ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OF THE

Environmental Data Revalidation / EIA Upgrade for Lagos Free Zone

Located at the Lagos Free Zone (LFZ)

Itoke Village

Ibeju Lekki Local Government Area of Lagos State

BY

Lagos Free Zone Company (LFZ)

FINAL REPORT

SUBMITTED TO

FEDERAL MINISTRY OF ENVIRONMENT

MABUSHI, ABUJA.

December, 2021

FINAL EIA REPORT

FOR THE

Environmental Data Revalidation / EIA Upgrade for Lagos Free Zone

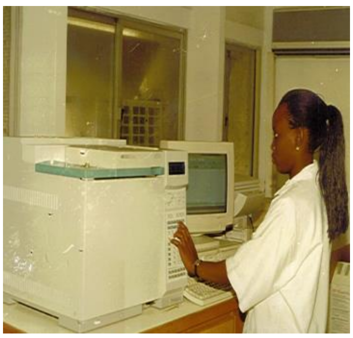
PROPONENT:

LAGOS FREE ZONE COMPANY (LFZ)

CONSULTANT:

GLOBAL ENVIRONMENTAL TECHNOLOGY LIMITED



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ACRONYMS AND ABBREVIATIONS

API	Area of Potential Influence
AHI	African Health Initiative
AIDS	Acquired Immune Deficiency Syndrome
BAT	Best Available Technology
BOD	Biological Oxygen Demand
BTEX	Benzene Toluene and Xylene
CDA	Community Development Association
CHEW	Community Health Extension Worker
COD	Chemical Oxygen Demand
CITES	Convention on International Trade and Traffic in Endangered Species
CSV	Creating Shares Value
CU	Co-efficient of Uniformity
DR	Death Rate
EA	Environmental Assessment
EAS	Environmental Audit Study
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statements
EMP	Environmental Management Plan
EQR	Environmental Quality Rating
EPI	Environmental Performance Indicator
FCT	Federal Capital Territory
FGD	Focus Group Discussion
FMEnv	Federal Ministry of Environment
FEPA	Federal Environmental Protection Agency
GET	Global Environmental Technology
GIS	Geographical Information System
GPS	Global Positioning System
GSM	Global System for Mobile Telecommunication
HDB	Hydrocarbon Degrading Bacteria
HDF	Hydrocarbon Degrading Fungi
HIV	Human Immunodeficiency Virus
HRH	His Royal Highness
HPD	Hearing Protection Device
HSE	Health Safety and Environment
ITD	Inter Tropical Discontinuity
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature and Natural Resources
KII	Key Informant Interviews
LASEPA	Lagos State Environmental Protection Agency
LCD	Liquid Crystal Display
LDA-	Lekki Development Authority
LFN	Laws of the Federation of Nigeria
LGA	Local Government Area

LGC	Local Government Council
LGDA	Local Government Development Area
LULC	Land Use/Land Cover
MoU	Memorandum of Understanding
MSG	Mono Sodium Glutamate
NAAQS	National Ambient Air Quality Standards
NESREA	National Environmental Standards Regulations and Enforcement Agency
NGSA	Nigeria Geological Survey Agency
NPC	National Population Commission
PAC	Project Affected Communities
PAH	Polycyclic Aromatic Hydrocarbon
PLC	Public Liability Company
PRL/A	Participatory Rural Learning Appraisal Approach
PSU	Primary Sampling Units
PPE	Personal Protection Equipment
PPSTESCOM	Post-Primary Schools Teaching Service Commission
QA/QC	Quality Assurance/Quality Control
RAP	Resettlement Action Plan
SEPA	State Environmental Protection Agency
SIA	Socio-Economic Impact Assessment
SPEB	State Primary Education Board
SSI	Semi-Structured Interviews
STEL	Short Term Exposure Unit
STI	Sexually Transmitted Infections
TBA	Traditional Birth Attendant
TDS	Total Dissolve Solids
THB	Total Heterotrophic Bacteria
THC	Total Hydrocarbons
THF	Total Hydrocarbon Fungi
TOC	Total Organic Carbon
ToR	Terms of Reference
TSS	Total Suspended Solids
TSP	Total Suspended Particles
TWA	Time Weight Average
UNECE	United Nations Economic Commission for Europe
USA	United State of America
WHO	World Health Organization
VOCs	Volatile Organic Compounds

SYMBOLS/UNITS

Ba	Barium
Cd	Cadmium
Ca	Calcium
CFU/g	Colony Forming Unit/Gram
CO	Carbon Monoxide
Cu	Copper
Cr	Chromium
dB(A)	decibel(s)
Fe	Iron
H_2S	Hydrogen Sulphide
Hg	Mercury
K	Potassium
Mn	Manganese
Mg	Magnesium
Mg/L	Milligram/Litre
Mg/Kg	Milligram/Kilogram
mS/cm	Millisiemens/Centimeter
Na	Sodium
NE	North East
NN	North-North
NH_3	Ammonia
Ni	Nickel
NO_3	Nitrates
NO_X	Oxides of Nitrogen
NW	North West
Pb	Lead
PM_{10}	Particulate Matter
PO_4^{3-}	Phosphates ion
ppm	Part Per Million
ppt	Part Per Thousands
SO_2	Sulphur Dioxide
SO_4^{2-}	Sulphates ion
USD	United States Dollars
V	Vanadium
Zn	Zinc
%	Percentage
°C	Degree Celsius
$\mu g/m^3$	Microgram/ Cubic Meter
µS/cm	Micro-Siemens/Centimetre

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EXECUTIVE SUMMARY

General Preamble

The Lagos Free Zone Company (LFZ) was set-up as a SPV (Special Purpose Vehicle) to plan, promote, develop and manage the Lagos Free Zone (LFZ). It is wholly owned by Tolaram, Singapore, the Promoters of LFZ. Presidential approval to set up a private, the LFZ, in Ibeju Lekki, Lagos was received in 2002 and was registered with Nigerian Export Processing Zone Authority (NEPZA).

In 2002, approx. 201 ha of land was allotted to the Lagos Free Zone for the first phase development of the FZ comprising the Port and Harbour and other Ancillary Facilities. Environmental impact assessment (EIA) studies were thereafter conducted for these proposed projects and requisite approvals received from the Federal Ministry of Environment (FMEnv).

Approximately 641 ha additional land (making total land approx. 842 ha) was allotted to the group in Ibeju-Lekki Local Government Area of Lagos State for the expansion of the LFZ. Lagos Free Zone thereafter carried out an ESIA of the Free Zone (FZ) with an Area Wide Baseline Survey (AWBS) embedded in the EIA.

Due to evolving new project dynamics, LFZ had decided to modify the Master Plan to retain the viability and functionality of the FZ. Also taking into cognizance the fact that the 5 years' validity period of the AWBS data (measured in 2015) had lapsed, LFZ plans to revalidate the data for both dry and wet seasons. This revalidated data would serve as the primary source of environmental data to support future EIA reports. Bearing in mind that LFZ is a brownfield with necessary FMEnv approvals for all on-going industrial/ factory developmental activities and investments, LFZ proposes to revise the EIA report for the LFZ to address the changes in the modified Master Plan.

Lagos Free Zone has commissioned Global Environmental Technology Limited, Lagos to carry out the EIA revalidation study.

This document presents the final report of the EIA exercise which comprises the wet and dry season fieldwork exercises carried out in 27th to 30th of July, 2020 and 14th to 16th February, 2021, respectively, to gather baseline data for the revalidated EIA.

The scope of this EIA is derived from FMEnv's EIA Act CAP E12, LFN 2004 as reflected in the approved ToR. The basis for this study is the generation of baseline environmental and social information on the project area/ characterising conditions before the commencement of the proposed project. The proposed project activities were then superimposed to generate potential impacts (negative and/or positive) that are likely to result from the proposed project implementation.

The study was carried out within the framework of both local and international environmental guidelines and regulations including the following;

- FMEnv Guideline on EIA
- National Environmental Standards Regulations and Enforcement Agency Act, 2007 (amended, 2018)

- Lagos State Environmental Protection Agency (LASEPA) Edict 1996
- National Laws on Disease Surveillance in Nigeria (Quarantine Act), 2020
- Nigeria Export Processing Zones Authority, Act No 63 1992 (with 3rd Schedule Amendment, 2021).
- National Policies on Environment (2016)

The Proponent

LFZ, previous registered and known as Lagos Free Trade Zone (LFTZ), is the first privately owned free trade zone in Nigeria. Spread over 842 hectares of land, the zone will have several industrial zones and offer access to an enormous consumer market across West Africa. It is designed to serve as an integrated hub with active road, rail and sea links, the LFZ is set to open up the investment, business and tourism potential of Nigeria to the world. Built within a distance of approx. 65kms from Lagos, this FZ is strategically located to serve the exponentially growing metropolis as well as the Nigerian hinterland. With readily available land, the FZ has the potential for expansion and the capacity to support a growing economy. With numerous industrial zones, well-laid plans for efficient operations and established connectivity to regional and international routes, the LFZ is the future destination for businesses in the region.

Need for the Project

The proposed LFZ, just like most FZs located in developing countries all over the world, is being set up to achieve the following needs:

- attract employers (multinational corporations) to the zone to set up factories to produce goods.
- attract domestic and foreign investment
- reduce poverty and unemployment,
- stimulate Nigeria economy in general and Lagos economy in particular.

Value of the Project

The estimated total project costs, including financing costs, for the establishment of the LFZ project is approximately $512.9 Million which include Phase 1A, 1B, 2 and 3 (All phase to be complected by 2035). Phase 1A will cost $277.3 Million to be completed by 2023. These costs essentially cover capital expenditure for infrastructure, facilities provisions, etc.

Benefits of the LFZ Development Project

Carrying out the LFZ development project will result in the following benefits to LFZ promoters and its shareholders and to Nigeria in general:

- The proposed development of Lagos Free Zone (LFZ) with supporting utilities and infrastructure facilities is considered to be one of the significant contribution to the GDP growth of Nigerian economy
- Increase in domestic and foreign investment into the local, State and Country.
- Provision of direct and indirect employment opportunities for Nigerians during the various developmental operations and;
- Increased derivation fund to local and state governments as well as other government mandated agencies/commissions. This will aid poverty alleviation and general socio-economic development within states and local government.

- The project located in strategic locations for export and import of cargoes and act as major player for growth of various industrial sectors located.
- During project implementation, demand for goods and services either directly or indirectly contribute the growth of other sectors such as cement, steel, heavy and light engineering industries, automobile sectors, construction equipment manufacturing industries, transport sector and other services.
- Once the project become operational, induced development in the surrounding areas would expected to occur and generate revenue for local and state economy.
- Substantial positive impact on socio economic profile of Ibeju Lekki region, in particular and Lagos in general both in terms of overall employment and skill development of local work force.
- Probable augmentation in infrastructure resources such as transport, health facilities and other basic facilities
- Civic amenities like medical facilities, education, sports/cultural activities are likely to improve in surrounding villages through Corporate Social Responsibility (CSR) initiatives
- The proposed terrestrial plantation will help to enhance the overall biodiversity of the region.

Sustainability of the Proposed

Economic Sustainability: Free-trade zones are organized around major seaports, international airports, and national frontiers—areas with many geographic advantages for trade. The commercial sustainability of the LFZ project is therefore guaranteed because the proposed project location has all the criteria listed above. Furthermore, the project is located in Lagos State, the commercial capital of Nigeria.

Environmental Sustainability: The findings and recommendations of this EIA would be integrated into all phases of the proposed project. Recommendations on the project process, waste management (handling, treatment and disposal) which were developed in line with the environmental regulations, guidelines and standards of the FMEnv as well as international best practices would ensure the environmental sustainability of the proposed project. Specific international practices relating to aquatic animal protection would also be employed. The implementation of the recommendations of this EIA report during all phases of the proposed activities assures the sustainability of the environment of the LFZ project area.

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

Best Available Technology (BAT) shall be applied right from the commencement of activities by project initiators, and these shall be further enhanced during all production activities.

Social Sustainability: The proponent will ensure periodic engagement throughout project life span so as to maintain cordial relationship with all stakeholders and host communities.

The company employment policy shall give preference to qualified indigenes of the host communities in a bid to ensure harmonious relationship.

<u>Project Option</u>

<u>Option A: "No Action" Option</u>

The "No Action" option implies that the project proponent will not embark on the proposed project and will therefore leave the project site as it is. In the same vein, all the significant positive impacts accruable from the proposed project stated in Section 2.4 above shall not be obtainable. This means that all the accruable benefits of the project will not be realizable. This makes the No Action alternative an inferior option which cannot be considered.

<u>Option B: Delayed Option</u>

This option implies postponing the implementation period of the proposed project. This would be necessary under certain circumstances such as; civil unrest, antagonistic public opinion, government policy, prevailing economic conditions, or other opposing force majeure. Presently, none of the circumstances that would warrant delay of the proposed project exists. Preliminary planning activities for the proposed project including consultations with stakeholders show that the project was highly desirable. The host communities, local and state governments support the project implementation as proposed by the proponent.

Also due to possible inflation and other associated costs that are time dependent, delaying the project will add to its overall cost. More so, it will delay the benefits (direct and indirect) associated with the project. Since there is no antagonistic circumstance to the proposed project, there will be no need to consider delaying it.

<u>Option C: Undertake the Proposed LFZ Development</u>

This action implies that LFZ should embark on proposed activities in the project area; that is, to develop the zone into a vibrant area for industrial, commercial and residential where people can connect with one another, with the best business and natural environment and eventually become an important part of Lagos economy, a new hub of export processing zone with port and maritime activity and a thriving industrial business zone – a unique new large scale development in Lagos state, Nigeria, Africa and the entire continent and hence realize the enumerated benefits to the country and all stakeholders.

<u>Project Alternatives - Selection Criteria</u>

LFZ has no alternative sites for its project, outside the subject site located approximate 60 km east of the city of Lagos. The unique feature is its proximity to the seaport. The integrated development of seaport and the LFZ will create a place where corporations can focus on their business, build partnerships and enjoy stress-free atmosphere.

Access to LFZ from Lagos city is through Lekki-Epe expressway and continues with coastal road towards Aboreji. The expressway currently has four lanes, dual directions ultimately. From Lekki-Epe expressway the road branches to primary road Eleko-Aboreji at Eleko junction. This road runs parallel to the coastline.

Project Description

Project Location

The LFZ is located approximately 65 km east of the city of Lagos which is an hour drive from Lagos city. It has regional road networks with Lekki-Epe Expressway being the most significant route from Lagos City, then continued with Eleko Beach Road and the Coastal Road. The FZ is accessible by a good road with the minor Eleko-Aboreji road running through it and connecting it to the Lagos-Epe Expressway about 12 km to the north.

Project Land take

Approximately 201 ha of land were allotted to the Project Proponent in 2002 by Lagos State Government for the first phase development of the FZ comprising of the Port and Harbour and other ancillary facilities. Additional 641 ha additional land (making total land approx. 842 ha) was allotted to the group in Ibeju-Lekki Local Government Area of Lagos State towards the expansion of the LFZ. All the undeveloped portions of the allotted lands are currently being prepared for planned developments.

Planned development activities

The conceptual master plan of LFZ aimed to strike a balance between work and business environment by creating diverse user-spaces for work, live, play and learn. Based on the master plan layout, the gross land use efficiency is about 71 percent of the total site.

In the ultimate planning period, LFZ is expected to create more than 24,000 new jobs across industrial and logistics sectors and more than 8,000 new retail and service-oriented jobs.

Based on the quantum of Residential lands created in the zone, it is also expected that LFZ will house more than 6,000 population.

No.	Land Use	Area (hectares)	Remarks
1.	Real Estate	56	
2.	Security & Civil Defense	2	
3.	Civic & Community	7	
4.	Logistics	84	
5.	Industrial	336	
6.	Existing Uses	42	
7.	Reserve Site	46	
8.	Customs Checkpoints	8	
9.	Transport Facilities	7	
10.	Rail Corridor	3	
11.	Green & Open Space	30	
12.	Water Bodies	14	
13.	Utilities	28	
14.	Roads	77	
15.	Future Use	12	
16.	Lekki Port	90	Lekki Port has already obtained approval from Federal Ministry of Environment.
	Total Land Area	842	

Industrial land

The Lagos FZ is being conceptualized as a multi-product industrial and logistics hub for the entire West African region. When fully developed, the zone will house a number of manufacturing complexes. The planning of LFZ is carried out to minimize the impact to the already operating factories there while future factory expansion provisions are also to be incorporated around existing plants in the plan. The four factories namely Insignia Printing, TG Raffles Palm Oil, TG Kellogs and TG Arla, are already situated in a row of lands fronting the Coastal Road.

The total industrial land in LFZ covers a total area of 484 hectares. The four components that make up the industrial space are the existing factories, new logistics lands, new industrial lands and the reserve site for future industrial lands.

Land Use	Area (hectares)
Logistics	84
Food & Beverage	131
Chemicals & Downstream Oil	68
Non-Metallic Minerals	61
Engineering	51
Pharmaceuticals	18
Paper	8
Existing Industrial Use	26
Reserve Site	25
Future Use	12
Total Land Area	484

The land parcels intended for industrial activities are subdivided and configured into rectangular plots that best fit the design of most conventional factory buildings and layouts corresponding to its industry sector. Land parcels with regular-shaped configuration are more efficient from industry practice as such formation allow developers to let parcels to be subdivided or amalgamated easily and efficiently without resulting in remnant land. This exhibits the strategy of land optimization that is greatly encouraged in the use of industrial land where market feedback on future tenant requirements are far from accurate in emerging economies.

Non-Industrial land

The non-industrial land of LFZ is predominantly maintained in the southern parcel that faces the beachfront. The location of this is farthest from the industrial activities of LFZ and the neighbouring developments such as Integrated Petrochemical and Fertilizer Complex, is deliberate as this land parcel will be less subjected to the pollution source.

Various types of non-industrial activities are envisaged within this cluster to allow for a reasonable land quantum of real estate and other supporting uses to cater to the necessary social and recreational needs of the industrial population. Within this, interesting lifestyle space formats are introduced to make the zone livelier and vibrant. As it is anticipated that the zone will attract more white-collared workforce, appropriate housing and accommodation are planned for this segment so that long commute from Lagos daily can be greatly reduced. The provision of residential for this group of population brings work closer to homes. Offerings for basic social amenities and facilities provides greater convenience to the new population as travelling to Lagos for supporting services and fulfilment of social needs can now be lessened when these can be reached within friendly walking distance.

Land Use	Area (hectares)
Commercial (C)	16
Mixed Use (MU)	10
Residential (R)	30
Security and Civil Defence (PS, CD)	2
Civic & Community (CC)	7
Existing Mixed Use	16
Reserve Site	21
Total Land Area	102

Water supply system

Water is one of the most essential utilities required for the success of the proposed development. At present, existing tenants depend on their own arrangements for water source. However, this can only be temporary measure as it is not sufficient to be used as a form of permanent supply for LFZ. In the long term, a more sustainable water supply system would be required to provide 100% centralized water supply to all users.

In general, the unit water demand comes from various sources including statistical data and projects carried out by the Consultant. Based on the proposed unit water demand and the proposed land use distribution and population, the water demand was worked out as shown below.

Land Use	Water Consumption Rate	Total Water Demand* (m^3 / day)
Real Estate	--	3,416
Security and Civil Defence	10 m^3/ha/day	22
Civic & Community	40 m^3/ha/day	308
Logistics	--	1,386
Industrial	--	20,790
Existing Uses	--	1,848
Reserve Site	40 m^3/ha/day	2,024
Customs Checkpoints	10 m^3/ha/day	88
Transport Facilities	15 m^3/ha/day	116
Green & Open Space	5 m^3/ha/day	165
Utilities	30 m^3/ha/day	924
Roads	5 m^3/ha/day	424
Total		31511

Power Requirement

The electrical infrastructure includes power plant, power substation, the high / medium / low voltage network. The demand projection is based on the approved land use breakdown. As shown in the Table, coincidence factor figure is applied, as commonly done in infrastructure planning. This is to account for the fact that not all consumers use their peak load at the same time. For LFZ, the coincidence factor (CF) figure of 0.5 is used.

Land Use	Power Demand Unit Rate (MVA / ha)	Total Power Demand (MVA)
Real Estate		13.55
Security and Civil Defence	0.50	0.50
Civic & Community	0.50	1.75
Logistics		14.50
Industrial		185.50
Existing Uses		17.00
Reserve Site	1.00 (Industrial) 0.30 (Non industrial)	15.65
Customs Checkpoints	0.30	1.20
Transport Facilities	0.20	0.70
Rail Corridor	0.01	0.02
Green & Open Space	0.01	0.15
Water Bodies	-	-
Utilities	0.30	4.20
Roads	0.02	0.77
Total		255.49

Treatment Facilities

Domestic and Industrial effluent treatment plant

Effluent treatment system is essential for environmental protection. The lack of an effluent treatment system would cause sanitation problems to LFZ. Generally, the effluent system comprises of a collection system of pipe network, effluent pumping stations and an effluent treatment plant (ETP). The objective of an effluent system is to ensure 100% of the effluent would be collected and treated to the required discharge standards.

The estimation of the LFZ's effluent flow was based on the estimated water demand. For this project, 80% of average water consumed is considered as effluent flow. In addition to that, 10% of average flow is considered as infiltration. The effluent generation had been worked out for Domestic and Industrial respectively.

Land Use	Total Domestic effluent (m^3 / day)	Total Industrial effluent (m^3 / day)
Real Estate	2,733	-
Security and Civil Defence	18	-
Civic & Community	246	-
Logistics	111	999
Industrial	1,036	15,596

Land Use	Total Domestic effluent (m^3 / day)	Total Industrial effluent (m^3 / day)
Existing Uses	1,478	-
Reserve Site	1,619	-
Customs Checkpoints	70	-
Transport Facilities	92	-
Utilities	739	-
Total	8,142	16,595

Solid waste management

Classification of the solid wastes is necessary as the handling of different composition of waste will require special efforts and careful planning. Potential solid wastes generated are broadly classified into two categories

i. Municipal Solid Waste
ii. Industrial Hazardous Solid Wastes

Land Use	Solid Waste Generation Rate	Total Solid Waste (t / day)	Solid Waste for Pilot Phase (t / day)
Real Estate		8.91	1.88
Security and Civil Defence	100 kg/ha/day	0.20	0.20
Civic & Community	150 kg/ha/day	1.05	0.30
Logistics		10.08	1.68
Industrial		60.66	24.84
Existing Uses		6.30	6.30
Reserve Site	150 kg/ha/day	6.90	-
Customs Checkpoints	100 kg/ha/day	0.8	0.60
Transport Facilities	60 kg/ha/day	0.42	0.24
Utilities	30 kg/ha/day	0.84	0.48
Roads	30 kg/ha/day	2.31	1.14
Total		98.47	37.66

The Existing Environment

In order to characterize the project environment, extensive review of already acquired wet season baseline data of the LFZ (October, 2020) and the Dry season (February 2021) sampling was carried out by specialists in the following areas: soil and hydrology; hydrobiology; landuse/GIS; climatology; air quality; vegetation; fisheries, wildlife and socio-economics. Soil (50), Air (14), Ground water (14), Surface water (7), Freshwater (7) were collected within the project area in 2020.

