregated in stockpiles	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								labeled sealed containers) for removal by a licensed contractor	on site away from all watercourses or water-bodies. All Special Waste shall be source segregated before treatment and/or disposal and then independently moved to a secure collection point. It is then collected by a specialist contractor	

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									(Ogun State Ministry of Environment and FMEnv) and transferred for suitable treatment and/or disposal facility (Ogun State Ministry of Environment and FMEnv approved).	
Worksite activities	**Solid** Waste cloth and	NA		Y	- Collection in drums onsite -	Contractors Collection /pick up		- Collected for removal	- Collect and transport to Ogun State Ministry of Environment and	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
	fabric				Segregation				FMEnv approved dumpsite or disposal facility	
Maintenance	**Solid** Oily rags and filters (drained)	NA		Y	- Collection in drums onsite - Segregation	Contractors Collection /pick up		- Stored in bunded areas on site (in clearly labelled sealed drums) for removal by FMEnv licensed contractor	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite or disposal facility	By a Nominated contractor
Maintenance	**Liquid** Used grease lubricants and oil	NA		Y	- Collection in drums onsite - Segregation	Contractors Collection /pick up		- Stored on-site at a construction site in bunded containment drums for	- All Special Waste shall be source segregated before treatment	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								removal by an FMEnv licensed contractor	and/or disposal and then independently moved to a secure collection point. It is then collected by a specialist contractor (Ogun State Ministry of Environment and FMEnv) and transferred for suitable treatment and/or disposal facility	

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									(Ogun State Ministry of Environment and FMEnv approved). Special Waste shall be recycled where possible (e.g. oils and solvents).	
Work site activities	**Solid** Sanitary Sewage	- 250kg/day at the rate of 1 kg per personnel per day	-	- Y	- Collection with On site Mobile Toilet	Contractor Evacuation System	Sanitary Sewage	- Stored on-site in an engineered soak-away system for latter evacuation to a certified sewage treatment	Sanitary wastes should be treated in a sewage treatment plant to the required regulatory limits before discharged effluent to the	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
								plant. - Covert waste materials to composting	environment. Sludge from treatment process could be dried and incinerated Collect and transport to a LAWMA a/ FMEnv. licensed Waste Management consultant.	
Vehicle Operations	**Gases/Emission:** - Sulphate	- **15000kg** of gaseous emission at the						Engine turn-off policy Regular Maintenance of		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
	Oxides - SO_x *Hydrogen Sulphide -H_2S* *Hydrocarbons - (HC)** ***Methane -*** *(CH4,* *Nitrogen Oxides - NO_X,* *Carbon Monoxide- CO,*	rate of 3kg/ltr of diesel consumed for 100 vehicles /truck consuming 50 liter of diesel/per day						construction vehicles ensuring that emission are within limit. SO_2 -830ug/l H_2S- 30ug/l CO- 5000ug/m^3 NO_X – 500ug/m^3 CH_4 – 500ug/m^3 VOCug/m^3 Particulates 5000ug/m^3 Emission/gas discharge should meet all		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
	Carbon Dioxides - CO_2, *Volatile Organic compounds - VOC,* *- Suspended Particulate Matter* *-Exhaust smoke*							regulatory standard- DPR, FMENV and OGSEPA for air quality		

Commissioning Phase Waste Stream and Management Strategy

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
Mobilisation of equipment, personnel and materials	**Solid** Food waste	- 200kg per day at the rate of 2kg per person for 100 personnel	-	- Y	- Collection in bins - Packing - Shredding - Weighing - Baling - Storing	Contractors Tipper	-	- Non-recyclable waste shall be segregated and stored in a wheelie bin at offices and lidded. - Compost waste where possible - Waste shall be collected on a weekly basis and removed by an FMEnv licensed contractor	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved composting or Material Recovery Facility (MRF) for recycling, or dumpsite/landfill facility for disposal	By a Nominated contractor
	Solid Sanitary	- 100kg/day at the rate of 1	-	- Y	- Collection with Onsite	Contractor Evacuatio		- Use mobile toilet on site for collection	- Collect and transport to a LAWMA or	By a Nominated