The Quality Assurance / Control for laboratory analyses were in accordance with FMEnv recommended method and this included blank analyses to establish analyse level, duplicate analyses to establish analytical precision, spiked and blank sample analyses to determine analytical accuracy.

Climate and Meteorology, Air Quality and Noise

Its climate is characterized by the dry and wet seasons though it rains in every month of the year with mean monthly rainfall of 104.4 – 288.4 mm. Its monthly relative humidity is 77 - 87% with air temperatures of about 22.5 – 33.7 °C. While the atmospheric pressure is 1015 – 1020 mbar the cloud cover is 6.7 – 6.9 Oktas with 51.2 – 165.7 hrs monthly sunshine periods. Its surface wind speed is 0.5 – 7.7 m/s with occasional calmness and southwest/northeast prevailing directions. All the measured microclimatic parameters during the study agreed with the climatic data in the two seasons.

The 1-hour averaging period concentrations of the monitored gaseous pollutants during the fieldwork showed VOCs levels 0.12 – 0.15 ppm in the wet season but not detected in the dry season. Also in the wet season CO was 2.1 – 7.1 ppm with SO_2 levels of 0.01 – 0.07 ppm but 0.3 – 6.6 ppm and 0.01 – 0.02 ppm respectively in the dry season. The wet season NO and NO_2 were 0.003 – 0.004 ppm and 0.002 – 0.004 ppm respectively with NO_2 level of 0.03 – 0.06 ppm in the dry season though NO was not detected in the season. While the wet season NH_3 levels were 0.10 – 013 ppm, H_2S levels were 0.01 – 0.04 ppm with O_3 levels of 0.01 ppm. In the dry season NH_3 was not detected but H_2S and O_3 were 0.02 ppm and 0.05 – 0.08 ppm respectively. None of these breached their respective 1-hour averaging period concentration limits in the wet and dry seasons. The daily equivalents SO_2 breached its FMEnv's 0.01 ppm daily limit in a location each in the wet and dry seasons. Also in the wet season, the daily H_2S limit was breached in three locations. However in the wet and dry seasons, all the other gaseous pollutants were within their respective FMEnv daily averaging period set limits. The 1-hour averaging period $PM_{2.5}$ were 14.0 – 42.8 µg/m^3 with PM_{10} levels of 42.0 – 223.5 µg/m^3 and TSP levels of 48.1 – 291.3 µg/m^3 in the wet season but 12.6 – 22.7 µg/m^3, 53.7 – 147.1 µg/m^3 and 59.2 – 170.0 µg/m^3 respectively in the dry season. The 1-hour TSP was within its 600 µg/m^3 FMEnv limit in all the locations in the two seasons. Though the daily PM_{10} breached its limit in a location in the wet season, $PM_{2.5}$ and TSP were within their respective limits in all locations both in the wet and dry seasons. Particulate matter in the project area was observed to have increase over time average concentrations ranging between and 48.1 – 122.3µg/m^3 with an average of 63.2µg/m^3.

While the minimum ambient noise levels were 35.1 – 61.7 dB(A) in the wet season they were 29.7 – 44.2 dB(A) in the dry season. The maximum and background levels were 39.8 – 79.3 dB(A) and 35.3 – 62.3 dB(A) respectively in the wet season but 41.4 – 66.9 dB(A) and 32.9 – 61.2 dB(A) in the dry season. The background noise was within the 90 dB(A) Shopfloor limit and within the 70 dB(A) Industrial Areal limit in all the locations in the two seasons. However, the 55 dB(A) day-time World Bank limit was breached by the background noise in two locations in the wet season and in a location in the dry season.

Since all the monitored air pollutants were within their limits in almost all the monitored locations in the wet and dry seasons, the proposed project area can described as un-degraded airshed using the World Bank classification thus having excellent carrying capacity for anthropogenic activities in the wet season.

The identified major sources of air pollutants and noise during the studies were commercial activities, vehicles and electric power generators

Hydrogeological Resources

The project area is within the eastern part of the Dahomey Basin, in south-western Nigeria which extends from the eastern part of Ghana, through Togo and the Republic of Benin, to the western margin of the Niger/Delta basin, just before the coast in Nigeria.

Six stratigraphic formations are identified by Jones and Hockey (1964) within the Dahomey Basin which are characterized as containing mudstone, shale, limestone, and sandstone.

The existing aquifers in the Dahomey Basin are important sources of water for the local population and have been exploited for drinking and commercial purposes. Water supply to the populace is usually from shallow dug wells and/or boreholes drilled into the Coastal Plain Sands Formation, and from the lagoon, which serves as a source of livelihood for the fishing population. The lagoon also serves as the major receptor of waste and wastewater discharges from the surrounding communities. Static water levels in the wet season varied from 1.5 to 2.0 m and from about 2.0 to 2.8 m below ground.

Oceanography and Hydrodynamics

Bathymetric survey over an area of approximately six (6) km (width along the shore) by nine (9) km (distance to offshore) show that the contours of the sea bottom generally follow the orientation of the coastline. Close to shore (offshore distance zero m to 100 m) the slope of the substrate is relatively steep (approximately 1:8 slope). Further offshore (100 m to 9 km) the slope of the substrate is gentle and varies typically between 1:200 and 1:1000. Ridges are found parallel to the coast in water depths between 1 to 10 metres; they presumably formed as a result of the transport of coarse sand by the west to east littoral currents.

Model studies off Lekki in a water depth of ten (10) m showed a highest water level of +1.8 m, a mean neap tide level of 1.2 m, and mean sea level of 1m with respect to the site datum (NIOMR, 2001). These levels are consistent with the tidal water elevations determined using the Mike 21 Global Tide Model.

The surface circulation in the Gulf of Guinea is governed by the gyral circulation in the North and South Atlantic Ocean that results in the eastward flowing Guinea Current. Generally, the current is weakest during the winter (November through February) and strongest during the summer (May through September).

Waves reaching the West African coast are of two origins: (1) waves generated by the local weak south-westerly winds, and (2) swells generated by storms in the southern part of the Atlantic Ocean. The direction of the approaching waves in the deep water was typically from the south to southwest. Wave heights are typically between 0.75 m and 1.75 m. The largest waves occur during the wet season (June to August) with average wave heights exceeding 1.5 m (typically 1 metre to 2.5 m). The average wave height in the dry season (December to February) is about 0.9m (typically 0.5 m to 1.5 m).

The beach sediments around the project area consist largely of coarse sand in the foreshore areas of the beach, and fine sand in wet muddy hollows along the vegetated back barrier areas. The dominant sediment grain sizes were medium to coarse sand, ranging from 0.4 to 1.4 mm in diameter. Generally, the sediments in the foreshore areas of the beach are coarser-grained (i.e., coarse sand) while sediments at the berm crest and in backshore areas are finer-grained (i.e., medium to coarse sand).

Soil Studies

In the dry and wet seasons, soils of the project area were found to have moderate fertility with good internal drainage and are quite impactable because of the relative ease of movement in the surface. Soil particle size distribution across both seasons indicated sand-sized particles dominance in the soil samples, silt-sized particles followed with clay being the least. This puts the soils in the sandy textural class.

Laboratory analysis results showed that depth did not introduce any significant difference in the soil parameters. The range of pH puts the soils in the slightly acidic to slightly alkaline class across the two seasons. Average Electrical Conductivity (EC) is 40.2 and 570.0µS/cm in the wet season, and 37 to 338 µS/cm in the dry season. Total Organic Carbon In the wet season, TOC recorded a ranged from 0.14% to 1.5% across the sampled stations for surface soil and 0.20% to 0.90% at the subsurface depth while in the dry season, TOC ranged between 0.1% to 1.3% at the topsoil and 0.1 to 0.9% at the subsoil depths.

Nutrients concentrations in both surface and sub-surface soils were relatively low. Levels of basic metals were in moderate amount at both depths with a slight drop during the dry season.

Total heterotrophic bacteria (THB), Total heterotrophic fungi (THD), Hydrocarbon utilizing bacteria (HUB), and hydrocarbon utilizing fungi (HUF) were found during the test for Soil Microbiology.

There are no significant changes in the physical and chemical properties of the soil between 2013 and the current site investigations in 2020.

Aquatic Studies

Water samples were obtained from marine and groundwater sources around the project area. Groundwater pH values recorded during wet season across the groundwater sources were all within the NSDWQ limits of 6.5 - 8.5, except at OKE1 where the recorded groundwater pH was 6.2. Dry season values ranged between 5.77 and 8.1. Higher pH values were recorded in the dry season than wet. This could be as a result of high water dilution due to abundant rain during the wet season

Dissolved Oxygen concentrations in groundwater ranged between 5.83 and 16.45mg/L in the wet season and 8.35 to 19.09mg/L in the dry seasons.

With the exception of Sulphate; Nitrate and Phosphate concentrations in the groundwater samples were low across both seasons. Nickel was 0.03 mg/L on the average in the dry season and 0.44 in the wet season. Heavy metals (Cadmium, Manganese and Zinc) were

<0.001. Generally, for the groundwater, no significant season-imposed difference on the basic parameters of the groundwater in the area was observed.

Surface water was largely alkaline in terms of class with average pH of 8.80 and 8.20 in the dry and wet seasons respectively. The average TDS concentration in the lagoon samples was 0.39 ± 0.033 (g/L) in wet season and 0.15 ± 0.04g/L in dry season across the seven sampled stations on the Lekki Lagoon. However, in the Atlantic source, the TDS average concentration was 36.54 ± 16.684g/L in wet season and 55.44 ± 1.54g/L in dry season.

Measured salinity value was high in the marine water than fresh water source with respective means of 50.21 ± 14.057ppt and 0.29 ± 0.039 ppt in wet season and 65.57 ± 2.6ppt and 0.10 ± 0.00 ppt in dry season. Mean turbidity value in the freshwater source was 44.14 ± 9.44 NTU. Similar average turbidity obtained at the marine waters was 48.13 ± 2.427 NTU for wet season while mean turbidity value in the freshwater source was 11.72 ± 3.0 NTU and that of the marine water 24.79 ± 4.1 NTU in dry season.

Nitrate, phosphate, chloride, sulphate and ammonia constitutes the tested anions in the two surface water sources. All the tested anions were within the permissible limits of FMEnv.

The sediment reaction as express by pH values range from 6.0 - 6.5 in the marine water samples and 6.4 - 6.9 in the freshwater samples. This result represents the wet season pH. For dry season, pH values ranged 6.2 - 6.7 and 5.5 - 5.67 for marine and fresh water sources. These pH values are closely related to the value detected in the surface of water. The essential nutrients determined during both seasons were sulphate, phosphate, nitrate, potassium, chloride and sodium. The sulphate (SO_4) content in the sampled sediments range from 55 -198 mg/kg in the marine water samples while a range of 185 - 303mg/kg was detected in the freshwater samples. On the other hand, in the marine environment, Phosphate (PO_3) and Nitrate (NO_3) ranged between 0.1 - 0.32mg/kg and 1.1 - 4.5mg/kg respectively while it recorded a range of 0.1 - 0.57mg/kg and 6 - 27mg/kg respectively in the freshwater sample source.

Vegetation Characteristics

The vegetation of the study site is basically a mangrove swamp. The entire project area comprises both wet land and dry land species as a result of the mosaic nature of the area where pockets of dry arable lands punctuate the larger wet land portion. Generally, the dry land portion had predominantly colonizing and invasive species. Prominent among these are: *Alchornea cordifolia, Chromolaena odorata, Smilax anceps, Ficus capensis, Tremia orientalis, Centrosema pubescence, Chloris pilosa, Newboudia laevis, and Mezoneuron sp*. Conversely, the marshy portion had wetland plant species like *Dryopteris filix-mas, Raphia hookeri, Xanthosoma saggitifolium, Nymphaea lotus, Avicennia marina, Rhizophora sp, Sporobolus pyramidalis, Avicennia germinans* and *Laportea aestuans.*

Since the study site has been impacted by human activities through human settlements and farming, economic plants: ornamentals, medicinal, and food crops were found in this area. This category of plants includes *Anacardium occidentale, Mangifera indica, Carica papaya, Manihot esculenta, Celosia argentea, Talinum triangulare, Elaeis guineensis, Gossypium hirsutum, Citrus limon, Azadirachta indica, Musa paradisiaca, and Terminalia catappa.*

It was observed that the vegetation composition in the study site remain relatively unchanged when compared with the last AWBS 2015. The reason is that the site falls within the marshy wetland ecosystem where the soil retain water almost throughout the year, hence the impact of dry season on vegetation cover and diversity is quite minimal. However, differences in terms of density were noted in some annual and ephemeral species like Elusine indica.

Wildlife Species

The wild life species prevailing in the area varied from invertebrates to large reptiles, birds and small mammals. Generally, the invertebrate groups consists of several arthropod groups including butterflies, moths, dragon flies, water boatman, beetles, praying mantes, grass hoppers, spiders, ants and termites.

The invertebrate phyla also included molluscs, Reptiles including lizards, monitor lizards, boars, pythons and venomous snakes. The mammalian groups include: rats, giant rats, gazelles, grass cutters, porcupines, ant eaters and deer.

The animals observed also includes a variety of Avian species seen hovering over coastal areas and nearby forested areas

Land Use

The proposed is located in the south eastern corner of the Ibeju-Lekki Local Government Area (LGA) of Lagos State off the Ajah-Epe Express Road.

A landuse/landcover map for the project area was developed using satellite imagery the map showed the various landuse around the project area providing insight into the possible interaction between the various landuses and the proposed project. The Landcover includes Built-Up-Area, Vegetation and Water Body.

Socio-Economics

The baseline socioeconomics of the project area was carried out following both the Nigerian Government and internationally laid down Socio-economic Impact Assessment Guidelines and methods taking into consideration the:

- Population and Socio-demographic Characteristics,
- Educational Characteristics
- Local Economy, Livelihood and Employment in Project-Affected Communities (Occupation/Employment and Income Generating Activities)
- Land Use and Management (Land Ownership/Access ,Market system ,Industrial Activities and Land Use)
- Personal Income Characteristics
- Availability and Functional Status of Community's Social Infrastructures
- Facilities (Electricity, Transportation and Communication, Water Supply, Housing and Housing Quality, Healthcare Facilities)
- Religion, Customs, Belief Systems and Heritage
- Traditional Power and Leadership in Project-Affected Communities

These were used to establish a baseline for the socio-economic environment of the project area. Five stakeholder's communities (Lekuru, Magbon-segun, Oke-segun, Itoke and Idotun) were consulted with at the homes of the community Baales and town hall in the case of idotun community. All the identified communities were less than 3km to the project site. Findings from consultations with the Project Affected Communities (PACs) showed that the resident population of proposed project environment is not opposed to the industrialization drive of the State Government within their immediate environment. The people are however, not unmindful that the land-take arising from the project, project construction activities and subsequent operation could affect them both positively and negatively.

By and large the project proponent solicited for the cooperation of the communities.

Associated and Potential Impacts and Mitigation Measures

This section of the report assesses the potential impacts of the LFZ development activities on the array of physical, biological and human resources described in details in Chapter 4 of this report. The activities were evaluated for impacts to aquatic, terrestrial and biological resources as well as cultural and socioeconomics resources. Impacts were identified as adverse or beneficial; direct or indirect, or cumulative. These classifications are defined as follows:

- *Direct impacts* are impacts that result directly from the proposed projects. These may include but not limited to local land use changes; impacts to soils; temporary construction impacts (e.g., noise, air quality); and local biodiversity changes.
- *Indirect impacts* are impacts resulting from activities induced by the proposed projects, but not directly attributable to it. These may include changes to the local economy and demographics.
- *Cumulative impacts* result from the sum total of project impacts and/or effect of impacts of other reasonably foreseeable activities in the project area of influence.

Potential environmental impacts (both adverse and beneficial) related to the proposed LFZ development activities were analyzed qualitatively and quantitatively. Impact quantification, in both relative and absolute terms, was conducted using an approach derived from the Battelle Method based on the preparation of a significance matrix containing a multi-criteria approach.

This method was applied only to the identified direct and indirect impacts. Cumulative impacts are addressed qualitatively since it was not possible to characterize other on-going or planned activities that could have a synergistic effect with the LFZ project activities.

Ranking of impacts for significance/ importance was achieved by averaging the results of each identified impact and it varies between 11 and 92. Impacts with values below 20 are 'negligible'; 'minor' between 20 and 25; 'moderate' between 26 and 40, and 'major' above 40.

Recommended mitigation measures to be considered to minimize impacts to the environment from implementation of the proposed project. The primary goal of the mitigation measures is to reduce the impact to an acceptable level for all of the project components.

Environmental Management Plan (EMP)

An Environmental Management Plan (EMP) is the essential and stand-alone component of an EIA that provides the assurance that the mitigation measures developed for reducing the effects of adverse associated and potential impacts to As Low As Reasonably Practicable (ALARP) as well as those proposed for enhancing beneficial impacts are implemented and maintained throughout the project lifecycle. The EMP for the proposed LFZ Project, outlining the strategies for managing hazards, associated and potential impacts and their effects on the environment, is presented in this chapter.

Hence, this EMP shall not be based on specific impacts and associated mitigation measures of all the possible development project activities anticipated in the industrial and non-industrial zones of the project area. The EMP shall focus on the anticipated impacts associated with the operations of the possible project activities identified for the development of the land resources in the LFZ. It is believed that individual Environmental Impact Assessment shall be carried out specifically for each potential industrial and non-industrial development interventions that would eventually occupy the LFZ plots, during which the impacts at all phases of such project life cycle shall be identified and mitigated by the developers. Hence, this EMP shall delimit its compilation to the prevailing baseline environmental and social conditions of the project area presented in this EIA report and the potential impacts of the implementation of the possible project activities presented herein, during the operation phase, on various environmental monitoring parameters and indicators presented in the chapter on baseline environmental and social conditions of the LFZ.

Remediation plan after De-commissioning

The following plans shall be put in place for the restoration of the project site after closure/de-commissioning:

- Soils contaminated from accidental oil and/or chemical spills during the operational phase shall be removed for ex-situ or offsite treatment. However, the soil can also be treated using various available in-situ treatment technologies i.e. landfarming.
- All equipment and debris shall be removed from the project environment and disposed of in an environmentally friendly manner.
- Indigenous plant species that were cut down during site clearing activities for access road/ site clearing shall all be replanted.
- The site shall be graded to its original landscape to prevent incidences of erosion.
- A good waste management plan shall be practiced. All used chemical containers and any other material shall be properly disposed of. For example, reusable or recyclable materials shall be taken back to the manufacturers of the products or sold to local vendors.
- Created access routes shall be blocked wherever possible, especially where subsequent use by local communities is not appropriate.
- After the restoration measures have been implemented, the site shall be photographed and monitored by the proponent's representatives. The aim is to enable the proponent through proper documentation, to effectively monitor the site recovery.

Conclusion and Recommendation

the results, analyses and interpretations have helped to identify all potential environmental impacts that may result from the proposed activity. With the impact prediction therefore, appropriate mitigation measures and environmental management/monitoring plans have been proffered.

From the results and the predicted associated impacts of the project, the proposed LFZ development could be carried out successfully with minimal environmental effects if all the identified mitigation measures proposed in the report are applied and the suggested monitoring requirements are complied with.

The management of LFZ shall follow the principles/ precepts/ guidelines of the Lagos State Ministry of Environment and FMEnv as listed in this EIA report. All mitigation measures shall also be carried out promptly in order to avoid accumulation/backlog of restoration activities. The Management of LFZ shall ensure that the members of the host communities are carried along if and where required to avoid any unrest.

ACKNOWLEDGEMENT

Lagos Free Zone (LFZ) wishes to acknowledge the Federal Government of Nigeria for the opportunity given to her through its agencies to conduct this Environmental Impact Assessment (EIA).

We are grateful to the Lagos State Government and the Ibeju Lekki Local Government for their support on this Project. We also acknowledge the support of Traditional rulers, Community Elders and leaders during the consultation process.

The contributions of the Environmental Consultant – Global Environmental Technology commissioned to execute this EIA is also acknowledged and commended.

CHAPTER ONE

1. INTRODUCTION

1.1 General

The Lagos Free Zone Company (LFZ) was set-up as a SPV (Special Purpose Vehicle) to plan, promote, develop and manage the Lagos Free Zone (LFZ). It is wholly owned by Tolaram, Singapore, the Promoters of LFZ. Presidential approval to set up a private, the LFZ, in Ibeju Lekki, Lagos was received in 2002 and was registered with Nigerian Export Processing Zone Authority (NEPZA).

In 2002, approx. 201 ha of land was allotted to the Lagos Free Zone for the first phase development of the FZ comprising the Port and Harbour and other Ancillary Facilities. Environmental impact assessment (EIA) studies were thereafter conducted for these proposed projects and requisite approvals received from the Federal Ministry of Environment (FMEnv).

Approximately 641 ha additional land (making total land approx. 842 ha) was allotted to the group in Ibeju-Lekki Local Government Area of Lagos State for the expansion of the LFZ. Lagos Free Zone thereafter carried out an ESIA of the Free Zone (FZ) with an Area Wide Baseline Survey (AWBS) embedded in the EIA.

As discussed, and agreed with the FMEnv, the objectives of the EIA with the embedded AWBS were:

- To establish the state of the environment within the FZ and thereafter use the study findings to set environmental standards that can be used to compel all industries that would be attracted to the Zone to be environmentally compliant.
- To enable LFZ to establish a benchmark environmental condition for the FZ which, once approved by the regulatory bodies (FMEnv), becomes valid and acceptable for use in desktop EIAs for projects to be sited within the Zone during the next 5 years' validity period of the area-wide environmental data.
- Upon the approval of the EIA with the embedded AWBS by the FMEnv, shall serve basis for monitoring and evaluating of the LFZ activities and comparing future site data.