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
	Sewage	kg per personnel per day			Mobile Toilet	n System		-	DPR licensed Waste Management consultant.	contractor
	Gases/Emission: - Sulphate Oxides - SO_x *Hydrogen Sulphide -H_2S* *Hydrocarbons -(HC)** ***Methan***	- **15000kg** of gaseous emission at the rate of 3kg/ltr of diesel consumed for 100 vehicles /truck consuming 50 liter of diesel/p						Engine turn-off policy Regular Maintenance of construction vehicles ensuring that emission are within limit. SO_2 -830ug/l H_2S- 30ug/l CO- 5000ug/m^3		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
	e **-** (*CH4,* *Nitrogen Oxides - NO_X,* *Carbon Monoxide- CO,* *Carbon Dioxides - CO_2,* *Volatile Organic compounds - VOC,* - *Suspended Particul*	er day						NO_X – 500ug/m^3 CH_4 – 500ug/m^3 VOCug/m^3 Particulates 5000ug/m^3 Emission/gas discharge should meet all regulatory standard- DPR, FMENV and OGSEPA for air quality		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
	ate Matter - *Exhaust smoke*									

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
Hydrostatic	**Liquid**		-	N			-	- Render	- Dispose of offshore	By a Nominated

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment Before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	On-site Treatment Contractor	Minimisation and Treatment Methods	Disposal Method	Offsite Contractor
Testing	Hydro test Water							harmless	with DPR approval and monitor receiving environment	contractor
Hydrostatic Testing	**Gas** Nitrogen		-	N			-	-	-	

Operational Phase Waste Stream and Management Strategy

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
Operational activities	**Solid** Glass	NA		Y	Segregation	Recycler Collection		- Glass will be segregated into a separate container so that off-site recycling can occur	- Collect and transport to an approved Ogun State Ministry of Environment, FMEnv and SON certified glass recycling facility through an approved FMEnv waste management contractor for recycling	By a Nominated contractor
Operational activities	**Solid** Plastics	NA		Y	Segregation	Recycler Collection		- Plastics shall be segregated for off-site recycling.	- Collect and transport to an approved Ogun State Ministry of Environment,	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									FMEnv and SON certified plastic recycling facility through an approved FMEnv waste management contractor for recycling	
Operational activities	**Solid** Paper and cardboard	NA		Y	Segregation	Recycler Collection		- Paper and cardboard shall be segregated for off-site recycling	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved composting facility or other paper recycling facility through an approved	By a Nominated contractor By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									FMEnv waste management contractor for recycling	
Vehicle Maintenance	**Solid** Tyres	NA		Y	Segregation	Recycler Collection		- Stored in a dedicated waste management area until there is sufficient quantity for an FMEnv licensed waste contractor to transport	- Collect and transport to an approved Ogun State Ministry of Environment, FMEnv and SON certified tyre (tyre-retreading) recycling facility through an approved FMEnv waste management contractor for	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									recycling - Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal	
Medical	**All** Medical	NA		Y	Segregation			- Improved HSE management will reduces accidents and hence reduction of first aid application and the production of wastes.	- Dispose waste using approved Ogun State Waste Mamagement Agency service provider	By a Nominated contractor
Vehicle Maintenanc	**All**	NA		Y	Segregation	Recycler	Batteries (wet cell	- Alkaline batteries to be	- Collect and transport to	By a Nominated

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
e	Batteries (wet cell and alkaline					Collection	and alkaline	stored separately from wet cell batteries in lidded and sealed containers in a bunded area	an approved Ogun State Ministry of Environment, FMEnv and SON certified battery recycling facility through an approved FMEnv waste management contractor for recycling - Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite/landfill facility for disposal	contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
Operational activities	**Solid** Waste cloth and fabric	NA		Y	- Collection in drums onsite - Segregation	Contractors Collection/ pick up		- Collected for removal	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite or disposal facility	By a Nominated contractor
Maintenance	**Solid** Oily rags and filters (drained)	NA		Y	- Collection in drums onsite - Segregation	Contractors Collection/ pick up		- Stored in bunded areas on site (in clearly labelled sealed drums) for removal by FMEnv licensed contractor	- Collect and transport to Ogun State Ministry of Environment and FMEnv approved dumpsite or disposal facility	By a Nominated contractor
Maintenance	**Liquid** Used	NA		Y	- Collection in drums	Contractors Collection/p		- Stored on-site at a	- All Special Waste shall	By a Nominated