Due to evolving new project dynamics, LFZ had decided to modify the Master Plan to retain the viability and functionality of the FZ. Also taking into cognizance the fact that the 5 years' validity period of the AWBS data (measured in 2015) had lapsed, LFZ plans to revalidate the data for both dry and wet seasons. This revalidated data would serve as the primary source of environmental data to support future EIA reports. Bearing in mind that LFZ is a brownfield with necessary FMEnv approvals for all on-going industrial/ factory developmental activities and investments, LFZ proposes to revise the EIA report for the LFZ to address the changes in the modified Master Plan.

Lagos Free Zone has commissioned Global Environmental Technology Limited, Lagos to carry out the EIA revalidation study.

This document presents the final report of the EIA exercise which comprises the wet and dry season fieldwork exercises carried out in 27th to 30th of July, 2020 and 14th to 16th February, 2021, respectively, to gather baseline data for the revalidated EIA.

1.2 The Proponent

LFZ, previous registered and known as Lagos Free Trade Zone (LFTZ), is the first privately owned free trade zone in Nigeria. Spread over 842 hectares of land, the zone will have several industrial zones and offer access to an enormous consumer market across West Africa. It is designed to serve as an integrated hub with active road, rail and sea links, the LFZ is set to open up the investment, business and tourism potential of Nigeria to the world. Built within a distance of approx. 65kms from Lagos, this FZ is strategically located to serve the exponentially growing metropolis as well as the Nigerian hinterland. With readily available land, the FZ has the potential for expansion and the capacity to support a growing economy. With numerous industrial zones, well-laid plans for efficient operations and established connectivity to regional and international routes, the LFZ is the future destination for businesses in the region.

1.3 EIA Objectives

This EIA has been executed to achieve specific objectives some of which are to:

- satisfy federal, state and local authorities' statutory requirements as well as global standards on environmental management and sustainability.
- provide information and evidence needed for developing an Environmental Impact Statement (EIS) for the FZ development activities in its entirety.
- provide all necessary answers to stakeholders (assessors, host communities, regulators, pressure groups and other interested parties).
- identify all aspects of the FZ development activities that may influence the environment positively or negatively.
- make appropriate recommendations to prevent, reduce or control identified potential and other associated impacts.
- develop control strategies to restore/ameliorate adversely impacted environmental components; and
- develop an Environmental Management Plan (EMP) for all project phases and life cycle of the FZ.

1.4 Scope of Work for the EIA

The work scope for the EIA is to:

- review national and international environmental regulations and standards, and consultation with FMEnv and other stakeholders.
- conduct an extensive and comprehensive literature review specific to the FZ to generate information on the social and environmental characteristics using existing/past studies, photographs, and maps.

- present detailed description of the FZ development activities in order to understand the interaction between project activities and the various environmental components of the area.
- conduct field sampling and survey of the FZ in order to gather and analyse social and environmental baseline data.
- identify, predict, interpret and evaluate potential impacts.
- develop effective mitigation/ameliorative measures and monitoring programme; and
- prepare progress, draft and final EIA reports following applicable guidelines and procedures.

The scope of work will cover portions of the entire 842 ha that are not yet utilized i.e. 752 ha and its surroundings. Specific details on the work scope enumerated above are described in the following subsections.

Description of the FZ Development Activities

This report provides a clear and concise description of the FZ development activities. The features include but is not limited to the following:

- Location
- Capacity
- Entities
- Utilities
- Site preparations for developmental activities
- Developmental drilling operations
- Production operation
- Site closure / abandonment
- Schedules for component activities

1.5 EIA Methodology

The methodology adopted in conducting the EIA for the LFZ development activities is presented in **Figure 1.1** and summarisedsummarized in the following text.

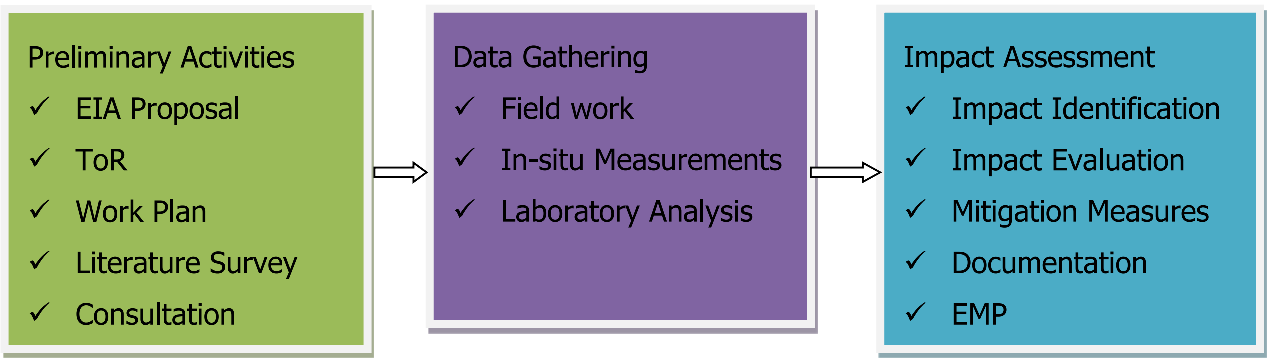


Figure 1.1: FZ Development EIA Methodology

Preliminary Activities

Preliminary activities included developing / preparation of EIA proposal, ToR and fieldwork execution plan for FMEnv approval. Prior to field data gathering exercise, a detailed literature survey was conducted and used to generate information on climate, geology, and the general physical, chemical and biological status of the FZ area as well as identify information gaps. This was achieved through consultation of existing studies/survey reports, technical publications, textbooks, etc.

Consultation

Consultation formed an integral part of preliminary activities and shall continue throughout the EIA process and the LFZ development activities. Tolaram Group LFZ is in constant consultation with all stakeholders (host community, regulators, experts, etc.) to ensure that their views and opinions concerning the FZ development/ improvement activities and associated/potential impacts were integrated into the revised EIA process. The results of all recent consultations have been included as basis for potential impact assessment and were clearly documented in the revised EIA report. The stakeholders consulted included but were not limited to:

- The Federal Ministry of Environment;
- Lagos State Ministry of Environment
- Ministry of Lands and Survey;
- The host communities;
- Community based organisations (CBO's); and
- Relevant non-governmental organisations (NGOs).

Data Gathering and Analysis

Field data gathering exercise were conducted to fill information gap identified from literature survey and also to validate existing information. This entailed visual observation, on-site measurements (air and water) and collection of ocean/surface/ground water, soil and sediment samples for laboratory analysis/testing.

Impact Assessment

This involved the analysis of project activities and their interactions with environmental components: soil, air, ocean/ surface/groundwater and human beings. The identification of ecologically sensitive areas and important species/communities (rare, commercially significant, socio-political concerns); were carried out.

The environmental aspects of the FZ development activities that may interact positively or negatively with the environment were also identified and classified as direct or indirect, normal or abnormal, residual and cumulative.

The associated and potential impacts of the developmental activities were identified based on experience and evaluated in-line with regulatory and industry guideline requirements.

Suggestion of Minimizing/Ameliorative Measures
Based on the identified significant impacts, and the understanding of the ecosystem of the area, mitigation measures were proffered in-line with safety, health and environment standards and codes (for design, construction, operation and decommissioning/abandonment) as well as national and international guidelines and professional judgement.

Furthermore, post auditing or monitoring were designed into the Environmental Management Plan to allow for environmentally sustainable operations.

1.6 Legal and Administrative Framework

The principal body responsible for environmental matters in Nigeria is the FMEnv. Consequently, the following instituted policies and regulations shall provide the legal and administrative framework within which this EIA will be executed.

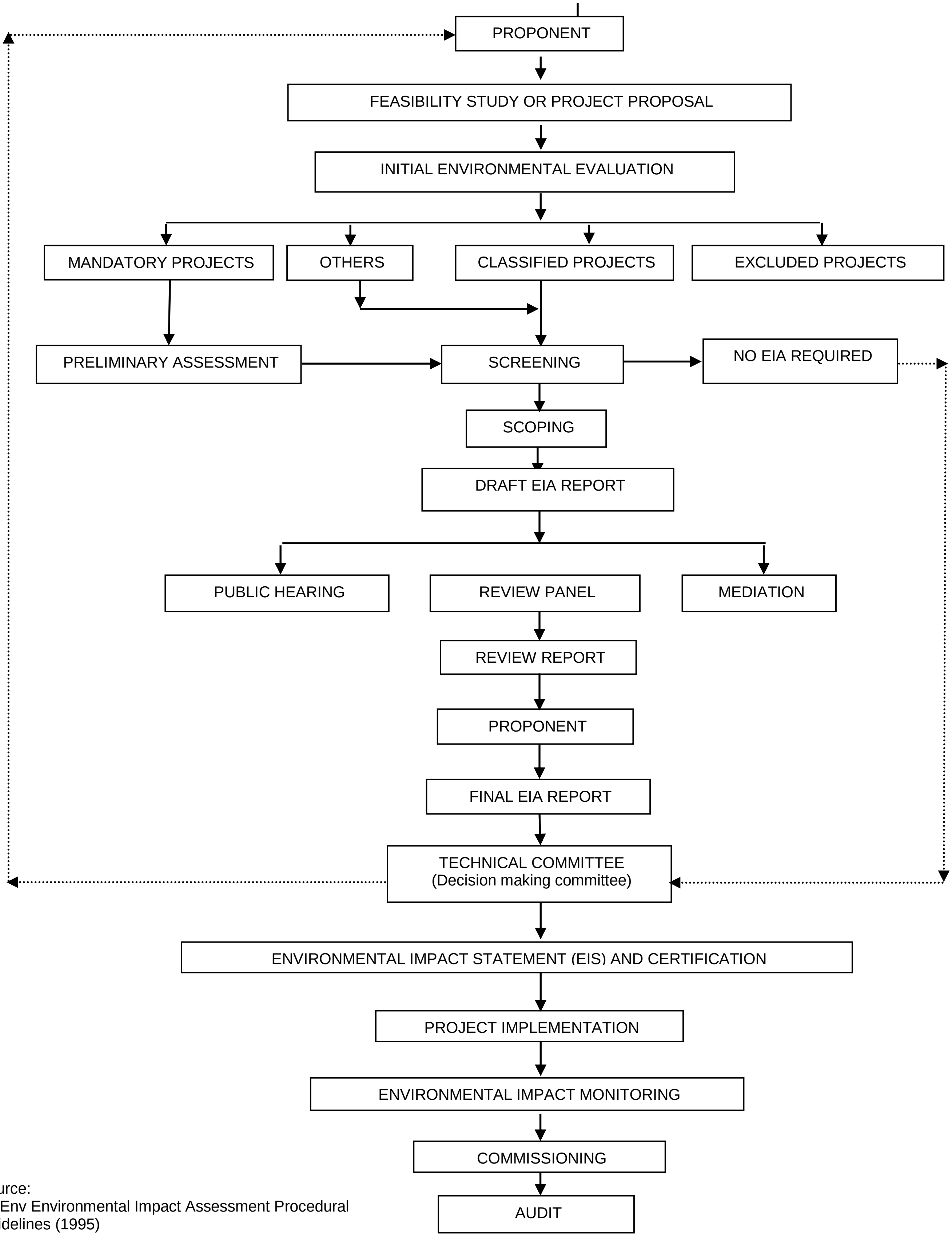
The FMEnv EIA process is presented in Figure 1.2.

1.6.1 National Policies

National Policies on Environment (2016)

The goal of the National Policy on the Environment is to 'ensure environmental protection and the conservation of natural resources for sustainable development'. Its strategic objective is to coordinate environmental protection and natural resources conservation for sustainable development.

This goal will be achieved by the following strategic objectives: securing a quality environment for good health and wellbeing; promoting sustainable use of natural resources and the maintenance of the biological diversity; promoting an understanding of the essential linkages between the environment, social and economic development issues; encouraging individual and community participation in environmental improvement; raising public awareness and engendering a national culture of environmental preservation; and building partnership among all stakeholders on environmental matters ensuring that gender is mainstreamed at all levels and times



Source:
FMEnv Environmental Impact Assessment Procedural Guidelines (1995)

Figure 1.2: Flow Chart of FMEnv EIA Review Procedure

1.6.2 National Laws, Regulations and Standards

The constitution of the Federal Republic of Nigeria (1999)

Sections 13 and 20 require the protection of environmental and natural resources in with Nigeria geographical boundaries . Requires any new development to ensure the protection of the environment.

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

The Environmental Impact Assessment (EIA) Act. CAP E12, LFN 2004. deals with the considerations of environmental impact in respect of public and private projects. The Act clearly stipulates among other things; the objectives of an EIA, list of project activities for which an EIA is mandatory, minimum content of an EIA, regulatory authorities of FMEnv, offences and penalties.

Nigeria Export Processing Zones Authority, Act No 63 1992 (with 3rd Schedule Amendment, 2021).

The body that regulates Free Zone development and operation in the country through Nigeria Export Processing Zone Act No 63 1992 CAP N107 with 3rd Schedule Amendment, 2021 confers power by section 27 of the Nigeria Processing Zones Act, 2004 to provide regulatory and supervisory requirement necessary to promote efficient and profitable operations in Nigeria Trade Zone.

National Environmental Standards and Regulation Enforcement Agency (NESREA) Act 2007 (amended, 2018): The Act establishes NESREA for the protection and development of the environment, biodiversity, conservation, and sustainability. It Empowers NESREA to enforce environmental standards, regulations, rules, laws, policies, and guidelines. NESREA undertakes post-EIA regulatory compliance monitoring including environmental audits, monitoring, and permitting.

Natural Resources Conservation Act (CAP 286 LFN, 1990): The Act provides for the conservation of natural resources in Nigeria and stipulates that the biological resources encountered or/and sensitive environments should be preserved.

Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN 2004: Prohibits the purchasing, selling, importing, storage, carrying, depositing, or dumping of harmful wastes on any land or territorial waters within Nigeria. Such acts incur severe penalties.

Land Use Act (CAP 202 LFN 2004): Provides legal basis and requirements for land acquisition and resettlement in Nigeria. The Act requires that the land transaction be properly documented with the state government's approval.

Factories Act Cap. 126 L.F.N. 1990, Cap. F1 L.F.N. 2004: Provides for the registration of factories; to provide for workers exposed to occupational hazards, but for whom no adequate provisions had been formerly made; to make adequate provisions regarding the safety of workers to which the Act applies and to impose penalties for any breach of its provisions. The Act stipulates that there must be drinking water, toilet facilities, first aid box and medevac at work sites.

Labour Act (Cap L1 LFN), 2004: Specifies obligations of an employer to pay worker's wages in legal tender, and to issue a written contract or statement detailing payment modalities after three months of commencement of employment. Applicable to all employment by and on behalf of the Project. Stipulates that no underage (less than 18 years) should be employed for project development.

Employee Compensation Act (2010): Provides basis for comprehensive compensation to employees who suffer from occupational diseases or sustain injuries arising from accidents at workplace or in the course of employment and is binding on employers with more than 5 staff.

National Minimum Wage Act, 2019: This Act specifies the duty of the employer to pay workers no less than the national monthly minimum wage. The Act stipulates that no workers is paid less than 30,000 naira per month.

National Environmental Protection (Effluent Limitations) Regulations (S.1.8) (1991): regulates the conduct of companies' activities through basic environmental standards. It limits and regulates solid gaseous and liquid waste discharges into the public watercourses including drains, rivers lakes and seas.

Environmental Protection (Pollution Abatement in Industries Facilities Generating Wastes) (S.1.9) (2004): prescribes minimum standards and permissible levels to be emitted or discharged into the environment. Amongst other things, it regulates air quality standards designed to achieve a desirable level of air quality, and the licensing of polluting activities and imposition of fuel quality standards.

National Environmental Protection (Management of Solid and Hazardous Regulations (S.1.15) 1991: This regulation deals with the identification, handling and disposal of solid, toxic and hazardous wastes. Provides classification for waste types and guidelines for their handling and disposal.

National Environmental (Noise Standards and Control) Regulations (S.I.35, 2009): Ensures tranquility of the human environment or surroundings and their psychological well-being by regulating noise levels. Noise abatement during the construction phase and compliance requirements to maintain noise levels within standards.

National Guidelines and Standards for Environmental Pollution Control (1991): Serves as a basic instrument for monitoring and controlling industrial and urban pollution. Applicable to development projects with the likelihood of pollution from project activity.

National Building Code (2007): The national building code set minimum standards on building pre-design, designs, construction, and post-construction to ensure quality and safety.

Environmental Impact Assessment Procedural Guidelines (1995): Indicates the process for conducting an EIA for projects in Nigeria in line with the requirements of the EIA Act CAP E12 LFN 2004. It provides guidance for the EIA process for projects.

National Environmental (Sanitation and Wastes Control) Regulations, 2009, S.I.28: The regulations strive for the adoption of sustainable and environmentally friendly practice in environmental sanitation and waste management to minimize pollution in Nigeria. It requires all owners or occupiers of premises are required to provide waste receptacles for storage before collection by licensed waste manager.

National Environmental (Surface and Groundwater Quality Control) Regulations, 2011, S.I.22: provide for quality control of and quality standards and requirements of surface waters and groundwater in Nigeria and enforcement. It defines offences and prescribe penalties for such offences.

National Environmental (Protection of Endangered Species in International Trade) Regulations, 2011: This provides for the conservation and management of wildlife and the protection of endangered species, as required under certain international treaties.

National Environmental (Soil Erosion and Flood Control) Regulations 2011, S.I.12: The standard ensure that projects on sites that are vulnerable to flooding, including facilities which serve such projects, are protected against flooding by appropriate design at the time of initial construction and minimize losses due to flood and erosion and their effects on vulnerable areas.

1.6.3 State Regulations

Lagos State Environmental Management and Protection Law 2017: This law provides for the development of an efficient waste management system that will involve the recycling of waste, recovering of materials, creation of markets for the recovered materials and encouragement of waste reduction among the people and industries in Lagos State.

Lagos State Urban and Regional Planning and Development law (2010) revised in 2015: This law establishes the Physical Planning and Development Agencies under the Ministry of Physical Planning and Urban Development including the Lagos State Physical Planning Permit Authority (LASPPPA), the Lagos State Building Control Agency (LASBCA) and the Lagos State Urban Renewal Agency (LASURA) with the responsibility to ensure physical planning, urban development, and urban regeneration and building control policies of the State.

Lagos State Waste Management Authority (LAWMA) Law No. 5 cap. 27, Vol. 40 2007 - LAWMA has the task of coordinating refuse disposal activities in Lagos. Initially it was mandated to take charge of general environmental sanitation and the collection, disposal, and management of domestic refuse. Subsequently, it was assigned the responsibility of cleaning primary and secondary drains, collection and disposal of industrial wastes, flood relief activities, and the collection and disposal of scrap and derelict vehicles.

1.6.4Local Government Area (LGA) Regulations

- Ibeju-Lekki Local Government Parking and Control of Traffic Bye-Law of 2006
- Ibeju-Lekki Local Government Stacking of Building Materials Bye-Law 2005
- Ibeju-Lekki Local Government Sand Digging and Filling Operation License Bye-Laws 2005

1.6.5 International Standards

- International Finance Corporation (IFC) Performance Standards
- World Bank EHS Guideline
- ILO Core Labour Standards (2002)
- ISO 14001 Environmental management System (EMS) 2015

1.6.6 International Agreements

- African Convention on the Conservation of Nature and Natural Resources of 1968;
- Convention on the Protection of the World Cultural and Natural Heritage of 1972;
- Convention on the Prevention of Marine Pollution by the Dumping of Wastes of 1972;
- Convention on the Conservation of Migratory Species of Wild Animals of 1979;
- The Montreal Protocol on Substances that deplete the Ozone layer 1987;
- The Convention on Climate Change 1992;
- The Convention on Biological Diversity, 1992.
- UN Guiding Principles on Business and Human Rights (2011)
- Kyoto Protocol on Climate Change, 1997
- Conservation on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, 1998
- Basel Convention on the Control of Trans-Boundary Movement of Hazardous Wastes and their Disposal, 1987.

1.6.7 Lagos Free Zone Policies on Health, Safety and Environment

Lagos Free Zone is committed to Environment, Health and Safety (EHS) excellence and considers outstanding EHS performance an integral measure of overall business success. In this regard, we have set up a framework for continuous improvement in EHS and regard this as one of our key drivers for enhanced overall business performance. The guiding principles for this framework are:

- Protection of Health & Safety of our People & Stakeholders
- Protection of Our Environment
- Proactive EHS Management
- Compliance
- EHS Organisation

We realize that the earth is the powerhouse of all businesses and consider the preservation of the natural environment to be of utmost importance. The company continually conducts its business in a way that does not, in any way, compromise the integrity of the natural environment surrounding company operations.

Lagos Free Zone is strongly committed to complying with all applicable Federal, State and Local Government Laws and Regulations, as well as requisite industry standards on health, safety and environmental management, and insists on the compliance of all its contractor organizations to same.

The EIA tool is one important management and decision-making tool that Lagos Free Zone employs in pursuing the achievement of its overall EHS philosophy and objectives.

1.6.8 Institutional Framework

1.6.8.1 National framework

- FMEnv: The FMEnv has the overall implementation of the ESIA outcomes. It issues the ESIA permit and monitors the compliance with the EIA act 2004.
- National Environmental Standards and Regulation Enforcement Agency (NESREA) have the responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources. It conducts audit to ensure compliance with the NESREA Act 2007.

1.6.8.2 State Framework

- Lagos State Ministry of Environment

The cooperation with FMEnv and other relevant National agencies is responsible for monitoring the implementation of the EIA and the Environmental Audit Report ("EAR") guidelines and procedures on all development policies and projects within the state.

- Lagos State Environmental Protection Agency

The Lagos State Environmental Protection Agency (LASEPA) have a part to play in the overall process ensure compliance with the state laws in the development of industrial facilities and has the powers to audit the environmental compliance of companies.

- Lagos State Waste Management Authority

The Lagos State waste management Authority manages the removing, collecting and disposing of domestic, commercial and industrial wastes in Lagos State. It manages the waste dumpsites and approves waste management plans for industrial plants.

1.6.8.3 Local framework

- Ibeju Lekki LGA

The LGA public health department is responsible for ensuring developmental activities do not negatively impact the health and wellbeing of the local residents.

1.7 Lagos Free Zone HSE Department

- The LFZ EHS department prepare, implement, monitor and reports the outcome of the ESIA activities to regulators and stakeholders.

1.8 Report Structure

The EIA process has been documented in accordance with regulatory requirements and guidelines. This report consists of the following chapters:

Chapter 1 Introduction
Chapter 2 Project Justification
Chapter 3 Project Description

Chapter 4 Description of the Existing Environment
Chapter 5 Assessment of Associated and Potential Environmental Impacts
Chapter 6 Mitigation Measures
Chapter 7 Environmental Management Plans
Chapter 8 Remediation Plans After Closure/Decommissioning
Chapter 9 Conclusions and Recommendations

CHAPTER TWO

2. PROJECT JUSTIFICATION

2.1 General

A **Free Zone** (**FZ**), also called **free-trade zone** is an area within which goods may be landed, handled, manufactured or reconfigured, and re-exported without the intervention of the customs authorities. This is not to be confused with an "Export Processing Zone" (EPZ) which is actually a type of Free Zone (FZ), set up generally in developing countries by the government to promote industrial and commercial exports. Only when the goods are moved to consumers within the country in which the zone is located do they become subject to the prevailing customs duties. Free Zones can be defined as labor-intensive manufacturing centers that involve the import of raw materials or components and the export of factory products. The world's first Free Zone was established in Shannon, Ireland (Shannon Free Zone). This was an attempt by the Irish Government to promote employment within a rural area, make use of a small regional airport and generate revenue for the Irish economy. It was hugely successful and is still in operation today. The number of worldwide free-trade zones proliferated in the late 20th century (Britannica, 2016).

The FZ in Nigeria are licensed, regulated, and managed by The Nigerian Export Processing Zones Authority (NEPZA), an agency of Federal Government responsible for promoting and facilitating local and international investments into the country.

NEPZA can license any entity to operate any of the following:

- Free Zone Developers License: This is granted to any entity to develop and operate a Free Zone in Nigeria but under the supervision, monitoring and regulation of NEPZA.
- Free Zone Enterprise License: This is granted to an entity to carry out approved business activities within a Free Zone -Manufacturing, Trading and Service provision.
- Export Processing Factory/Export Processing Farm License: This is granted to export oriented companies located in the Nigerian Customs territory which have capacity to export about 75 per cent of their production.

Table 2.1 List of current Free Zones, Border Free Zones and Export Processing Zones in Nigeria

No.	Name	Location	Status	Ownership
1	Calabar Free Zone	Cross River State	Operational	Fed. Govt.
2	Kano Free Zone	Kano State	Operational	Fed. Govt.
3	Onne Oil & Gas Free Zone	Rivers State	Operational	Fed. Govt./ Private
4	Lagos Free Zone	Lagos State	Under Construction	Private
5	Tinapa Free Zone and Tourism Resort	Cross River State	Under Construction	State/ Private
6	Olokola Free Zone	Ondo & Ogun State	Under Construction	State/ Private

Table 2.1 List of current Free Zones, Border Free Zones and Export Processing Zones in Nigeria

No.	Name	Location	Status	Ownership
7	Snake Island Integrated	Lagos State	Operational	Private
8	Maigatari Border Free Zone	Jigawa State	Operational	State
9	Banki Border Free Zone	Borno State	Declaration	State
10	Ladol Logistics Free Zone	Lagos State	Operational	PricatePrivate
11	Ibom Science & Tech. Park Free Zone	Akwa Ibom	Under Construction	Public/ private
12	Living Spring Free Zone	Osun State	Under Construction	State
13	Airline Services Export Processing Zone	Lagos State	Operational	Private
14	Lekki Free Zone	Lagos State	Under Construction	State/ Private
15	Egbeda Free Zone	Oyo State	Declaration	State
16	OILSS Logistics Free Zone	Lagos State	Declaration	Private
17	Brass LNG Free Zone	Bayelsa State	Under Construction	Public/ Private
18	Abuja Technological Village	Abuja	Under Construction	Public/ Private
19	Specialized Railway Industrial FZ –Kajola	Ogun State	Under Construction	Public/ private
20	Imo Guongdong FZ	Imo State	Under Construction	Public/ Private
21	ASCON FPZ	Akwa Ibom State	Operational	Private
22	Calabar Free Port	Cross River State	Operational	Fed. Govt.
23	Ogun-Guangdong Zone	Ogun State	Operational	State/ Private
24	Warri Industrial Business Park	Delta State	Initial stage	State/ Private
25	ICT Park Asaba	Delta State	Initial stage	Public/ Private
26	Koko Free Trade Zone	Delta State	Initial stage	Public/ Private

2.2 Need for the Project

The proposed LFZ is set up to achieve the following purpose:

- attract employers (multinational corporations) to the zone to set up factories to produce goods.
- attract domestic and foreign investment.
- reduce poverty and unemployment.
- stimulate Nigeria economy in general and Lagos economy in particular.

The development of Lagos FZ presents an opportunity to embrace the concept of work-live-play, with a variety of employment, leisure, and residential uses within walking distance of each other.

Lagos FZ supported with Lekki Port shall be an important economic destination in Lagos State and Nigeria. Total integration of FZ and seaport through efficient land-use arrangement and a well-planned infrastructure system will create conducive environment for residents and investors to work, rest and play harmoniously. In the FZ, a number of forward-looking companies have already found surroundings that support and enhance the growth of their business in a flexible and efficient manner.

Also, it will transform the previously small and scattered villages into a thriving location for the benefit of the whole region as well as the local community, creating economic growth, a variety of employment and training opportunities and additional local services and facilities.

Lagos FZ shall create a decisive business environment of an unrivalled setting. The foundation of the overall development is a belief that companies globally prefer to operate in optimum, efficient surroundings, benefiting from shared facilities.

More so, Lagos FZ is directed towards making a vibrant area for industrial, commercial, and residential with the best business and natural environment. Fully developed, it will be an important part of Lagos economy, a new hub of export processing zone with port and maritime activity and a thriving industrial business zone – a unique new large-scale development in Lagos state, Nigeria, Africa and the entire continent.

In 2019, Nigeria exported a total of $63.8B, making it the number 47 exporter in the world. During the last five reported years the exports of Nigeria have changed by -$39.5B from $103B in 2014 to $63.8B in 2019. The most recent exports are led by Crude Petroleum ($46B), Petroleum Gas ($7.78B), Scrap Vessels ($2.26B), Flexible Metal Tubing ($2.1B), and Cocoa Beans ($715M). The most common destination for the exports of Nigeria are India ($10.5B), Spain ($6.32B), United States ($4.68B), France ($4.37B), and Ghana ($4.04B) (https://oec.world/en/profile/country/nga). Exports in Nigeria increased to 1070267.12 NGN Millions in March from 949123.09 NGN Millions in February of 2021 (source: National Bureau of Statistics, Nigeria).

2.3 Value of the Project

The estimated total project costs, including financing costs, for the establishment of the LFZ project is approximately $512.9 Million which include Phase 1A, 1B, 2 and 3 (All phase to be complected by 2035). Phase 1A will cost $277.3 Million to be completed by 2023. These costs essentially cover capital expenditure for infrastructure, facilities provisions, etc.

On an average 318 Jobs/Hectare (Direct & Indirect) are created due to free zone across the world. Based on this statistic, LFZ is estimated to generate approx. 235,000 direct & indirect jobs in addition to approx. 170,000 jobs created from port project. Phase 1, zone is expected to generate approx. 9,500 direct jobs and approx. 78,500 indirect jobs.

2.4 Benefits of the LFZ Development Project

Carrying out the LFZ development project will result in the following benefits to LFZ promoters and its shareholders and to Nigeria in general:

- The proposed development of Lagos Free Zone (LFZ) with supporting utilities and infrastructure facilities is considered to be one of the significant contribution to the GDP growth of Nigerian economy
- Increase in domestic and foreign investment into the local, State and Country.
- Provision of direct and indirect employment opportunities for Nigerians during the various developmental operations and;
- Increased derivation fund to local and state governments as well as other government mandated agencies/commissions. This will aid poverty alleviation and general socio-economic development within states and local government.
- The project located in strategic locations for export and import of cargoes and act as major player for growth of various industrial sectors located.
- During project implementation, demand for goods and services either directly or indirectly contribute the growth of other sectors such as cement, steel, heavy and light engineering industries, automobile sectors, construction equipment manufacturing industries, transport sector and other services.
- Once the project become operational, induced development in the surrounding areas would expected to occur and generate revenue for local and state economy.
- Substantial positive impact on socio economic profile of Ibeju Lekki region, in particular and Lagos in general both in terms of overall employment and skill development of local work force.
- Probable augmentation in infrastructure resources such as transport, health facilities and other basic facilities
- Civic amenities like medical facilities, education, sports/cultural activities are likely to improve in surrounding villages through Corporate Social Responsibility (CSR) initiatives
- The proposed terrestrial plantation will help to enhance the overall biodiversity of the region.

2.5 Sustainability of the project

Economic Sustainability

Free-trade zones are organized around major seaports, international airports, and national frontiers—areas with many geographic advantages for trade. The commercial sustainability of the LFZ project is therefore guaranteed because the proposed project location has all the criteria listed above. Furthermore, the project is located in Lagos State, the commercial capital of Nigeria.

Technical Sustainability

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

Best Available Technology (BAT) shall be applied right from the commencement of activities by project initiators, and these shall be further enhanced during all production activities.

Environmental Sustainability

The findings and recommendations of this EIA would be integrated into all phases of the proposed project. Recommendations on the project process, waste management (handling, treatment and disposal) which were developed in line with the environmental regulations, guidelines and standards of the FMEnv as well as international best practices would ensure the environmental sustainability of the proposed project. Specific international practices relating to aquatic animal protection would also be employed. The implementation of the recommendations of this EIA report during all phases of the proposed activities assures the sustainability of the environment of the LFZ project area.

Social Sustainability

The proponent will ensure periodic engagement throughout project life span so as to maintain cordial relationship with all stakeholders and host communities. The company employment policy shall give preference to qualified indigenes of the host communities in a bid to ensure harmonious relationship.

2.6 Project Options

2.6.1 Option A: "No Action" Option

The "No Action" option implies that the project proponent will not embark on the proposed project and will therefore leave the project site as it is. In the same vein, all the significant positive impacts accruable from the proposed project stated in Section 2.4 above shall not be obtainable. This means that all the accruable benefits of the project will not be realizable. This makes the No Action alternative an inferior option which cannot be considered.

2.6.2 Option B: Delayed Option

This option implies postponing the implementation period of the proposed project. This would be necessary under certain circumstances such as; civil unrest, antagonistic public opinion, government policy, prevailing economic conditions, or other opposing force majeure. Presently, none of the circumstances that would warrant delay of the proposed project exists. Preliminary planning activities for the proposed project including consultations with stakeholders show that the project was highly desirable. The host communities, local and state governments support the project implementation as proposed by the proponent.

Also due to possible inflation and other associated costs that are time dependent, delaying the project will add to its overall cost. More so, it will delay the benefits (direct and indirect) associated with the project. Since there is no antagonistic circumstance to the proposed project, there will be no need to consider delaying it.

2.6.3 Option C: Undertake the Proposed LFZ Development

This action implies that LFZ should embark on proposed activities in the project area; that is, to develop the zone into a vibrant area for industrial, commercial and residential where people can connect with one another, with the best business and natural environment and eventually become an important part of Lagos economy, a new hub of export processing zone with port and maritime activity and a thriving industrial business zone – a unique new large scale development in Lagos state, Nigeria, Africa and the entire continent and hence realize the enumerated benefits to the country and all stakeholders.

2.6.4 Project Alternatives - Selection Criteria

LFZ has no alternative sites for its project, outside the subject site located approximate 60 km east of the city of Lagos. The unique feature is its proximity to the seaport. The integrated development of seaport and the LFZ will create a place where corporations can focus on their business, build partnerships and enjoy stress-free atmosphere.

Access to LFZ from Lagos city is through Lekki-Epe expressway and continues with coastal road towards Aboreji. The expressway currently has four lanes, dual directions ultimately. From Lekki-Epe expressway the road branches to primary road Eleko-Aboreji at Eleko junction. This road runs parallel to the coastline.

CHAPTER THREE

3. PROJECT DESCRIPTION

3.1 Project Location

The LFZ is located approximately 65 km east of the city of Lagos (Refer to Figures 3.1 and 3.2) which is an hour drive from Lagos city. It has regional road networks with Lekki-Epe Expressway being the most significant route from Lagos City, then continued with Eleko Beach Road and the Coastal Road. The FZ is accessible by a good road with the minor Eleko-Aboreji road running through it and connecting it to the Lagos-Epe Expressway about 12 km to the north.

The main air gateway is from Murtala Muhammad International Airport located on the other side of Lagos City. Travel from LFZ to international airport is close to 100km and takes about 2.5 hours. The future airport is much closer to LFZ, just about 40km to the northern of LFZ.

Rail connectivity towards LFZ is a long-term vision that is envisaged by the Government. LFZC being a visionary master developer/ promoter of LFZ, has safeguarded rail corridor and dry port within the site. It may connect to future rail network towards Lagos City and can merge with existing rail network.

Lekki Port is part of LFZ overall development. It is the only Deep-Sea Port in the area with container handling and dry bulk terminals. The port is designed to be an integrated, modern, multipurpose port which aims to leverage on physical and economic advantages offered by the region.

Itoke Village (approx. 500m) and Idotun Village (approx. 700m) are nearest habitation located towards south of LFZ. Total project has approximately 842 hectares out of which green area (greenbelt and landscaping) and blue area (waterbody) covers 44 hectares. Approximately 90 hectare is reserved for Lekki Port development.

3.2 Project Land Take

Approximately 201 ha of land were allotted to the Project Proponent in 2002 by Lagos State Government for the first phase development of the FZ comprising of the Port and Harbour and other ancillary facilities. Additional 641 ha additional land (making total land approx. 842 ha) was allotted to the group in Ibeju-Lekki Local Government Area of Lagos State towards the expansion of the LFZ.

All the undeveloped portions of the allotted lands are currently being prepared for planned developments.

Figure 3.1: Map of Lagos State showing LFZ Development Project Location

Figure 3.2: Map Showing the LFZ Project Location and Salient Environmental Features

3.3 Overview of LFZ Concept Master Plan

The revised Master Plan of LFZ has sought to achieve the following development objectives:

a) A better place to do business

LFZ acts as a new Economic Growth Node for the Lekki Area in Lagos – lending strength with the synergy of the Lekki Port and under a reputable developer, the zone will provide a better location and business friendly industrial development zone that can easily tap on the port infrastructure for fast transportation to overseas as well as domestic markets.

b) Supporting enterprise of the future

The zone recognizes the need to diversify the Nigeria's economy to be less dependent on the oil sector. The zone provides opportunities for other industrial sectors including new value chain spectrum of targeted sectors and industries aimed at better skill sets and renumeration. A wide-ranging land parcellation strategy offers flexible land sizes and factory buildings for current and future tenants to choose for either a purpose-built facility or a plug in an operate manufacturing/ logistics space.

c) Connected by road, rail and sea

LFZ will be connected to important transport corridors that enables easy access to the neighbouring regions and other African countries via new expressways and major roads. The zone's long-term plan is to have seamless connectivity to the New Lekki Port and to tap on the rail corridor serving the port. The easy access to multi modal opportunities is a critical and key strength of the LFZ.

d) Supporting Economic Diversity

The plan of LFZ supports a mix of land uses. Industrial and business activity is the key economic driver in the zone and is supported with land uses that enable further value creation for the location in future. It also encourages flexibility to adapt to changes in market demand and allows innovative development uses that can yield higher efficiency. The provision for mixed and supporting uses are accommodated to ensure vibrancy and adaptability.

e) An Important Employment Hub

LFZ will provide at least more than 40,000 new jobs opportunities across new industry sectors such as Food & Beverages, Electronics, Chemicals and service-oriented sectors, posing equal opportunities for employment of the young population in the country to improve their standard of living.

f) Haven for Investors, Visitors & Residents

With the backing of locally established, globally connected and reputable developer, LFZ is positioned as a reliable, attractive, safe, modern and business friendly investment destination to business, trade, work, live, play and learn in Nigeria.

g) **Creating New Quality of Life**

With an intent to create a community living in LFZ, there are opportunities to create unique neighbourhood character for modern living and dedicated locations for social amenities. These includes incorporating diversity in development densities and typologies and creating a partially self-contained zone with education, medical and shopping amenities to encourage types of development that support small and independent businesses within the community to showcase local arts and culture.

h) **Living in Harmony with the Environment**

The zone is sandwiched between Dangote's integrated petrochemical and fertilizer hub in the north, and the Atlantic Ocean in the south. Given the unique setting of its location and surrounding environment, LFZ has embraced the externalities of the site and is planned to better respond to site externalities, through deployment of suitable buffer distances and land zoning strategies.

i) **Enhancing its Environment**

LFZ recognizes the importance of the natural environment and takes a conscious effort to take its environmental stewardship in planning and implementing LFZ. Therefore, the plan of LFZ coincides with green and blue elements of the environment, where its plan includes ample emphasis on green perimeter, landscaped green linkages and preservation of natural water bodies, that ultimately link and interact with each other to form natural corridors. The plan provides opportunity to integrate passive recreation through the created green corridors and nature trails. This demonstrates clear commitment of a green industrial zone.

The development concept for LFZ is envisaged to enable the development to function as an integrated economic model. It generates different layers of economic movements that cover industrial and non-industrial activities.

Industrial as the primary activity is expected to attract critical mass, resulting in substantial land take off. Secondary activity will be the logistics use that will derive synergies with the new Lekki Port and expected to further benefit from having shared services.

Tertiary activities would include real estate and support infrastructure such as residential and commercial which include retail, hotels, offices and others. It will create a wholesome environment in order to enable an attractive destination positioning as an integrated industrial township.

These layers of economic activities would be supported with reliable hard infrastructure such as roads, water, power, gas and sewage and waste disposal systems. There are also supporting facility such as skills training centre, maintenance services as well as soft infrastructure such as one-stop shop, single-window clearances, facility management and attractive incentives and policies to setup business in LFZ.

The selected industrial clusters in LFZ includes Food and Beverage, Chemical and Downstream Oil, Non-metallic Minerals, Engineering, Pharmaceuticals and Paper. The Logistics Use are distributed into Warehousing and Inland Port.

Non-industrial Use are Commercial, Residential and Mixed-Use. The term mixed-use is used to define plot which has commercial and residential uses together. For example, the Headquarter Office plot in LFZ is considered as Mixed-Use as it also has staff accommodation blocks in the same plot.

Other supporting uses within LFZ jurisdiction includes Security, Civil Defense, Civic and Community Uses. There is Iskh Tolaram Foundation Centre is proposed by LFZ to be located adjacent to the Headquarter Office.

Custom Checkpoints are part of Free Zone requirements. In the layout there are three custom checkpoints located at the western, center, and eastern sides of LFZ bonded zone. Parcel 2 which is a non-bonded zone will not have custom checkpoints. It will have direct access to the plot from Coastal Road. A separate access is also envisaged to the proposed utility plot.

The final layout master plan also touched on development phasing. The whole development is distributed into 4 phases named as Phase 1A, Phase 1B, Phase 2 and Phase 3. The area distribution for each phase has reasonable size and manageable for implementation at any one time. The size of each phase is approximately 278 Ha, 113 Ha, 122 Ha and 239 Ha respectively. Port area of 90 hectare is exclusive of this planning. Separate approval has already been received for the same from Federal Ministry of Environment. The sequence of each phase is also prepared in line with infrastructure planning.

Within Phase 1A, a start-up area totaling about 106 hectares (net) and 278 hectares (gross) is demarcated. The start-up, also known as the Pilot Phase, has been determined based on ease of development and land readily accessible via Coastal Road. The land quantum for this pilot phase is based on the Market Study's recommendation. It is also within an area where LFZC has already allocated some industrial parcels to industrialist and built internal roads. Pilot Phase has Industrial, Logistics, Mixed-Use and supporting components.

Road network within LFZ caters to industrial and non-industrial traffic. The road hierarchy has three categories namely Primary Access, Secondary Access, and Local Access. Road ROW and number of lanes are as follows:

Table 3.1: Road networks within the LFZ

Road Hierarchy	ROW Width	No. of Lanes
Primary Access (industrial area)	46.6 m	Dual 3
Secondary Access (industrial area)	39.8 m	Dual 2
Local Access (industrial area)	29.0 m	Dual 1

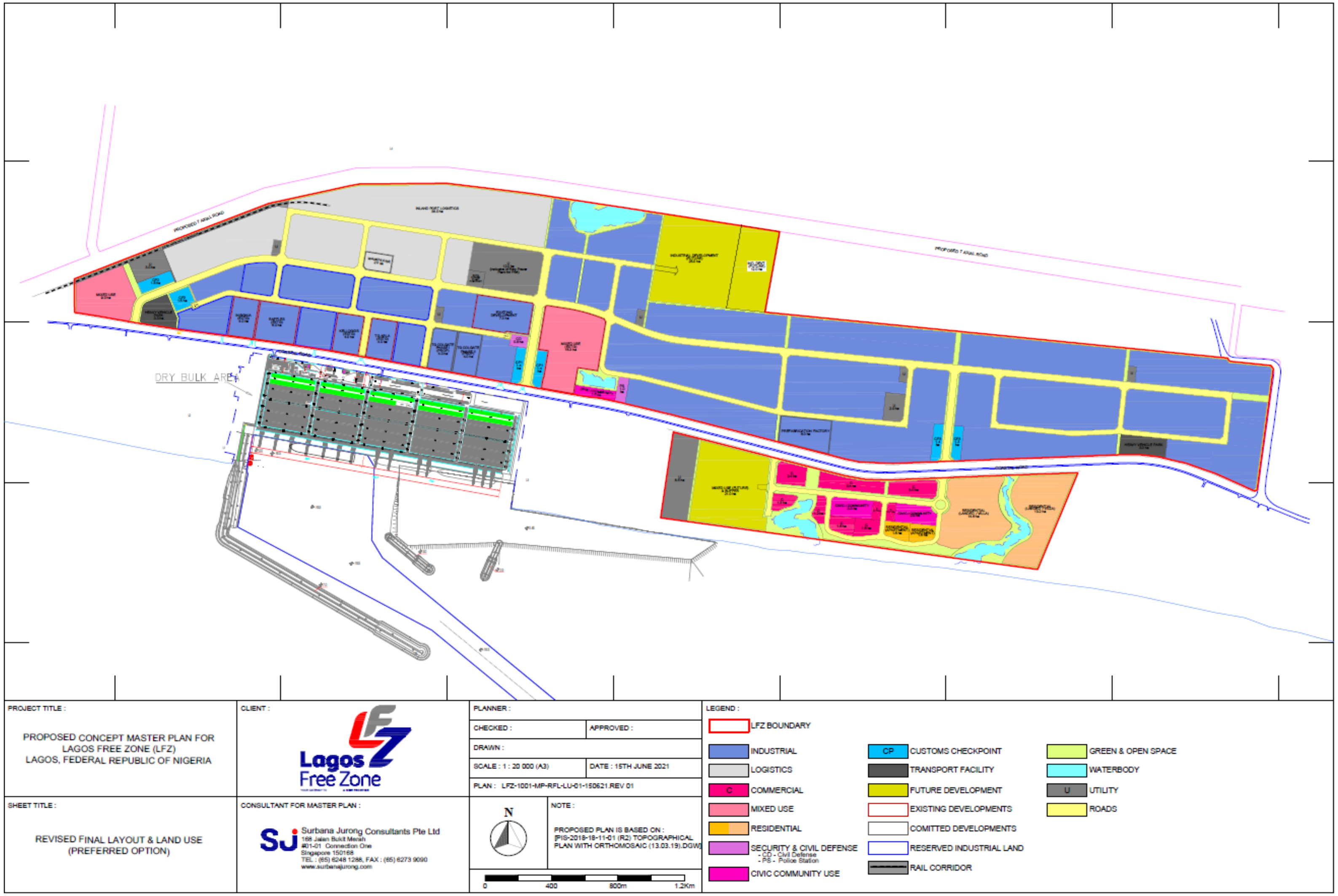


Figure 3.3: Allotted LFZ Development Area

The following section show the final land use plan, road hierarchy plan, industrial cluster plans, development phasing plan and pilot phase plan, for reference.