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
	grease lubricants and oil				onsite - Segregation	ick up		construction site in bunded containment drums for removal by an FMEnv licensed contractor	be source segregated before treatment and/or disposal and then independently moved to a secure collection point. It is then collected by a specialist contractor (Ogun State Ministry of Environment and FMEnv) and transferred for suitable treatment and/or disposal facility	contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									(Ogun State Ministry of Environment and FMEnv approved). Special Waste shall be recycled where possible (e.g. oils and solvents).	
Operational activities	**Solid** Sanitary Sewage	- 250kg/ day at the rate of 1 kg per personnel per day	-	- Y	- Collection with Onsite Mobile Toilet	Contractor Evacuation System	Sanitary Sewage	- Stored on-site in an engineered soak-away system for latter evacuation to a certified sewage treatment plant. - Covert waste materials to composting	Sanitary wastes should be treated in a sewage treatment plant to the required regulatory limits before discharged effluent to the environment. Sludge from treatment process could be dried and	By a Nominated contractor

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
									incinerated Collect and transport to a Ogun State Ministy of Environment/ FMEnv. licensed Waste Management consultant.	
Vehicle Operations	**Gases/ Emission : -** Sulphate Oxides - *SO_x Hydrogen Sulphide - H_2S Hydrocarbons - (HC)* **Methane** - (CH4, Nitrogen Oxides -	**- 3000kg** of gaseous emission at the rate of 3kg/ltr of diesel consumed for 20 vehicles/ truck consuming 50 liter of diesel/per day						Engine turn-off policy Regular Maintenance of construction vehicles ensuring that emission are within limit. SO_2 -830ug/l H_2S- 30ug/l CO- 5000ug/m^3 NO_X – 500ug/m^3 CH_4 – 500ug/m^3 VOCug/m^3 Particulates 5000ug/m^3 Emission/gas		

Source	Waste Type	Rate of Generation	Hazard Rating	Onsite Treatment before Discharge (Y/N)	Onsite Treatment Technology	Evacuation Method	Onsite Treatment Contractor	Minimisation and Treatment Strategies	Disposal Method	Offsite Contractor
	NO_X, Carbon Monoxide- CO, Carbon Dioxides - CO_2, Volatile Organic compounds - VOC, - Suspended Particulate Matter -Exhaust smoke							discharge should meet all regulatory standard- DPR, FMENV and OGSEPA for air quality		
Pigging Operations	**Solid** Hydrate, Wax, Scale	-NA	H	Collection in drums an		Contractors Evacuation			- Dispose of offshore with DPR approval and monitor receiving environment	By a Nominated contractor

Waste Generation

Effective and responsible handling and disposal of wastes are key elements in the environmental management system. It is, therefore important that an effective waste management scheme or plan be in place to avoid contravening the above regulations and the TGNL HSE policy.

The scale of waste generation shall be obtained from the client and the information shall be used to develop a preliminary plan, which shall be validated as we undertake the actual performance.

The waste as applicable to the community/industry/location shall include but not limited to:

- Polyethylene bags/nylon
- Rubber products
- Wastewater
- Garbage/refuse
- Batteries/batteries water
- Used oil
- construction & demolition
- contaminated soil
- empty oil/chemical drums
- food waste
- garden waste
- plastic/glass/metallic cans
- maintenance waste (filters, wires, tubulars, etc)
- organic solvent
- packaging materials

- paints and thinners
- paper
- scrap metal
- sewage
- used oils (lube/engine)
- wooden pallets

Inventorisation and Segregation

The waste streams shall be collected in separate bins as indicated below to enable easy and proper management. These wastes shall be properly quantified using industrial measuring scales and sometimes by estimation using standard techniques. The measurements shall be entered into an electronic system and reports shall be generated as desired by the client.