Table 3.2: Road networks within Non-Industrial Area

Road Hierarchy	ROW Width	No. of Lanes
Primary Access (non-industrial area)	39.8 m	Dual 2
Secondary Access (non-industrial area)	29.0 m	Dual 2
Local Access (non-industrial area)	26.4 m	Dual 1

3.4 Planned Development Activities

The conceptual master plan of LFZ aimed to strike a balance between work and business environment by creating diverse user-spaces for work, live, play and learn. Based on the master plan layout, the gross land use efficiency is about 71 percent of the total site.

In the ultimate planning period, LFZ is expected to create more than **24,000** new jobs across industrial and logistics sectors and more than 8,000 new retail and service-oriented jobs.

Based on the quantum of Residential lands created in the zone, it is also expected that LFZ will house more than 6,000 population.

Table 3.3: Land use for developmental activities

No.	Land Use	Area (hectares)	Remarks
1.	Real Estate	56	
2.	Security & Civil Defense	2	
3.	Civic & Community	7	
4.	Logistics	84	
5.	Industrial	336	
6.	Existing Uses	42	
7.	Reserve Site	46	
8.	Customs Checkpoints	8	
9.	Transport Facilities	7	
10.	Rail Corridor	3	
11.	Green & Open Space	30	
12.	Water Bodies	14	
13.	Utilities	28	
14.	Roads	77	
15.	Future Use	12	
16.	Lekki Port	90	Lekki Port has already obtained approval from Federal Ministry of Environment.
	Total Land Area	**842**	

3.4.1 Industrial Land

The Lagos FZ is being conceptualized as a multi-product industrial and logistics hub for the entire West African region. When fully developed, the zone will house a number of manufacturing complexes. The planning of LFZ is carried out to minimize the impact to the already operating factories there while future factory expansion provisions are also to be incorporated around existing plants in the plan. The four factories namely Insignia Printing, TG Raffles Palm Oil, TG Kellogs and TG Arla, are already situated in a row of lands fronting the Coastal Road.

The total industrial land in LFZ covers a total area of 484 hectares. The four components that make up the industrial space are the existing factories, new logistics lands, new industrial lands and the reserve site for future industrial lands.

Table 3.4: Land Use for Various Industrial Projects

Land Use	Area (hectares)
Logistics	84
Food & Beverage	131
Chemicals & Downstream Oil	68
Non-Metallic Minerals	61
Engineering	51
Pharmaceuticals	18
Paper	8
Existing Industrial Use	26
Reserve Site	25
Future Use	12
Total Land Area	**484**

The land parcels intended for industrial activities are subdivided and configured into rectangular plots that best fit the design of most conventional factory buildings and layouts corresponding to its industry sector. Land parcels with regular-shaped configuration are more efficient from industry practice as such formation allow developers to let parcels to be subdivided or amalgamated easily and efficiently without resulting in remnant land. This exhibits the strategy of land optimization that is greatly encouraged in the use of industrial land where market feedback on future tenant requirements are far from accurate in emerging economies.

3.4.2 Non-Industrial Land

The non-industrial land of LFZ is predominantly maintained in the southern parcel that faces the beachfront. The location of this is farthest from the industrial activities of LFZ and the neighbouring developments such as Integrated Petrochemical and Fertilizer Complex, is deliberate as this land parcel will be less subjected to the pollution source.

Various types of non-industrial activities are envisaged within this cluster to allow for a reasonable land quantum of real estate and other supporting uses to cater to the necessary social and recreational needs of the industrial population. Within this, interesting lifestyle space formats are introduced to make the zone livelier and vibrant. As it is anticipated that the zone will attract more white-collared workforce, appropriate housing and accommodation are planned for this segment so that long commute from Lagos daily can be greatly reduced. The provision of residential for this group of population brings work closer to homes. Offerings for basic social amenities and facilities provides greater convenience to the new population as travelling to Lagos for supporting services and fulfilment of social needs can now be lessened when these can be reached within friendly walking distance.

Table 3.5: Land Use for Non-Industrial Projects

Land Use	Area (hectares)
Commercial (C)	16
Mixed Use (MU)	10
Residential (R)	30
Security and Civil Defence (PS, CD)	2
Civic & Community (CC)	7
Existing Mixed Use	16
Reserve Site	21
Total Land Area	**102**

The Commercial use is proposed to contain shops, Retail Mall, Commercial and Business Centre, Business Hotels, Visitors Centre and Amenity Centres, which will be characterized by interesting building formats, modern shopping areas and hotels to represent the commercial and hospitality centre of LFZ.

The Mixed Use includes a combination of commercial and offices spaces to facilitate the economic transactions arising from the growing real estate of the zone. Higher density building formats to accommodate offices for finance companies, banks, logistics companies, freight forwarders offices and amenities such as convenience shops, minimart, restaurants, food court, cafes and eateries.

The existing Mixed Use comprises the existing Tolaram HQ Office and is further proposed to contain a wider range of uses such as office spaces and the Medical Facility. The requirement for Residential in the Pilot Phase is envisaged to be located within this area to provide for the immediate housing demand. The location of the Helipad is tentatively proposed in the southern parcel of LFZ due to safety landing requirements.

The Civic and Community use will accommodate the Iskh Tolaram Foundation Centre and other educational facilities and services such as international school, civic centre, library, kindergartens and childcare centres. This will satisfy the educational and training needs for professional skills upgradation and children care services that are required for the family units who will reside in LFZ.

3.4.3 Green and Blue Plan

The importance of greenery and water bodies is essential in relieving the industrial landscape of the free zone. As a respite from the industrialized façade, the use of interweaving greenery and elements of blue within the master plan is a clever way of harmonizing the different uses of land. Not only the greenery serves as landscaping elements, it is to also function as green buffers to separate non-conforming activities from each other and placate the impact of any environmental pollution that may arise from the activities.

For LFZ, different types of greenery are proposed to inject nature elements in the plan. The existing ponds and the landscaped areas surrounding them, are maintained as the main green and blue nodes of the zone. Perimeter green as wide as 9 metres is observed in the areas of the free zone. Within the ROW, planting strips (verge green) are planned to act as continuous green linkages that connect throughout the zone to the main green and blue nodes. Within each plot, maintaining a small quantum of setback for private green within each industrial plot is recommended as plot guideline requirement to further enhance the greenery and of the zone.

Within the non-industrial area of LFZ, there will be plenty of green and open space areas for leisure and recreational facilities. Small gardens, playgrounds, plazas and atriums will be planned as congregation areas for the new community. The activation of passive green into active areas such as jogging track, boardwalk and promenades demonstrates efficient use of these areas to attract people outdoors to play and take up recreational activities.

As the non-industrial area of the zone already contains small natural water tributaries, the green and blue proposal calls for the preservation of these and augmenting them into better utilization such as swales. Using swale instead of the conventional concrete trapezoidal drain is a feature of sustainable storm water drainage. Swales act as both a storm water conveyance element to convey the storm water and treatment system to remove coarse sediments. They can also double up as landscaping features that can increase the value and attractiveness of the site. It is widely applicable at residential areas and community areas such as parks and gardens. The green and blue component of LFZ make up a total of 44 hectares, which is 6% of the overall land use of the zone.

3.4.4 Associated Infrastructure Development

As a key pillar, the infrastructure development plays a paramount role in determining the success of Lagos Free Zone. The proposed locations and the land area requirements for various infrastructure services are shown in the Figure 3.4 below:

The proposed major utilities include: a Desalination Plant, a Power Plant, a Sewage Treatment Plant & an Industrial Effluent Treatment Plant, two Solid Waste Management Facilities, a Telecom Centre, a Gas Station, etc. As shown in the plan, two centralized utility plots are reserved to consolidate the utilities for a more efficient land use planning.

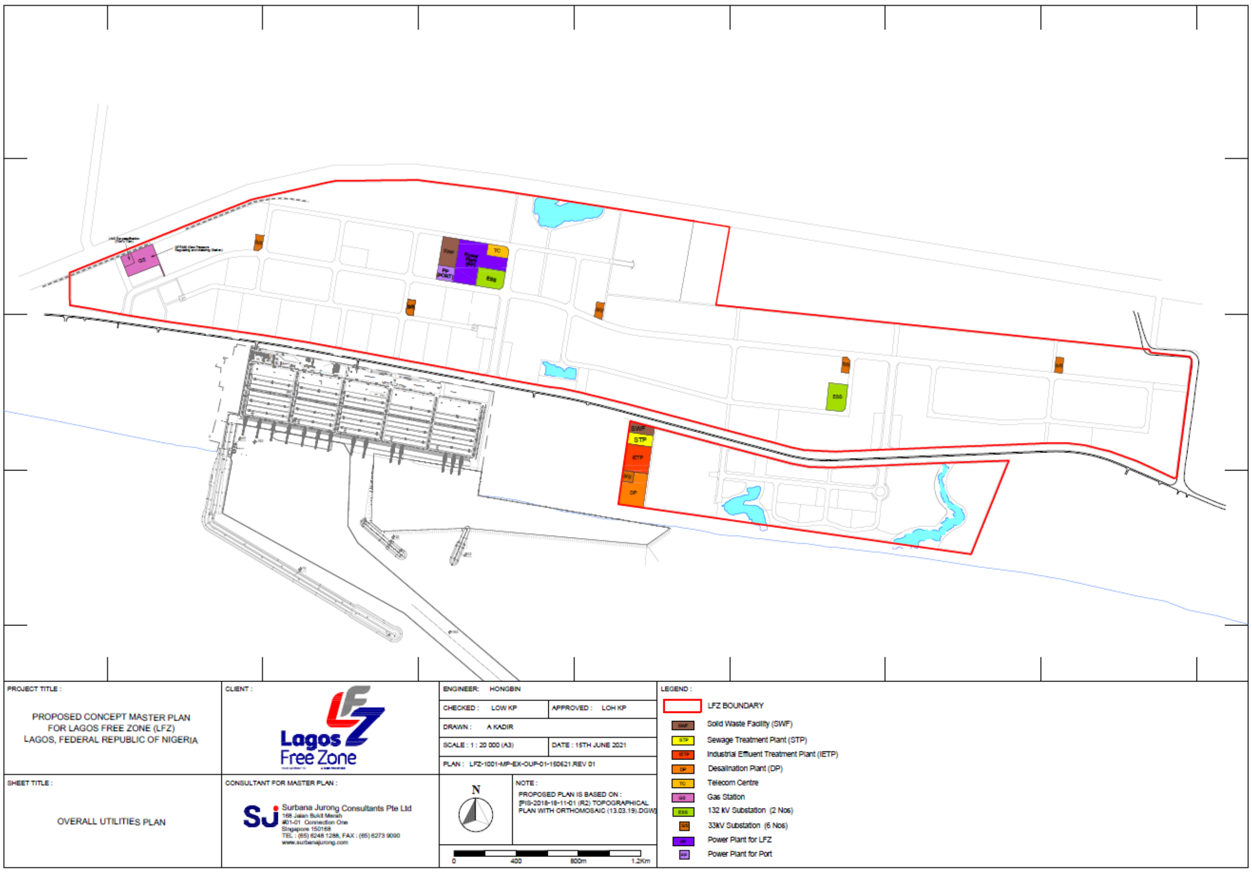


Figure 3.4: Utilities Plan

3.4.5 Water Supply System

Water is one of the most essential utilities required for the success of the proposed development. At present, existing tenants depend on their own arrangements for water source. However, this can only be temporary measure as it is not sufficient to be used as a form of permanent supply for LFZ. In the long term, a more sustainable water supply system would be required to provide 100% centralized water supply to all users.

In general, the unit water demand comes from various sources including statistical data and projects carried out by the Consultant. Based on the proposed unit water demand and the proposed land use distribution and population, the water demand was worked out as shown below.

Table 3.6: Inventory for Water Use and Consumption

Land Use	Water Consumption Rate	Total Water Demand* (m^3 / day)
Real Estate	--	3,416
Security and Civil Defence	10 m^3/ha/day	22
Civic & Community	40 m^3/ha/day	308
Logistics	--	1,386
Industrial	--	20,790
Existing Uses	--	1,848
Reserve Site	40 m^3/ha/day	2,024
Customs Checkpoints	10 m^3/ha/day	88
Transport Facilities	15 m^3/ha/day	116
Green & Open Space	5 m^3/ha/day	165
Utilities	30 m^3/ha/day	924
Roads	5 m^3/ha/day	424
Total		**31511**

- **Fire Fighting Demand** - It should be noted that firefighting demand is not included in the daily water demand estimation as the occurrence of fire is unlikely to happen every day.
- **Water Requirement for Power Plant** - Water requirement for power plant had not been considered in the daily demand. Same shall be estimated during detailed engineering.
- **Desalination Plant** - Based on the water requirement, a desalination plant is proposed as the ultimate source of potable water to the zone. The advantage of having desalination plant is that it could be located within the LFZ's site and seawater quantity is generally unlimited so that client can have better control over the water source.

In supplying potable water to the LFZ's tenants, direct pumping system has been considered. Generally, a pumping system comprises the ground storage facilities, pumps, pipes and appurtenances. The potable water is initially stored in water storage tank.

Water pipes would be laid primarily along roads and a looped network would be proposed wherever possible to improve the reliability. Within the network, all arterial and secondary mains are looped and interconnected so as to eliminate dead ends and permits water circulation.

The objectives of the water supply system were to cater for the anticipated peak water demand requirements. In addition to the daily water supply for various tenants, the piping system would also cater for water firefighting demand.

Recycling of Water - For sustainable development, water source diversification could be explored to complement the water supply. The complimentary water sources include rainwater harvesting and recycled water. The source for recycled water is from wastewater treatment plant. The recycled water could be treated to standards required for its various non-potable uses (i.e. made fit-for-purpose) such as landscaping, toilet flushing, cooling etc.

3.4.6 Domestic and Industrial Effluent Treatment Plant

Effluent treatment system is essential for environmental protection. The lack of an effluent treatment system would cause sanitation problems to LFZ. Generally, the effluent system comprises of a collection system of pipe network, effluent pumping stations and an effluent treatment plant (ETP). The objective of an effluent system is to ensure 100% of the effluent would be collected and treated to the required discharge standards.

The estimation of the LFZ's effluent flow was based on the estimated water demand. For this project, 80% of average water consumed is considered as effluent flow. In addition to that, 10% of average flow is considered as infiltration. The effluent generation had been worked out for Domestic and Industrial respectively.

Table 3.7: Daily Effluent Generated within the LFZ

Land Use	Total Domestic effluent (m^3 / day)	Total Industrial effluent (m^3 / day)
Real Estate	2,733	-
Security and Civil Defence	18	-
Civic & Community	246	-
Logistics	111	999
Industrial	1,036	15,596
Existing Uses	1,478	-
Reserve Site	1,619	-
Customs Checkpoints	70	-
Transport Facilities	92	-
Utilities	739	-
Total	**8,142**	**16,595**

It is proposed to construct ETP of capacity of 25 MLD through modular plants to meet the future requirements. ETP consists of primary and secondary treatment facilities. Raw effluent from various sources (washings) will be collected in a collection tank and treated in oil and grease removal trap. The effluent free from oil is then treated in primary clarifier. The sludge generated from the primary clarifier is then sent to sludge dewatering facility. The effluent from the clarifier is subjected to biological treatment process and the treated effluent is further treated in pressure sand filter and activated carbon filter and stored in collection tank. The treated water will be reused in the firefighting systems and dust suppressions systems as a substitute to the freshwater consumption.

A suitable sewage treatment plant will be developed to treat sewage generated from the zone during the initial phase of the project. The treatment process consists of primary and secondary treatment units. Sewage will be initially treated in Grit Chamber followed by Screen Chamber. The sewage free from grit is subjected to biological treatment process using activated sludge process including secondary clarifier.

The treated effluent from biological process is stored in intermediate tank where disinfection shall be carried out. The disinfected water is filtered in dual media filter and stored in treated sewage collection tank where it will be recycled for landscaping and green belt development.

3.4.7 Solid Waste Management

The success of keeping the environment clean and green would require proper waste management system to be implemented. The direction is to transform the LFZ into a development with efficiently operated solid waste disposal services.

The development of the LFZ with diverse urban and industrial activities results in generation of various types of solid wastes. The waste stream usually comprises the office wastes, food waste, rubbish ashes, street waste, packing, bottles, old paper/cardboard, ferrous metal, plastics, construction and demolition waste, wood/timber, organic material, used slag, non-ferrous metal, glass, textile/leather, scrap tyres, street sweepings, landscape and tree trimmings, general wastes from parks and other recreational areas and others.

Classification of the solid wastes is necessary as the handling of different composition of waste will require special efforts and careful planning. Potential solid wastes generated are broadly classified into two categories:

Municipal Solid Waste

Municipal solid waste comprises the residential, commercial, and industrial wastes generated in LFZ area in either solid or semi-solid form excluding industrial hazardous wastes. The majority types of municipal solid waste are food wastes, paper, plastic, rags, metal and glass, with some hazardous household wastes such as electric light bulbs, batteries and automotive parts. These wastes shall be disposed of to government approved dump sites by LAWMA accredited waste management company.

Industrial Hazardous Solid Wastes

With increase in industrial activities, the amount of hazardous waste generated will increase. The wastes in the category are the discarded solid material of manufacturing processes and industrial operations. They cover a vast range of substances which are unique to each industry. It usually includes hazardous chemical wastes, electronic wastes, process waste, etc. For this reason, they are considered separately from municipal solid wastes. The industrial hazardous and toxic waste generated are required to be stored properly and disposed in an environmentally sound manner. Industries generating this type of solid waste had to treat it according to standards specified by the Authorities under relevant rules before disposing.

Options for these wastes involve treating the hazardous waste and neutralization followed by sanitary landfilling / incineration. In the short interim, disposal of these wastes shall be handled by LAWMA accredited industrial waste management company.

The estimated solid waste generation for the LFZ is shown in the following table. This table 3.8 shows the solid waste generated under different land uses.

Table 3.8: Daily Waste Inventory Generated within the LFZ

Land Use	Solid Waste Generation Rate	Total Solid Waste (t / day)	Solid Waste for Pilot Phase (t / day)
Real Estate		8.91	1.88
Security and Civil Defence	100 kg/ha/day	0.20	0.20
Civic & Community	150 kg/ha/day	1.05	0.30
Logistics		10.08	1.68
Industrial		60.66	24.84
Existing Uses		6.30	6.30
Reserve Site	150 kg/ha/day	6.90	-
Customs Checkpoints	100 kg/ha/day	0.8	0.60
Transport Facilities	60 kg/ha/day	0.42	0.24
Utilities	30 kg/ha/day	0.84	0.48
Roads	30 kg/ha/day	2.31	1.14
Total		**98.47**	**37.66**

The solid waste system comprises generation, storage, collection, transportation, disposal, etc. Priority should be given to minimize the solid waste generation. Waste generated can be minimized by adopting the waste management hierarchy, i.e., the 3Rs - Reduce, Reuse and Recycle:

- Reduce - to avoid unnecessary waste generation.
- Reuse - to use again.
- Recycle - to convert unwanted things into useful and marketable recycled products.

When it comes to collection, it would be better to have different waste collection systems for domestic waste and industrial waste. Hazardous and infectious waste generated from industrial and healthcare facilities shall be considered separately from municipal solid wastes. They are required to be handled by approved waste operators in an environmentally sound manner.
LFZ will make use of regional SWM facilities as the final disposal sites through LAWMA. Intermediate facilities can be proposed to consolidate the waste.

Waste generated is collected, segregated and stored in the facilities before sending to final disposal sites. These facilities receive loads of solid waste in varying sizes and consolidate them into tractor/trailer size loads and then transports the larger loads to the final disposal sites. These facilities also provide services in sorting out and storing recyclable waste. These not only reduce the non-bio-degradable waste disposed to the disposal site, at the same, minimize the amount of solid waste to be disposed.

Two Solid Waste Facilities (SWF) are proposed to serve LFZ. The Solid Waste Facility will include the following functions:

- Waste transfer station: waste from all over the site will be centralized here before sending to the final disposal site.
- Resource recovery through sorting and recycling i.e. recovery materials such as paper, glass, metals etc. through separation.

- Resource recovery through waste processing i.e. recovery of materials such as compost or recovery of energy through biological, thermal or other processes.
- Waste transformation (without recovery of resources) through reduction of volume, toxicity or other physical/ chemical properties of waste to make it suitable for final disposal.

The solid waste generated daily from industries/commercial/residential activities shall be collected via trucks and transported to the proposed solid waste facilities.

Table 3.9: Summary of Wastes Stream associated with the Proposed Project and Handling Techniques

Waste Streams	Sources	Waste Generation Phase	Handling Techniques
General rubbish, refuse, and putrescible wastes (food wastes)	Wood splinter, domestic waste, food packs	C, O	On-site waste segregation; disposal of non-reusable waste through a third-party waste contractor approved by LAWMA.
Cleared vegetation	During site clearing and preparation	C	Composting, collection for biomass fuel
Scrap metals	Used tubular and casings, metal drums, used iron rods	C, O	Scrap metals will be collected for recycling
Excavated materials	Foundation works	C	Excavated materials generated during foundation works will be used for back-filling. Excess excavated spoil will be stockpiled and reused as part of materials for construction of plant buildings.
Sanitary waste	Office/Administrative area	C, O	Periodic evacuation of content of the septic tank by LAWMA accredited third party waste contractor.
Gaseous waste and noise pollution	Vehicular activities	C, O	Incorporating air pollution control devices (e.g. catalytic converters) and noise suppression equipment (e.g. mufflers)
Diesel/ petrol/engine oil/lubricant	Vehicular activities	C, O	Use of spill absorbent kits. Used absorbent materials to be disposed of by accredited third party waste contractor LAWMA

Construction (C) Operation (O)

3.4.8 Gas Supply

LFZ would be providing gas supply to the tenants. The intention was to have a gas pipeline network initially, such that the piped gas meets the demand of the industries for power generation needs as well as heating needs (boilers operation etc.). Two-hectare Land is earmarked for GPRMS (Gas Pressure Regulating and Metering Station). This may include a burn-pit and a flare besides Gas Metering Station. For LNG regasification, a plot of size 70m x 70m is also earmarked along with the plot for GPRMS. The GPRMS & LNG Regassification area shall be located closer to Western Boundary to allow optimization of pipeline costs and for proper network planning and design.

3.4.9 Power Supply

Power supply is a critical infrastructure provision. The power supply system for LFZ will be self-dependent and stand-alone system. Currently, the existing tenants obtained their power supply through their own power generation individually. A centralized power supply is needed for LFZ to make it more efficient for the tenants.

The electrical infrastructure includes power plant, power substation, the high / medium / low voltage network. The demand projection is based on the approved land use breakdown. As shown in the Table, coincidence factor figure is applied, as commonly done in infrastructure planning. This is to account for the fact that not all consumers use their peak load at the same time. For LFZ, the coincidence factor (CF) figure of 0.5 is used.

Table 3.10: Power supply inventory at the LFZ Facilities

Land Use	Power Demand Unit Rate (MVA / ha)	Total Power Demand (MVA)
Real Estate		13.55
Security and Civil Defence	0.50	0.50
Civic & Community	0.50	1.75
Logistics		14.50
Industrial		185.50
Existing Uses		17.00
Reserve Site	1.00 (Industrial) 0.30 (Non industrial)	15.65
Customs Checkpoints	0.30	1.20
Transport Facilities	0.20	0.70
Rail Corridor	0.01	0.02
Green & Open Space	0.01	0.15
Water Bodies	-	-
Utilities	0.30	4.20
Roads	0.02	0.77
Total		**255.49**

Phase 1 of the project activities will be equipped with a 10MW gas fired power plant will be adopted to meet the requirements of environmental protection and energy saving, and this will be scaled up to 40MW capacity within 5 to 7 years. By having its own gas fired power plant, LFZ could have better control over the power source. For better efficiency, LFZ is proposing step down 132KV – 33KV – 11KV transmission arrangement. For this purpose, 2 numbers of 132kV/33kV substations are proposed with one of them co-locating with the proposed power plant serving LFZ and 6 numbers of 33kv/11kv substations proposed.

The design and build of the generators allow easy mobilization and scalability whilst guaranteeing efficient power production. Table 3.11 provides summary specifications of power turbines proposed for installation at LFZ.

Table 3.11: Summary Specifications of Proposed Gas Turbines

Specifications	5MW (Cummins QSK60 Gas)	10MW (Cummins QSK60 Gas)	10MW (20V35/44G MAN ES gas engine)
Engine rating	1375 Kva (1 MW rating)	1375Kva (1 MW rating)	10,027 - 10,420 kW_{el}
Installation information	6 x 1375kVA Gas Generators with 20Mtrs LV each of required sets of cables. 2 x 6MVA Transformer RMU, Energy Meter, and Gas train	12 x 1375kVA Gas Generators with 20Mtrs LV each of required sets of cables. 4 x 6MVA Transformer RMU, Energy Meter, and Gas train	Single unit Up to 48.6% electrical efficiency CO_2 emissions per produced kWh: *Naturalgas:202g/kWh*
Emissions Ratings (per engine)	Nitrogen Oxides (NOx) - 1330 489mg/nm^3 CH_4 (Methane) – 1330mg/nm^3 CO (Carbon Monoxide) - 489/mg/nm^3	Nitrogen Oxides (NOx) - 1330 489mg/nm^3 CH_4 (Methane) – 1330mg/nm^3 CO (Carbon Monoxide) - 489/mg/nm^3	
Noise Ratings (per engine)	Sound power 104 dBA Sound pressure (at 1m) = 87dBA Sound pressure (at 7m) = 80dBA	Sound power 104 dBA Sound pressure (at 1m) = 87dBA Sound pressure (at 7m) = 80dBA	

3.4.10 Telecommunication

The telecommunications industry has undergone great changes over recent years. Increasingly, users are using more and more data than voice for their communications. For this development, access network to customers’ premises would be adopting the broadband as a standard provision. For high bandwidth provision would be most effectively done using optical fibre networks, but wireless broadband technology will be increasingly offered in future. The types of services for all customers might consist of the following:

- Voice - consumers are increasingly looking into using VOIP because of cost consideration. We can expect more and more of such traffic to be carried over their broadband facility and IP network.
- Broadband - for e-mail, Internet access, streaming and downloading of music/ video.
- Data network - dedicated data network for security reasons, as well as for transfer of large data files.
- VSAT (Very Small Aperture Terminal), TVRO (Television Receive-Only) and DTH (Direct to Home) – for direct connections to customers' various offices.
- Mobile communications
- Wi-Fi, WiMax facilities - for residential premises and certain public areas
- WLAN/LAN - This will likely be provided by the telco or the tenants themselves and will be planned for at a later stage. Optical fibre or CAT 6 cables can be used.
- IPTV - Coaxial or CAT 6 cabling may have to be run from the Equipment Room to the customers' premises.
- Road traffic management and surveillance cameras - The telecommunications infrastructure can be extended also to meet such needs. Appropriate cross pipes/conduits can be incorporated in the detailed design, to allow cabling and services to be picked up from an existing nearby building.

One telecom centre is required to serve the LFZ and optical fibres would have to be run to all premises in order to meet both existing and future bandwidth demand.

CHAPTER FOUR

EXISTING ENVIRONMENT

4.1 General

This chapter presents the biophysical, social and health baseline status of the Lagos Free Zone (LFZ) project area. The descriptions presented here are based on the wet and dry seasons field data gathering and socioeconomic survey.

4.2 Data Gathering Approach

Data gathering for this EIA was accomplished by a multidisciplinary team covering literature review, sample collection, testing and analyses as well as reporting in line with Nigerian guidelines and international best practices.

The study methodology is presented in Sections 4.2.1 – 4.2.2 and detailed in Appendix 4.1, while findings on the biophysical conditions are presented in Section 4.3.

4.2.1 Literature Review

Literature review was carried out to generate relevant background information on the immediate and regional environment of the LFZ project area. It involved previous environmental studies in the area and technical publications.

4.2.2 Field Sampling/Measurements

Field sampling was carried out in the presence of FMEnv and LFZ (Proponent) representatives. The wet and dry season fieldwork data gathering exercises was carried out between 27th to 30th of July, 2020 and 14th to 16th February, 2021.

Sampling Design

Sampling design was done to comprehensively cover and characterize the entire LFZ project area. The area was geographically gridded taking cognizance of the different vegetation cover, marine and freshwater systems and human settlements in the area. A map showing the distribution of sampling points in the LFZ project area is presented as Figures 4.1.

Positioning

Positioning was carried out with the aid of a Gamin Oregon 550T 12 channels Global Positioning System (GPS). During the fieldwork, the GPS was used to enhance the geo-rectification, ground-truthing and interpretation of the products. Detailed coordinates of sampled stations are also presented in Appendix 4.1.

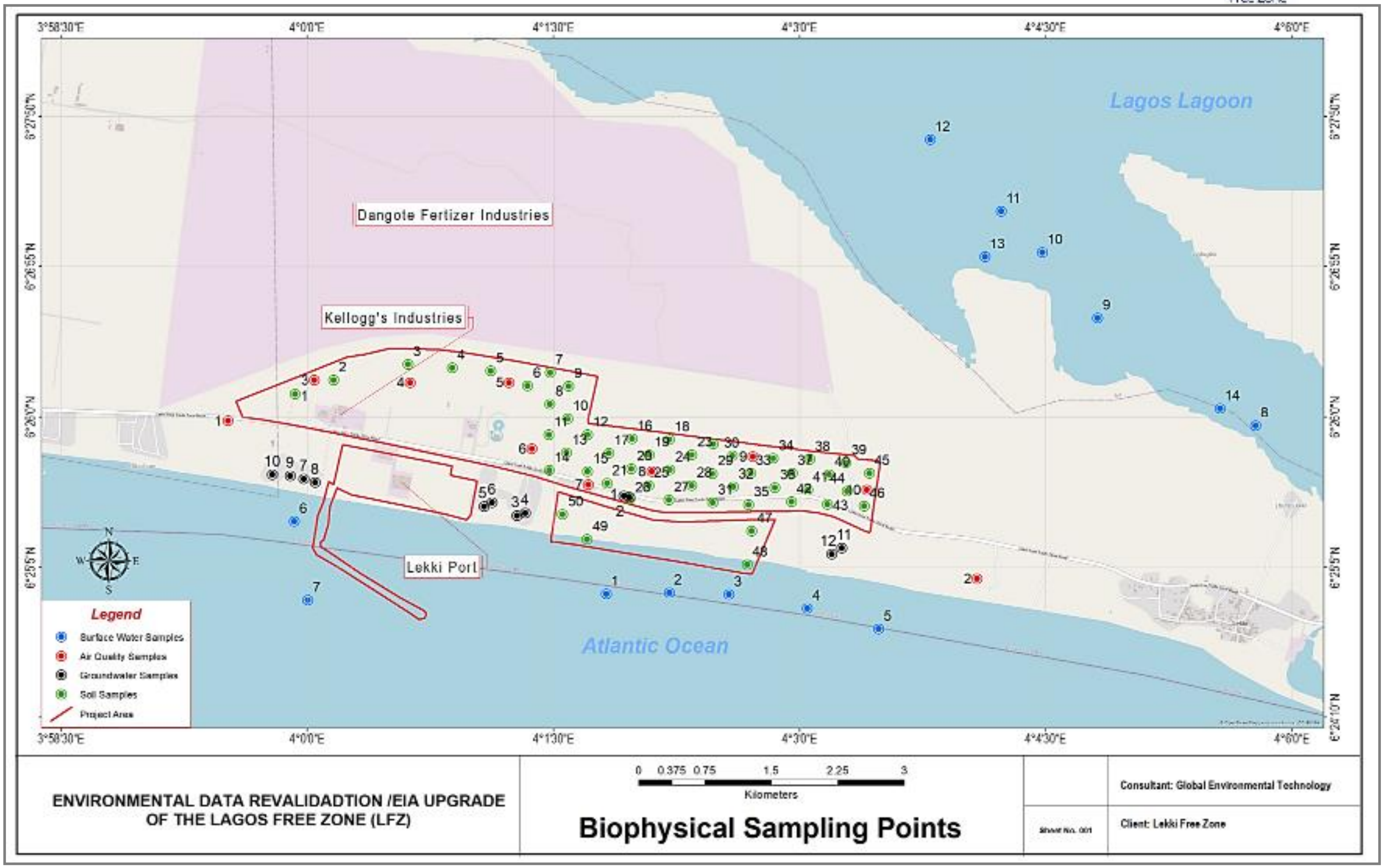


Figure 4.1: Distribution of Biophysical Sampling Points in the Study Area

Laboratory Analysis

All soil, marine and fresh water and sediment samples collected during the fieldwork exercise were taken to Searchgate Laboratories Limited; 38 Diya Street. Ifako, Gbagada, Lagos for physico-chemical and microbiological analyses. Details on samples handling and analysis protocols are presented in Appendix 4.1.

4.3 Description of Ecological Baseline Conditions

4.3.1 Regional Meteorological Features

Long-term (1990 - 2019) data measurements of Lagos, as obtained from the Nigeria Meteorological Agency (NIMET, 2020) were used to describe the climate of the proposed project area. Climatic characteristics of the area follows the tropical pattern relative to the Inter-Tropical Convergence Zone (ITCZ). When the ITCZ swings to the south of the equator, the north-east winds prevail producing the dry season harmattan but whenever it moves to the north of the equator, the south westerly wind prevails bringing rainfall and the wet season. These give the proposed project area both the dry and wet seasons.

Rainfall

The two (2) dominant rainfall regimes in the project area are a long wet season (March - November) and a short dry season (December - February) with a total rainfall of about 2400 mm. The lowest rainfall is in January and the maximum in July (Figure 4.2). The rainfall regime is characterized by double maxima that occurs in July and September. A "short break" usually experienced in August is associated with the brief southward retreat of the Inter-Tropical Discontinuity (ITD) during the period. The relatively high rainfall relates to the contiguity of the area with the Atlantic Ocean. The water body also complements the ITD-initiated rainfalls.

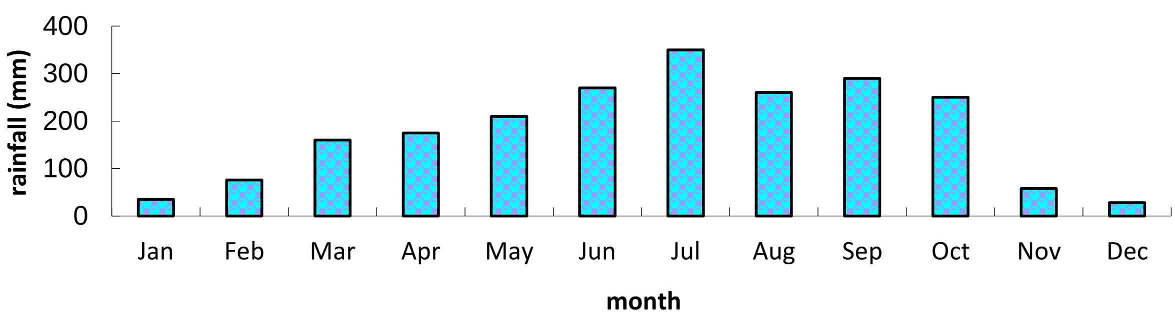


Figure 4.2: Monthly Rainfall Distributions in the Area (NIMET, 2020)

Relative Humidity

The relative humidity in the project area is high with mean of 84.4% and 72.9% at 10:00 hours and 16:00 hours, respectively (Figure 4.3). The relative humidity is highest in the wet season and lowest in the dry season with minimal variation (Table 4.1). The high relative humidity is attributed to its closeness to Atlantic Ocean and typical of the southern part of Nigeria.

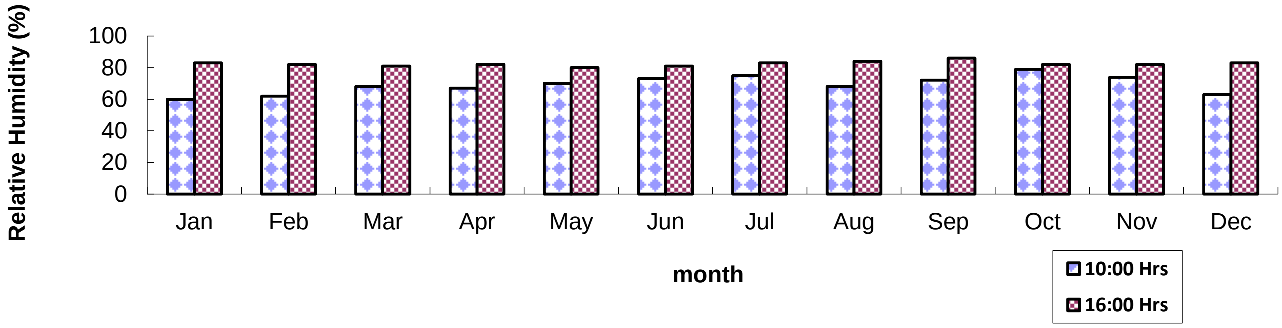


Figure 4.3: Monthly Relative Humidity Distributions in the Study Area (NIMET, 2020)

Table 4.1: Mean Measured Microclimatic Parameters

Season	Level	Air Temperature (°C)	Relative Humidity (%)	Atmospheric Pressure (mbar)	Wind	
					Speed	Direction
Wet	Minimum	23.2	64.1	1013.2	0.1	Southwest
	Maximum	30.4	98.3	1017.1	7.2	Southwest
	Mean	26.1	83.3	1014.6	2.3	Southwest
Dry	Minimum	28.0	67.3	1008.2	0.7	Southwest
	Maximum	33.1	94.2	1012.4	4.4	Southwest
	Mean	29.5	82.1	1009.6	2.7	Southwest

Air Temperature

The proposed project area experiences uniformly high temperatures with measured range of 22.5 – 33.7 °C (Figure 4.4). The air temperatures are subjected to minimal diurnal and seasonal variations (Table 4.1) characteristic of climate in the southern part of Nigeria.

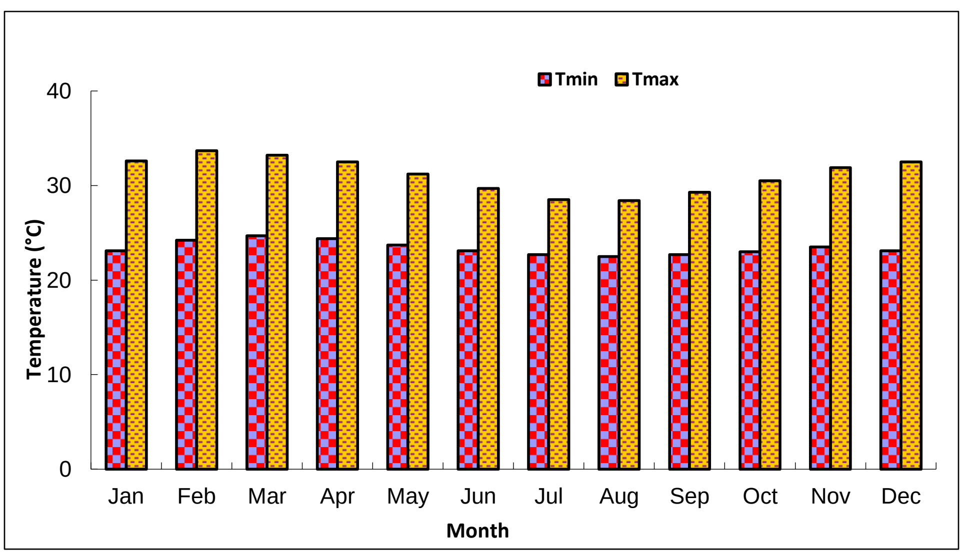


Figure 4.4: Mean Monthly Air Temperature in the Study Area (NIMET, 2020)

Atmospheric Pressure

The mean atmospheric pressure in the climatic data is 1015 – 1020 mbar with the minimum and maximum in January and June respectively (Figure 4.5). This corresponds with the mass movements of air over he ITZC.

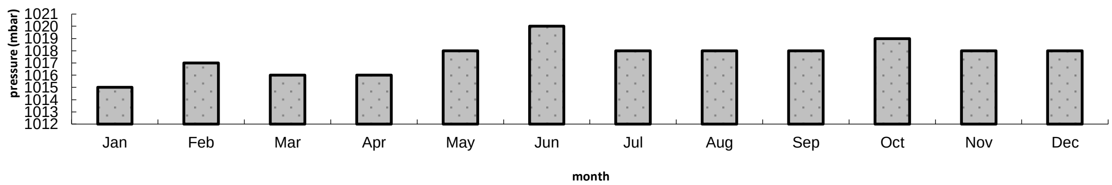


Figure 4.5: Atmospheric Pressure Pattern in the Study Area (NIMET, 2020)

Cloud cover

Cloud cover in the area appears high throughout the year with very little variations. Cloud cover is highest in May - October and lowest in June - July with average monthly levels of 6.7 – 6.9 Oktas, indicating a generally overcast sky with some bits of blue sky (Figure 4.6).

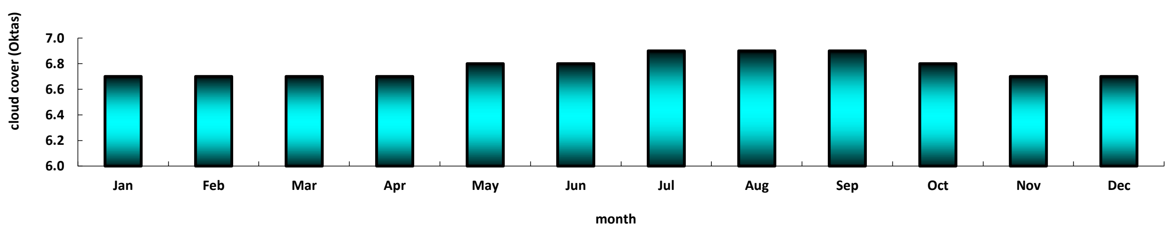


Figure 4.6: Cloud Cover Distribution in the Study Area (NIMET, 2020)

Wind Speed and Direction

Surface wind speed in the area is characterized by small diurnal variation influenced by both land and sea breezes. The two major wind regimes are the Northeast and the Southwest Trade Winds. The measured prevailing wind speeds in the wet (0.1 – 7.2 m/s) and dry (0.7 – 4.4 m/s) seasons were in the southwest direction (Figure 4.7) within historical measurements.