Colour-coded bins shall be placed at strategic locations on the platform for different waste items. Waste collectors shall ensure the proper segregation and maintenance of the facilities. These bins shall be covered and kept under a roof to avoid rain influx in the absence of a standard by our client we shall use our own waste segregation colour-code.

Waste Inventory

Wastes anticipated from the project belong to the following broad categories:

- Solid Wastes to include worksite generated waste like plastics, bottles, empty containers, papers, organic waste, cuttings (soil and sand), packaging items, garbage's, obsolete items and welding materials (torches and spent electrodes)
- Food waste
- Domestic and sanitary waste

a. Solid Waste and Sewage

The estimate of the domestic waste including is based on the manpower requirement at various phase of the project.

Project Phases	Pre-Construction Phase	Construction Phase	Pre-Commissioning Phase	Operations Phase
Skilled	100 - 150	150 – 250	100 - 150	20 - 30
Unskilled	100 - 200	300 – 500	100 - 200	NA
Total	**350**	**550**	**350**	**30**

The average waste estimate is based on the followings

Project Phases	Waste per personnel
Solid Waste	2kg/personnel
Waste water	50 liters/personnel
Sewage	1 kg/personnel

b. Gases/Emission

Waste Oil

Gaseous Emission and discharges

Spent lubricant

Grease

Used batteries

Vehicular Emission and Oily Waste is based on the estimated numbers of vehicle during the project phases as below

Project Phases	Pre-Construction Phase	Construction Phase	Pre-Commissioning Phase	Operations Phase
Truck	20	60	20	0
Earth moving equipment	20	60	20	0
Project Vehicle	10	20	10	5
Project Buses	2	5	5	0

c. Drilling cuttings and solids

The HDD process is expected to generate drill cutting and solids. The estimated volume of drill cuttings to be generated by the HDD operation for a length of about 300m is as below.

Hole Diameter: 36 inches

Footage Drill: 300m

Porosity %: 0.25

Cutting Density: 2.2

Calculated Hole Capacity: 0.314846

Solid Waste (weight) in pounds = 188858.8

Solid Waste (weight) in tonnes = 90 tonnes

d. Other Hazardous Waste (NA)

- Paints and paint chemicals such as thinners
- Pigging sludge

Waste Characterisation and Source

Solid Waste

Domestic Refuse

These types of waste include cleared vegetation, garbage and kitchen waste domestic refuse, pigging trash, scrap metals, filters, welding torches and spent electrodes. Trees would be felled along ROW and cut into usable lengths for ease of transportation. In line with waste management procedures, identified solid wastes will be sorted and disposed of in designed areas. Waste prevention measures will include:

- The disposal of industrial wastes would be conducted in designated areas in accordance with regulation.
- Rejected Raw material products from facility will be managed through
    - improved material management system
    - collection and gathering of all rejected raw material in appropriate storage condition for returned to the manufacture/supplier.

Industrial Refuse, Office Waste and Camp rubbish

These types of waste include scrap, packaging materials and chemical containers filters, welding torches and spent electrodes. Waste prevention measures will include:

- The disposal of industrial wastes would be conducted in designated areas in accordance with regulation.

- Rejected Raw material products from facility will be managed through
  - improved material management system
  - collection and gathering of all rejected raw material in appropriate storage condition for returned to the manufacture/supplier.

Scrap Metal/Plastics

This will include waste scrap metals and off cuts

Medical Waste

This will include d*ressing materials, clinical materials & cleaning materials*

Liquid Wastes

Hydrotest water

Prior to the operation, the pipeline will be pressure-tested using fresh water from drilled boreholes. The borehole water is fresh; as a result addition of inhibitors will not be necessary for the hydro-testing process. The need for corrosion inhibitors would have arisen if the water had not been fresh. Since no inhibitor is involved, disposal of the hydro-test water into the environment will not constitute any harm to the environment. The period for which the hydro-test would be undertaken is short (24 hours) and therefore does not require the use of an inhibitor. The source of water for the hydro-testing will be boreholes drilled for the purpose of the hydro-test in the study area. The nearby water bodies will serve as the recipient of water bodies.