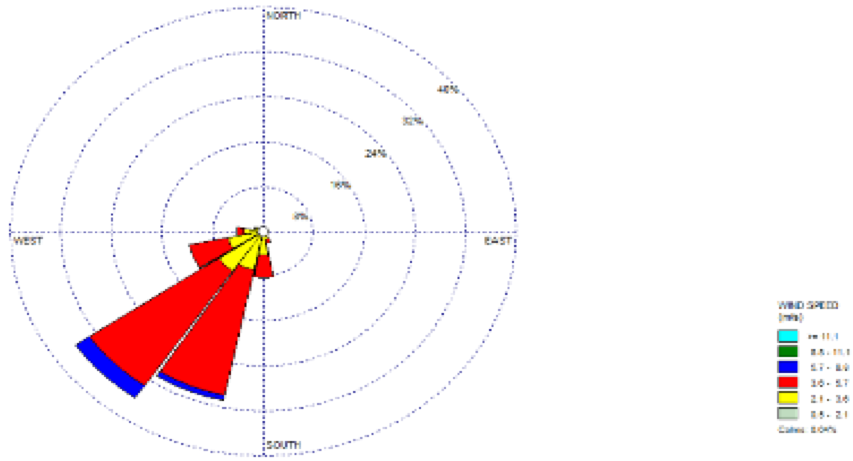


Figure 4.7: Windrose of the Proposed Project Area (NIMET, 2020)

Sunshine Pattern

The annual sunshine period in the study area is approximately 1500 hrs with monthly average of 121.9 hrs (Figure 4.8). This area receives minimum sunshine between July and September associated with the greater amount of cloudiness and rainfall, and maximum sunshine occurs between December and January due to the prevalent clear skies.

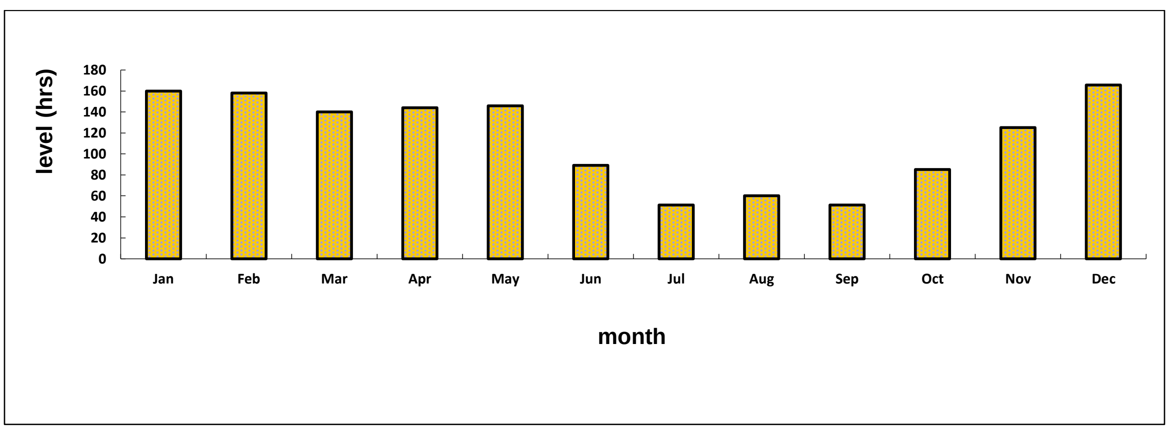


Figure 4.8: Sunshine Pattern in the Study Area (NIMET, 2020)

4.3.2 Geology and Hydrogeology

The project site is situated within the eastern part of the Dahomey Basin, in south-western Nigeria. The Dahomey Basin extends from the eastern part of Ghana, through Togo and the Republic of Benin, to the western margin of the Niger/Delta basin, just before the coast in Nigeria.

Within the Dahomey Basin, six stratigraphic formations are identified by Jones and Hockey (1964). The stratigraphic formations range in age from the Eocene to present and are characterized as containing mudstone, shale, limestone, and sandstone.

The Dahomey Basin was formed from tectonic rifting which led to subsidence during the lower Cretaceous. The gentle subsidence experienced by the basin changed the environment rapidly from continental to open marine, during which time sand and shale were deposited locally. The thickest sediments occur to the west of the Nigerian-Dahomey border, specifically at the Republic of Benin (Billman, 1976; Omatsola and Adegoke, 1981).

Lagos State is situated entirely within the coastal plain, with only few areas rising much above sea level. The fresh surface waters in Lagos State include rivers and creeks which feed directly into Lagos lagoons. A consequence of low-lying topography and many surface waters is the formation of wetlands which, in turn, limit the area of agriculturally productive soil. The existing aquifers in the Dahomey Basin are important sources of water for the local population and have been exploited for drinking and commercial purposes.

Seismic Potential

Although Nigeria is not located within the major seismic zones of the world, over the years, several minor earthquakes have been experienced in some parts of the country. The first widely reported tremor in Nigeria was in 1933. Other events were reported in 1939, 1964, 1984, 1990, 1994, 1997, 2000 and 2006. The intensities of these events ranged from III to VI based on the Modified Mercalli Intensity Scale. Of these events, only the 1984, 1990, 1994 and 2000 events were instrumentally recorded. They had body wave magnitudes ranging from 4.3 to 4.5, local magnitudes between 3.7 and 4.2, and surface wave magnitudes of 3.7 to 3.9.

When these events occurred, there were no functional seismological observatories in Nigeria. However, that has now changed with the establishment of a seismographic network managed by the Centre for Geodesy and Geodynamics located in Toro, Nigeria. Remote sensing, geological and geophysical studies have revealed the presence of a NNE-SSW trending Ifewara-Zungeru fault zone which has been shown to be linked with the Atlantic fracture system. The dynamics of the Atlantic fracture zones have been suggested to be responsible for the seismic activities experienced in the areas (Akpan and Yakubu, 2010).

Literature searches indicate inconclusive evidence regarding the potential for tsunamis along coastal Nigeria. New tsunami warning stations have been installed in Africa to better track sea level rises and predict tsunamis (Natural Environment Research Council, 2007).

Hydrogeology

The Atlantic Ocean and Lekki Lagoon, a part of the barrier lagoon-complex in Lagos, are the main hydrological features in this coastal group of villages. The Lekki Barrier separates the lagoon from the sea; only the Lagos Lagoon is directly connected to the sea, and this occurs about 60 kilometres west of the project site. Freshwater swamps are found at the margins of the lagoons and along the valleys of the influent rivers.

Water supply to the populace is usually from shallow dug wells and/or boreholes drilled into the Coastal Plain Sands Formation, and from the lagoon, which serves as a source of livelihood for the mostly fishing population. The lagoon also serves as the major receptor of waste and wastewater discharges from the surrounding communities. Earlier attempts made in the area to harness the groundwater resource that is readily available have not been very successful due to lack of appropriate initial investigation and incursion of saline water into the boreholes. Static water levels in the wet season varied from 1.5 to 2.0 m and from about 2.0 to 2.8 m below ground in the dry season.

Borehole logs of the Coastal Plains Formation in the area reveal frequent facies changes and fining-upward lithological sequences, characteristic of cyclic sedimentation in a nearshore depositional basin. Specifically, the formation is made up of loose deposits overlying unconsolidated, very poorly sorted clayey sands, gravelly sands, and sandy clays that are interbedded with grey clays and peat. The sands are generally friable but become denser with depth. Borehole logs also reflect a multi-layer aquifer system consisting of three major aquiferous zones, separated by thick layers of clay aquiclude, with the following characteristics:

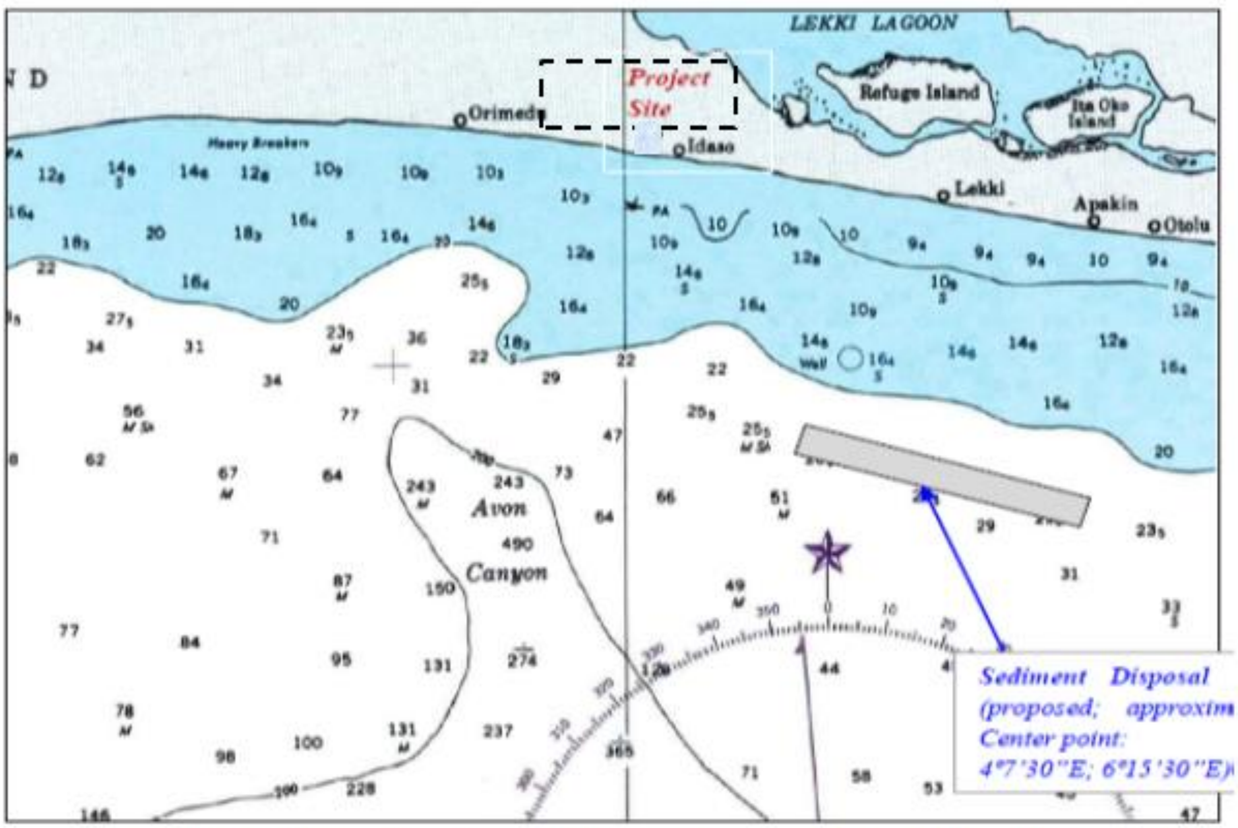
- The uppermost water-bearing horizon is a water table aquifer that is mostly tapped for domestic supplies via private dug wells or boreholes. This aquifer is very susceptible to external influences as it is directly exposed to direct recharge from precipitation, stormwater runoff, and drainage channel. The static water level in boreholes tapping this aquifer varies between wet and dry seasons.
- The middle aquiferous zone consists of two water-bearing horizons at depths of about 30 to 35 m and 45 to 55 metres. The two horizons are separated by a 10-metre-thick layer of clay. They are confined at the top and bottom by clay layers of variable thickness between 25 metres and 10 metres, respectively.
- The lower aquiferous zone is located at a depth of about 65 metres depth and consists of three productive zones, beginning with a 6-m thick layer of fine white sand from 64 to 70 metres. It is separated from the second water-bearing horizon by a 4-metres thick clay layer. Both the second and third water-bearing horizons are made of coarse sands, separated from each other by a 22-metre-thick clay and peat layer. The lowermost water-bearing zone extends from 108 to 116 metres, underlain by another thick clay layer.

4.3.3 Oceanography and Hydrodynamics

Bathymetry

The Project area is located along the northern shore of the Gulf of Guinea within the Atlantic Ocean. Water depths gradually increase seaward reaching 20 m at approximately 10 km from shore (Figure 4.9). The shelf edge (i.e., water depth of 200 m) is located approximately 30 km from shore, although the distance varies due to the existence of Avon Canyon to the south southwest of the site. Beyond the edge of the continental shelf, there is a steep drop off with water depths exceeding one kilometre in the open ocean.

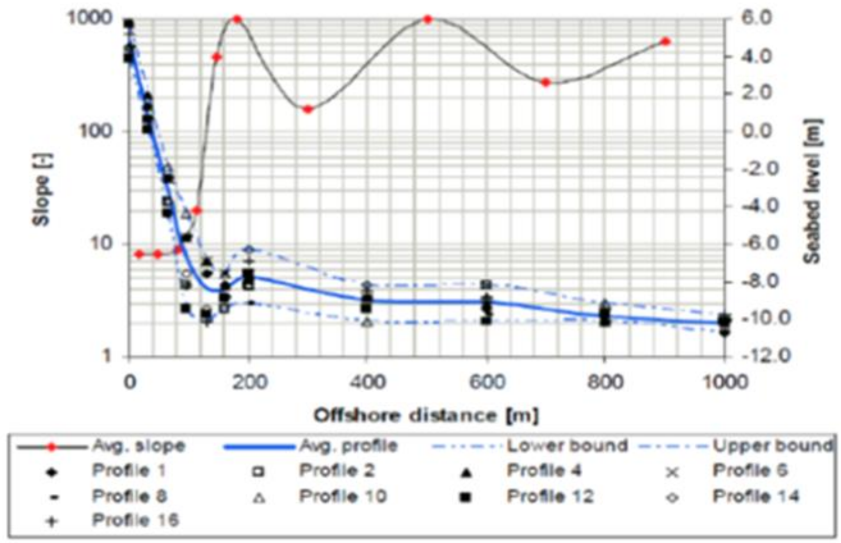
Avon Canyon is a north-south trending trench within the continental shelf that extends from about ten km offshore to the edge of the shelf. The canyon has a width of about 10 km and a water depth exceeding 350 m.



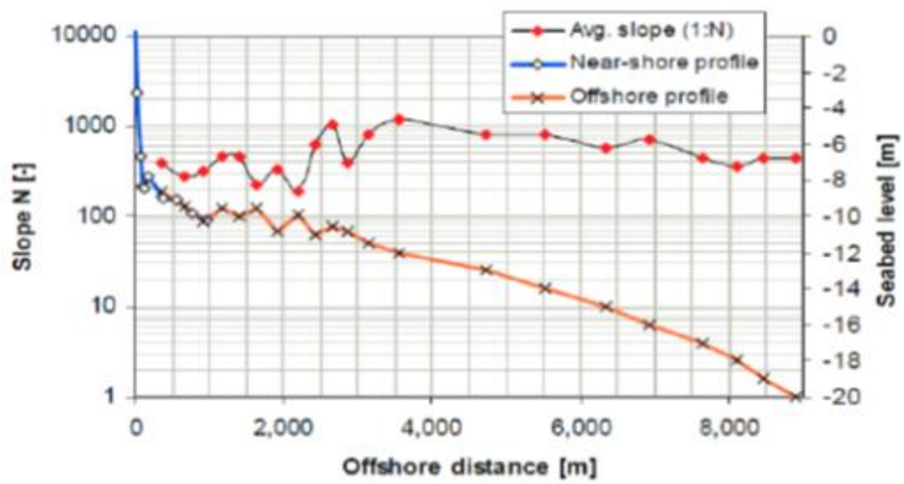
Source: NIMA (National Imagery and Mapping Agency), 2012, Nautical chart 57120

Figure 4.9: Bathymetry of the Offshore Waters near Project Site

A bathymetric survey was carried out by Galcoast (2002) over an area of approximately six (6) km (width along the shore) by nine (9) km (distance to offshore). The contours of the sea bottom generally follow the orientation of the coastline, as shown by water depth measurements along transects perpendicular to the coast (Figure 4.10).



(a): Shore to 1KM Offshore



(b): Shore to 8KM Offshore

Seabed elevations are based on Lower Low Water Spring (LLWS)

Figure 4.10: Offshore Seabed Profiles and Slopes near the Project Site.

Close to shore (offshore distance zero m to 100 m) the slope of the substrate is relatively steep (approximately 1:8 slope). Further offshore (100 m to 9 km) the slope of the substrate is gentle and varies typically between 1:200 and 1:1000. Ridges are found parallel to the coast in water depths between one to ten metres; they presumably formed because of the transport of coarse sand by the west to east littoral currents.

B. Tides and Water Level Variations

Model studies off Lekki in a water depth of ten (10) m showed a highest water level of +1.8 m, a mean neap tide level of 1.2 m, and mean sea level of one metre with respect to the site datum (NIOMR, 2001). These levels are consistent with the tidal water elevations determined for Lekki using the Mike 21 Global Tide Model; the average tidal range at Lekki is about one metre, with about 0.5 m at neap tide and 1.5 m at spring tide (Delta Marine Consultants, 2008a). For comparison, the tidal range near Lagos is 0.49 m during neap tide and 0.86 m during spring tide.

In addition to the astronomical tides, water levels can increase due to other factors, primarily storms. Eleven such events of high-water levels over tidal elevations were observed at the Lagos Bar station bet ween 1994 and 1999.

These events were preceded by high wind speeds in the range of 12 m/s to 15 m/s resulting in a recorded maximum water level of one metre above the astronomical tide. Design water levels for a port and harbour facility within the LFZ have been chosen accordingly (Table 4.2).

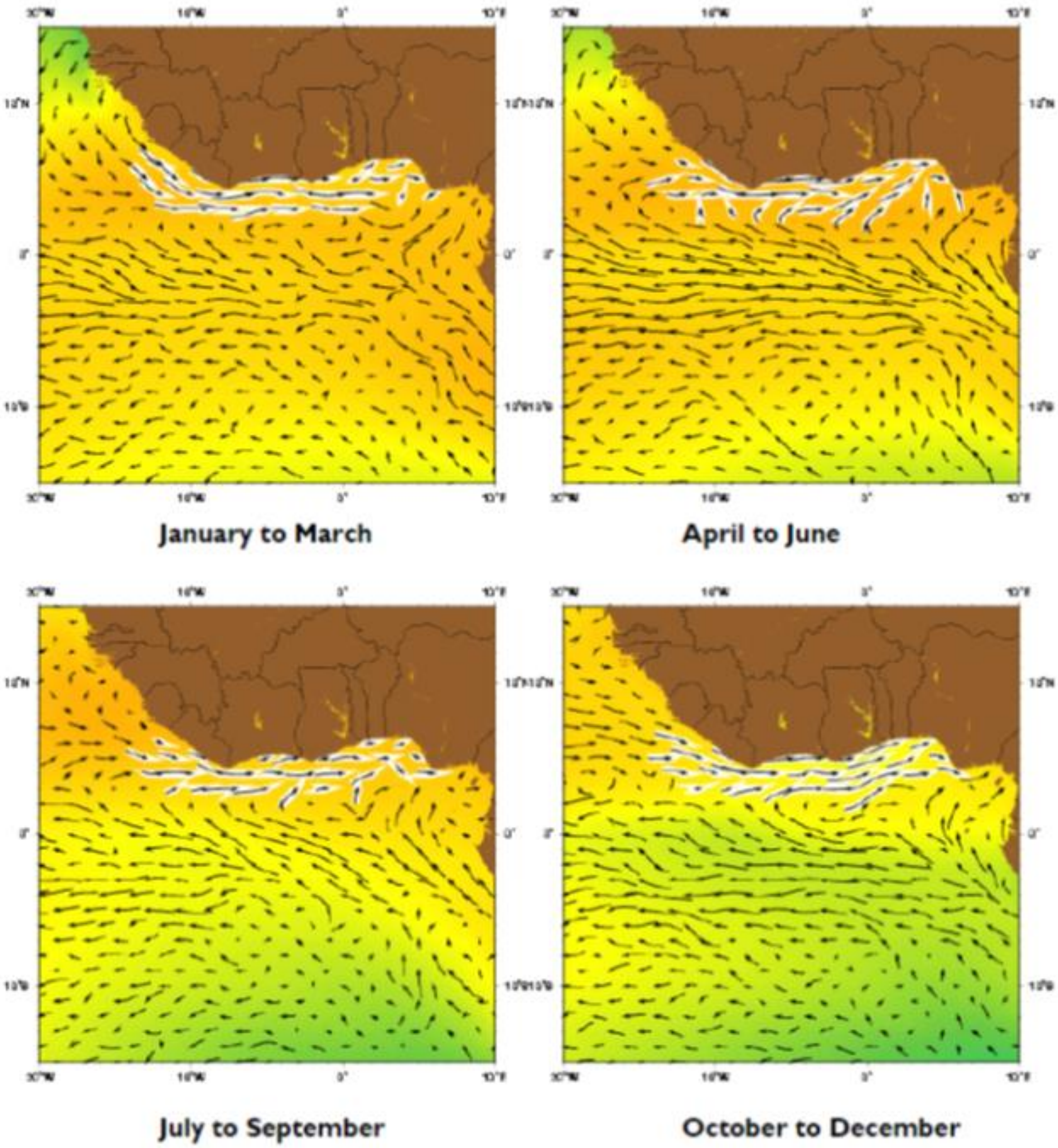
Table 4.2: Design Water Levels (*)

Extreme Water Level	High extreme water level (MHHW + storm surge + sea level changes)	LAT +2.5 m
	Low extreme water level (MHHW + storm surge + sea level changes)	LAT +0.1 m
Operational Water Level	High water level MHHW	LAT +1.5 m
	Mean sea level MSL	LAT +0.9 m
	Low water level MLLW	LAT +0.3 m

(*) LAT: Lowest Astronomical Tide; MHHW: Mean Higher High Water; MSL: Mean Sea Level; MLLW: Mean Lower Low Water

C. Currents

The surface circulation in the Gulf of Guinea is governed by the gyral circulation in the North and South Atlantic Ocean that results in the eastward flowing Guinea Current (Figure 4.11). Generally, the current is weakest during the winter (November through February) and strongest during the summer (May through September).



Source: Gyory. J., B. Bischof, A.J. Mariano, and E.H. Ryan, 2012

Figure 4.11: Seasonal Velocity Patterns of the Guinea Current (White Arrow) Along the Coast of West Africa

The near-shore currents in the project area is mostly driven by wind and to a lesser degree by tides (Delta Marine Consultants, 2008a). Wind-induced velocities are much larger than tide-driven velocities. Wind-induced currents tend to be parallel to the wind direction but turn into a shore-parallel current as they approach the shoreline. Velocities are irregular, fluctuating on time scales of one to several days. Tidal currents are fluctuating also as a result of the tidal cycle and have peak velocities of about ±0.05 m/s. Near shore currents typically have velocities of 0.05 m/s to 0.15 m/s.