Spent Diesel and Oil

These wastes would emanate from working equipment such as welding machines, excavators, bulldozers etc. These wastes shall be scooped, contained and disposed of in designated sites.

Water Based Spent Mud/Drill Fluids (Bentonite and other additives)

The drilling fluid to be used for the HDD process and operation is a mixture of bentonite (naturally occurring clay that is extremely hydrophilic with high swelling characteristics) and fresh water.

Industrial and Human Waste/Sewage

This will include hazardous human waste like sewage (grey water) and sewerage (black water)

Waste Minimisation

The waste minimisation techniques to be adopted for the management of the wastes to be generated from this project is ***"reduce, reuse, recycle and recover (4rs)".***

The table below shows that each waste stream shall be subjected to this screening with cost and quality in view, to be able to develop effective strategies their management.

A tentative plan for this presented below. The validation and final development of the real case approach shall be developed after an evaluation of the generation scale has been done.

Waste Minimisation Alternatives

Waste name	Minimisation options			
	Reduce	reuse	recycle	recover
Used phone cards	√	√	√	
Polyethylene bags/nylon	√		√	√
Rubber products	√		√	
Wastewater		√	√	
Garbage/refuse	√		√	√
Batteries	√		√	
construction & demolition	√	√		
empty oil/chemical drums	√		√	
food waste	√		√	√
garden waste	√		√	
Glass	√		√	
maintenance waste (filters, wires, tubular, guages, etc.)	√		√	
organic solvent	√			
packaging materials	√	√		
paints and thinners	√	√		
drilling waste	√			√
computer consumable		√	√	√
obsolete chemicals	√			√
contaminated soil	√			√

Paper	√		√	
Plastics	√		√	
scrap metal	√		√	
used oils (lube/engine)	√		√	
wooden pallets	√	√		
Wastewater	√	√	√	√
Asbestos	√			
Obsolete chemical				√
Phone cards	√		√	
Fabrics/leather	√		√	
Cement	√	√		√

Waste Movement, Treatment and Disposal

The manner, which TGNL shall adopt in managing the waste to be generated from the project, shall be in line with regulatory requirement. All movement of waste shall be accompanied using a manifest. This manifest shall comply with NESREA, FMEnv, DPR and our client's standards..

Facilities, systems and equipment to be deployed

Equipment

1. Industrial measuring scale
2. Plastic waste collection bins (various sizes)
3. Polyethylene bags various sizes)
4. Buggies, bulldozers, pushers
5. Waste tracking system

6. PPE's
7. Personnel vehicles

Systems

- Waste Tracking Document (Regulatory Standard)

Personnel

- Project Manager
- Waste Advisers
- Waste Monitors
- Field Crew (Waste Management Operators)
- Drivers

Tracking system

Every waste to be moved shall be documented properly from generation to disposal. The information needed for the full manifesting shall include the following:

WASTE MANIFEST FORM

Waste Generating Facility					
Carrier (Truck, Local e.t.c)					
Destination					
Date					
Item	**Waste Description**	**MSDS** **Y**	**N**	**Waste Vol Or Weight**	**Check ( ) the appropriate Handling/Disposal Method Used**
					Recycle
					Reuse
					Neutralize
					Process through sewage system
					Send to waste disposal site
					Recycle to scrap
					Return to vendor
Waste disposed by:				Signature:	
This is to certify that the above named materials are properly packed for transport to disposal site				This is to certify that the above materials are received at the specified disposal site.	
Vendor Supervisor	Date			Signature	Date
Copy:					

DAILY/WEEKLY WASTE TRACKING SYSTEM

LOCATION……

DATE……..

S/N	**DATE**	**NATURE/ TYPE OF WASTE**	ESTIMATED VOLUME/WEIGHT (Gal.Litre.Kg.e.t.c) OF WASTE	HOW WASTE WAS HANDLED OR TREATED	CUMULATIVE ESTIMATED RECORD	SIGNATURE

CHAPTER NINE

DECOMMISSIONING AND ABANDONMENT

9.1 Introduction

The decommissioning plan for the gas pipeline is as discussed below:

- Decommissioning of pipeline section construct a 12" x 135km Pipeline Network from KP312 of Escravos Lagos Pipeline System's Above Ground Installation at Ibefun, Ogun State to Rite Foods Nigeria Limited Ososa, Ogun State.
- Decommissioning of the pipeline section from Sagamu Interchange to Abeokuta Ogun State, Sagamu Interchange to J4, Ogun State to Sagamu Metering State, Sagamu Benin Express Junction Ogun State

9.2 Decommissioning Plan

9.2.1. Decommissioning of Sagamu Natural Gas Pipeline Network Construction Project

The Sagamu LDZ pipeline network has a minimum life expectancy of twenty-five (25) years. The operation and maintenance procedure provide for monitoring the performance and the integrity of the pipeline network. When the performance of the network scales to diminishing returns, TGNL 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 FMEnv and or DPR prior to the commencement of the process.

The following activities are involved in decommissioning/abandonment:

- Removal of above-ground facilities and site clean-up;
- Disposal of wastes;
- Rehabilitation of the site.

9.3 Decommissioning

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, TGNL shall be consulted for their decision regarding the disposal of the equipment after removal.

For the decommissioning of the pipeline network the current abandonment method is proposed:

- Flushing of the line
- Fill and Cap the line with an inert gas
- Leaving the line in the ground

This procedure is subject to change in the future as technology develops.

9.4 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 TGNL waste disposal guidelines.

9.5 Rehabilitation of Site

After all categories of wastes have been satisfactorily disposed of, the topsoil shall be stripped and replaced with topsoil from the un-impacted neighborhood. Seedlings of the original vegetation shall be obtained from neighboring areas and planted.

9.6 Remediation Plans after Decommissioning/Closure

Decommissioning and abandonment/closure programmes are integral parts of this ESIA. 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 lifecycle of the project. The plan shall conform to the nationals/state statutory requirements in force at the time of the decommissioning, and TGNL's 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.

9.7 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 revegetated.

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 backfilled with topsoil.
- 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.

CHAPTER TEN

CONCLUSIONS AND RECOMMENDATIONS

10 Conclusion

The Environmental and Social Impact Assessment Study of the proposed Sagamu LDZ Natural Gas Pipeline Network Construction Project by Transit Gas Nigeria Limited (TGNL) was conducted in accordance with the Environmental Impact Assessment Act No 86 (110102), Environmental Guidelines and Standards for the Petroleum Industry in Nigeria" (EGASPIN) published in 2002 by the Department of Petroleum Resources (DPR) and World Bank Operational Policy (OP) 4.01 on Environmental Assessment. 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
- Impact assessment
- Management plan
- Reporting and disclosure

Baseline information on receptors and resources were obtained during the ESIA from available data sources and field surveys during the wet and dry seasons. A description of the existing environmental, health and socio-economic conditions was put together as a basis against which the impacts of the project was assessed and evaluated. The biophysical, social-economic and health impacts of the project were assessed and mitigation measures recommended to avoid or minimize adverse impacts and enhance positive impacts.

The significant impacts identified are air quality impairment as a result of methane (CH_4) emission/venting during operation, contamination of rivers due to hydro-test waste water discharge (commissioning), spillage of sludge and pigging spoil during operation and

maintenance, physical and economic resettlement as a result of land-take for right of way, youth agitation due to dissatisfaction/ disagreement and Workplace Health and Safety impacts (construction). However, each of the potential impacts has adequate mitigation measures recommended for project implementation.

In consideration of the above, any environmental issue to impede the development of the proposed Sagamu LDZ Natural Gas Pipeline Network Construction Project has been mitigated to as low as reasonably practicable.

The project is therefore recommended for implementation because the benefits to be derived are much greater than the environmental impacts that can be adequately managed.

The project also has a high environmental, economic and social acceptability. A monitoring plan has been recommended to take care of any unforeseen event that may induce environmental changes in the future during the lifespan of the project.

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