Currents at the project site are mostly heading toward the east and occasionally to the east southeast; near shore currents to the west are exceptional. Approximately 750 m offshore of the proposed port, the current velocities are typically around 0.1 m/s to 0.2 m/s, with prevailing current directions of east and ESE. Current directions of southeast and west are exceptional.

D. Waves

Waves reaching the West African coast are of two origins: (1) waves generated by the local weak south-westerly winds, and (2) swells generated by storms in the southern part of the Atlantic Ocean. Offshore wave data from 1997 to 1999 are available from the Datawell wave rider buoy at a site located about 240 km SSE of Lagos at a water depth of 200 m ('Bonga site'). Wave heights measured by this buoy ranged between 0.5 and 3 m, with most waves ranging between 1 and 2 m. Wave periods ranged between 4 s and 20 s, with most periods ranging between 9 and 13 s. The direction of the approaching waves in the deep water was typically from the south to southwest.

Operational and extreme offshore wave conditions were derived from hindcast data of the NOAA Global Wave Model (Delta Marine Consultants, 2008a). The NOAA hindcast data were validated against Jason-1 satellite data. A correction factor of 1.5 was applied for extreme wave heights regarding temporal and spatial variability of wave conditions. The prevailing offshore wave direction is south to southwest (occurring about 95 % of time - Figure 4.12). The predominant sea state is 'swell' (about 92 % of time) and occasionally 'sea' (about eight % of time). Waves during the sea state are more variable than during the swell state and come more from the southwest than during swell (Figure 4.13). Typical peak wave periods are four seconds to seven seconds for sea, and 9 seconds to 15 seconds for swell. Swell periods may reach occasionally 16 seconds to 20 seconds.

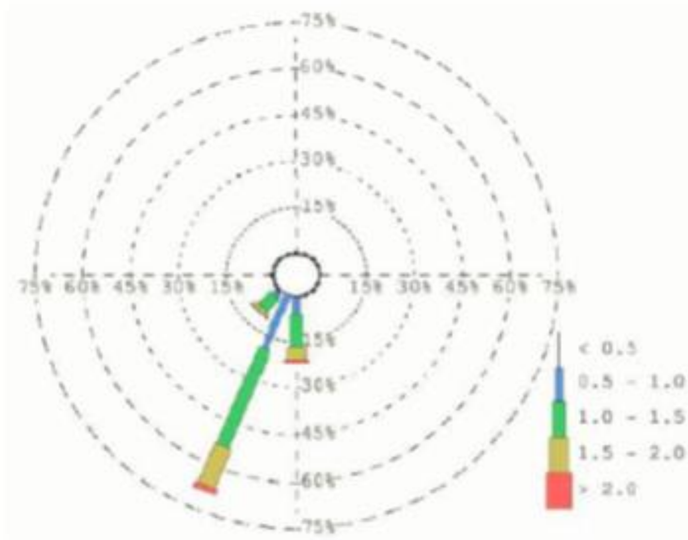
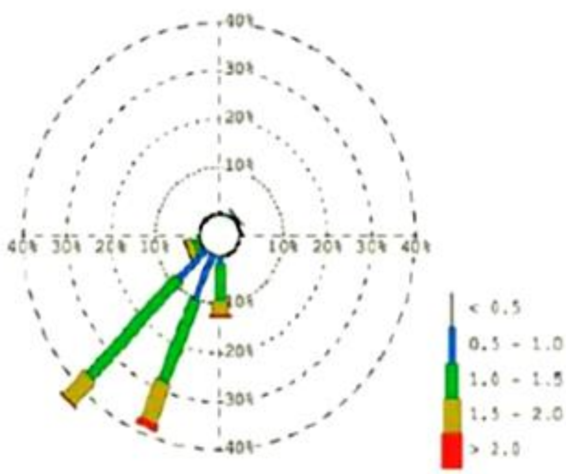


Figure 4.12: Wave Rose (Total Sea)



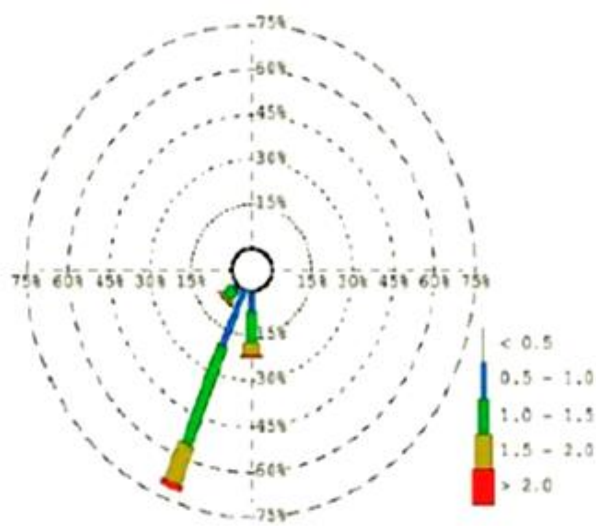


Figure 4.13: Wave Rose of Sea (Left) and Swell (Right)

Wave heights are typically between 0.75 m and 1.75 m. The largest waves occur during the wet season (June to August) with average wave heights exceeding 1.5 m (typically 1 metre to 2.5 m). The average wave height in the dry season (December to February) is about 0.9m (typically 0.5 m to 1.5 m).

Offshore wave heights of three m are rarely exceeded. Extreme offshore wave heights assessed from NOAA hindcast data by extreme value analysis are summarized in Table 4.3. Significant wave heights were determined as 3.5 m for a return period of one year, and 4.6 m for a return period of 100 years.

Coastal waves along the sand bar near the project site typically have a south-westerly approach and break obliquely with breaker angles ranging from 15 degrees to 25 degrees to the shore.

Table 4.3: Extreme Offshore Wave Condition

Return Period (Years)	Significant Wave Height(m)	Typical Peak Wave Period (s)		Typical Wave Direction
		Sea	Swell	
1	3.5	8.5	11-16 s	SSW (180° – 225°)
10	4.1	9		
100	4.6	10		

Source: Wave Condition Estimate developed by GET, 2011

E. Coastal Morphology

The project site is located on the 'Lekki Barrier'. The barrier lagoon coast, of which the Lekki Barrier system is a part, extends for about 200 km from the Benin-Nigeria border eastwards to the western limit of the mud beach in Ondo State. The morphology of this system is determined by the coastal dynamics and drainage. Generally, the beaches are erosive due to lack of rivers and streams, which is reflected in the absence of growing spits and barriers.

The beach sediments around the Town of Lekki consist largely of coarse sand in the foreshore areas of the beach, and fine sand in wet muddy hollows along the vegetated back barrier areas. The dominant sediment grain sizes collected at nine beach stations were medium to coarse sand, ranging from 0.4 to 1.4 mm in diameter. Generally, the sediments in the foreshore areas of the beach are coarser-grained (i.e., coarse sand) while sediments at the berm crest and in backshore areas are finer-grained (i.e., medium to coarse sand).

Storms result in steeper beach slopes and an inland retreat of the shoreline, while calm conditions cause beaches to be restored to the original beach profile with the shoreline shifting seaward again. Modeling indicates that storms cause coastal retreat of 12 to 32 m in the project area.

F. Longshore Sediment Transport

The persistent easterly direction of the Guinea Current and the oblique coastal waves from the southwest result in high sediment transport rates. The eastward littoral drift originates in Ghana and extends all the way up to the end of the barrier lagoon coast in Western Nigeria. Sediment transported along the coast is mainly supplied by rivers in Togo and Benin.

The littoral sand transport at Cotonou in Benin is estimated to be 1.2 million m^3/year, decreasing to 0.75 million m^3/year at Badagry Beach about 12 km west of the Lagos Inlet. There are no rivers entering the Gulf of Guinea along the Lekki Barrier due to the large lagoon system to the north of the barrier that captures sediment supplied from land further to the north.

To the east of the project site, the largest source of sediment entering the Gulf of Guinea is the Niger River. Some of its sediment is transported to the northwest along the coast (Figure 4.14). The annual sediment transport rate along the coast between the Ramos and Forcados Rivers (tributaries of the Niger River) is estimated at 0.5 million m^3/year**.**

Some of the fine-grained sediments reach the Mahin mud coast, located to the north of the Benin River. In this area, south-westerly waves break almost parallel to the coast, resulting in little or no longshore sediment transport. Most of the sand that is transported northward from the Niger Delta does not reach the Mahin mud coast as much of it is believed to be transported offshore.

Based on this information, and given the prevailing easterly current direction, sediment from the Niger River does not affect the project site.

G. Coastal Erosion

Coastal erosion is widespread along most of the West African coastline and the main areas include Abidjan Harbour in Ivory Coast, Keta Coast in Ghana, Lome Harbour in Togo, Cotonou Harbour in Benin and Lagos in Nigeria. Natural causes for erosion include low-lying coastal topography, intensity of wave and current climate, vulnerable soil characteristics and the nature of shelf width. At locations such as Lome, Cotonou, and Lagos, erosion is mainly caused by harbour and shoreline protection structures, such as moles.

Near Lagos, much of the sediment transported from the west is trapped by three breakwaters, known as 'harbour moles', constructed to protect the entrance to Lagos Harbour. One estimate reported 0.5 million m^3/year. As a result, Bar Beach on Victoria Island, located just to the east of the moles, has been eroding. The annual erosion rate was estimated between 25 m and 30 m for the period 1981 to 1985.

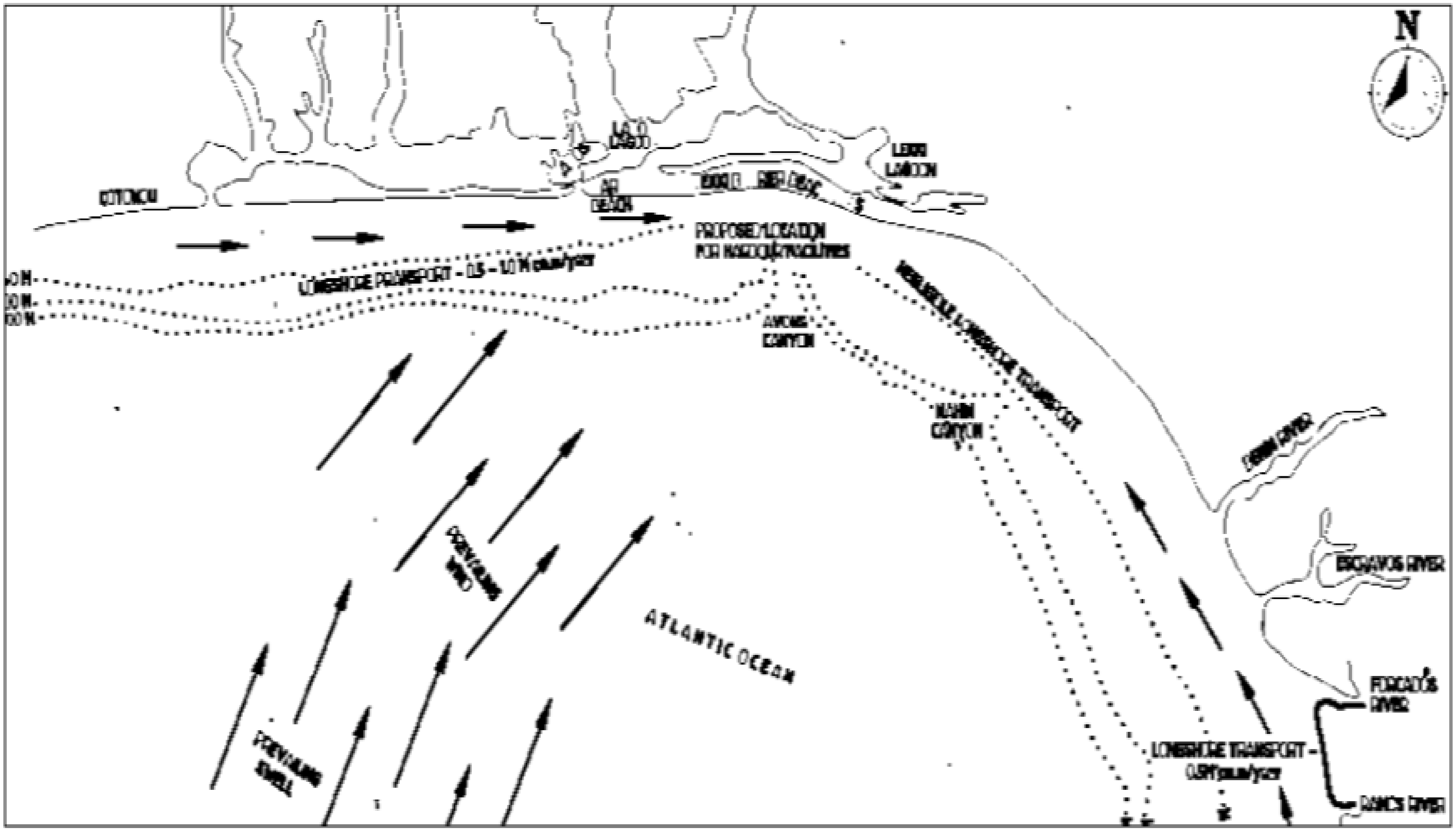


Figure 4.14: Longshore Sediment Transport along Western Nigeria Coast

4.3.4 Air Quality

A one-hour averaging period of monitored gaseous (VOC, CO, SO_2, NO, NO_2, NH_3, H_2S, CH_4 and O_3) pollutants concentrations in the wet and dry seasons are presented in Appendix 4.2. CH_4 was detected in the wet season while VOCs, NO, NH_3 and CH_4 were not detected in the dry season. These were extrapolated into daily equivalent for the repsctive pollutant gases (Table 4.4). The daily equivalents of SO_2 exceeded FMEnv daily limit of 0.01 ppm at AQ12 in wet season and AQ6 in dry season. H_2S also exceeded regulatory limits at three locations in wet season. All the other gaseous pollutants were within their respective regulatory limits.

CO, NO, NO_2, and SO_2 are combustion products, indicative of fossil fuel (in vehicles and electric power generators) and biomass burning. SO_2 and NO_2 have health implications and adverse effects on the environment and their present levels indicate some levels of degradation in the airshed. Though not conventional air pollutants, VOCs are toxics with short- and long-term adverse health. Ground level O_3 is formed in the atmosphere by photochemical reactions between NOx and VOCs. Breathing O_3 in the ambient environment may trigger health challenges in some classes of people including those with asthma, older adults and outdoor workers. The presence of H_2S in the area could be attributed to decomposition of sulphide vegetation aided by the presence of moisture in the atmosphere which is more of natural source than anthropogenic. Their detection in more locations during the wet season than in the dry season supports this suggested source.

Particulates including $PM_{2.5}$, PM_{10} and TSP were detected in all the sampling locations both in the wet and dry seasons (Appendix 4.2) and extrapolated daily equivalents presented in Table 4.4. The daily equivalents of the measured PM_{10} exceeded its regulatory limit in a location in the wet season (AQ13). $PM_{2.5}$ and TSP were within their respective regulatory limits in all locations both in the wet and dry seasons. In the study area, detected particulates could be from dust re-suspension, vehicular emissions, and other fuel combustion activities.

Investigated Airshed Classification

Since all the monitored air pollutants were within their limits in almost all the monitored locations in the wet and dry seasons, the proposed project area can be described as un-degraded airshed using the World Bank classification (World Bank, 1999). With this, the airshed has an excellent carrying capacity for anthropogenic activities in the two seasons.

Air Quality - AWBS (Wet Season, 2013) vs *Present EIA, 2021*

Air Quality assessment was undertaken in the project area to establish present air shed and investigate change that might have occurred over time. Tables 4.5 presents summary of two season results on air quality from both studies. As seen from the tables, gaseous pollutants are still at background levels and are by far, below regulatory limit. However, particulate matter in the project area was observed to have increase over time average concentrations ranging between and 48.1 – 122.3µg/m^3 with an average of 63.2µg/m^3.

Table 4.4: Daily Equivalents of Measured Gaseous Pollutants during the Study

Season	Station	Concentrations (ppm)									Particulates (µg/m^3)		
		VOC	CO	SO_2	NO	NO_2	NH_3	H_2S	CH_4	O_3	$PM_{2.5}$	PM_{10}	TSP
Wet Season	AQ1	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	15.1	42.8	46.6
	AQ2	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.00	0.00	11.1	38.5	50.8
	AQ3	0.00	0.00	0.00	0.00	0.00	0.06	0.02	0.00	0.00	10.3	29.3	34.9
	AQ4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.7	31.0	32.3
	AQ5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.6	28.4	28.7
	AQ6	0.08	1.08	0.00	0.00	0.00	0.06	0.01	0.00	0.00	9.3	40.0	57.4
	AQ7	0.06	2.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.8	23.4	26.6
	AQ8	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	9.2	21.5	24.7
	AQ9	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	14.4	45.7	62.7
	AQ10	0.08	3.44	0.01	0.00	0.00	0.00	0.02	0.00	0.00	8.1	32.1	45.7
	AQ11	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	9.6	27.7	36.5
	AQ12	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	7.2	44.8	61.3
	AQ13	0.08	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.01	22.0	114.7	149.5
	Mean	0.02	0.83	0.01	0.00	0.00	0.02	0.01	-	0.00	11.1	40.0	50.6
	Stdev	0.04	1.42	0.01	0.00	0.00	0.03	0.01	-	0.00	4.0	23.8	32.4
	AQ14 (Ctrl)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.01	24.0	62.0	71.0
Dry Season	AQ1	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	6.5	27.6	30.4
	AQ2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.5	49.5	74.5
	AQ3	0.00	0.15	0.00	0.00	0.02	0.00	0.00	0.00	0.04	8.9	42.0	54.2
	AQ4	0.00	1.69	0.00	0.00	0.00	0.00	0.01	0.00	0.00	10.0	46.7	60.5
	AQ5	0.00	0.51	0.01	0.00	0.00	0.00	0.00	0.00	0.04	8.1	33.9	42.2
	AQ6	0.00	0.51	0.02	0.00	0.00	0.00	0.00	0.00	0.00	9.9	36.9	45.8
	AQ7	0.00	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.03	8.8	40.6	67.4
	AQ8	0.00	1.90	0.01	0.00	0.00	0.00	0.00	0.00	0.00	9.4	36.7	38.3
	AQ9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.1	40.5	44.0
	AQ10	0.00	3.39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	11.3	41.1	52.2
	AQ11	0.00	0.51	0.01	0.00	0.00	0.00	0.00	0.00	0.00	9.1	58.6	76.3
	AQ12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.6	75.5	87.2
	AQ13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.2	57.8	64.1
	Mean	0.00	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.01	9.6	45.2	56.7
	Stdev	0.00	1.19	0.01	0.00	0.01	0.00	0.00	0.00	0.02	1.5	12.7	16.7
	AQ14 (Ctrl)	0.00	0.21	0.00	0.00	0.00	0.00	0.00	-	0.00	22.8	110.2	128.7
FMEnv Limit		1.60	10.0	0.01	0.04 – 0.06		0.28	0.01	-	0.10	25.0	80.0	250

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

Table 4.5: AWBS, 2013 vs Present EIA, 2021 Air Quality

Parameters	Min.	Max.	Avg.	Min.	Max.	Avg.	FMEnv Limit
	AWBS (Wet Season, 2013)			Present (Wet Season, 2021)			
SO_2	<0.1	<0.1	<0.1	0.0	0.07	0.03	0.01
NO_2	<0.01	<0.01	<0.01	0.0	0.004	0.0	0.04-0.06
CO	<0.1	1.0	<0.1	0.0	7.1	5.3	10.0
H_2S	<0.1	<0.1	<0.1	0.0	0.04	0.02	-
VOCs	<0.01	<0.01	<0.01	0.0	0.15	0.14	0.28
NH_3	<0.1	4.0	1	0.0	0.13	0.12	1.9
TSP	27.1	114.2	47.01	48.1	122.3	63.2	250
	AWBS (Dry Season, 2013)			Present (Dry Season, 2021)			
SO_2	<0.1	<0.1	<0.1	0.0	0.03	0.01	0.01
NO_2	<0.01	<0.01	<0.01	0.0	0.06	0.01	0.04-0.06
CO	<0.1	<0.1	<0.1	0.0	5.7	1.7	10.0
H_2S	<0.1	<0.1	<0.1	0.0	0.02	0.002	-
VOCs	<0.01	<0.01	<0.01	0.0	0.0	0.0	0.28
NH_3	<0.1	<0.1	<0.1	0.0	0.0	0.0	1.9
TSP	44.85	215.7	84.99	59.2	170.0	110.5	250

Ambient Noise Levels

The measured day-time ambient noise levels obtained during the fieldwork are summarized in Table 4.6. The background levels were within the 90 dB(A) FMEnv's 8-hour limit and within the 70 dB(A) World Bank Industrial Areal limit in all the sampling locations in the two seasons (Figure 4.15). However, the 55 dB(A) day-time World Bank limit was breached by the background noise in two locations in the wet season but in a location in the dry season. The identified major sources of noise during the two seasons were commercial activities, vehicles and electric power generators.

Table 4.6: Measured Day-Time Ambient Noise Levels during the Study

Season	Sampling Station	Levels, dB(A)		
		Minimum (L_{Min})	Maximum (L_{Max})	Background (L_{90})
Wet Season	AQ1	47.7	68.2	49.3
	AQ2	42.7	47.5	42.8
	AQ3	35.4	40.7	35.6
	AQ4	37.0	44.3	37.1
	AQ5	40.3	44.6	40.4
	AQ6	51.1	55.3	51.5
	AQ7	45.6	51.6	46.3
	AQ8	52.5	62.1	55.0
	AQ9	59.7	68.7	60.0
	AQ10	38.9	47.5	39.9
	AQ11	35.2	39.8	37.0
	AQ12	35.1	41.1	35.3
	AQ13	61.7	79.3	62.3
	AQ14 (Ctrl)	34.2	38.9	35.6
Dry Season	AQ1	36.4	44.6	37.7
	AQ2	29.7	41.4	32.9

	AQ3	32.3	46.1	38.9
	AQ4	33.4	45.1	35.8
	AQ5	36.8	46.7	37.7
	AQ6	41.3	64.6	43.5
	AQ7	32.4	50.9	39.4
	AQ8	38.6	42.5	61.2
	AQ9	44.2	53.1	44.9
	AQ10	38.7	52.1	42.4
	AQ11	37.8	66.9	40.4
	AQ12	-	-	-
	AQ13	-	-	-
	AQ14 (Ctrl)	54.9	41.8	43.5
FMEnv Limit		-	-	90.0

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

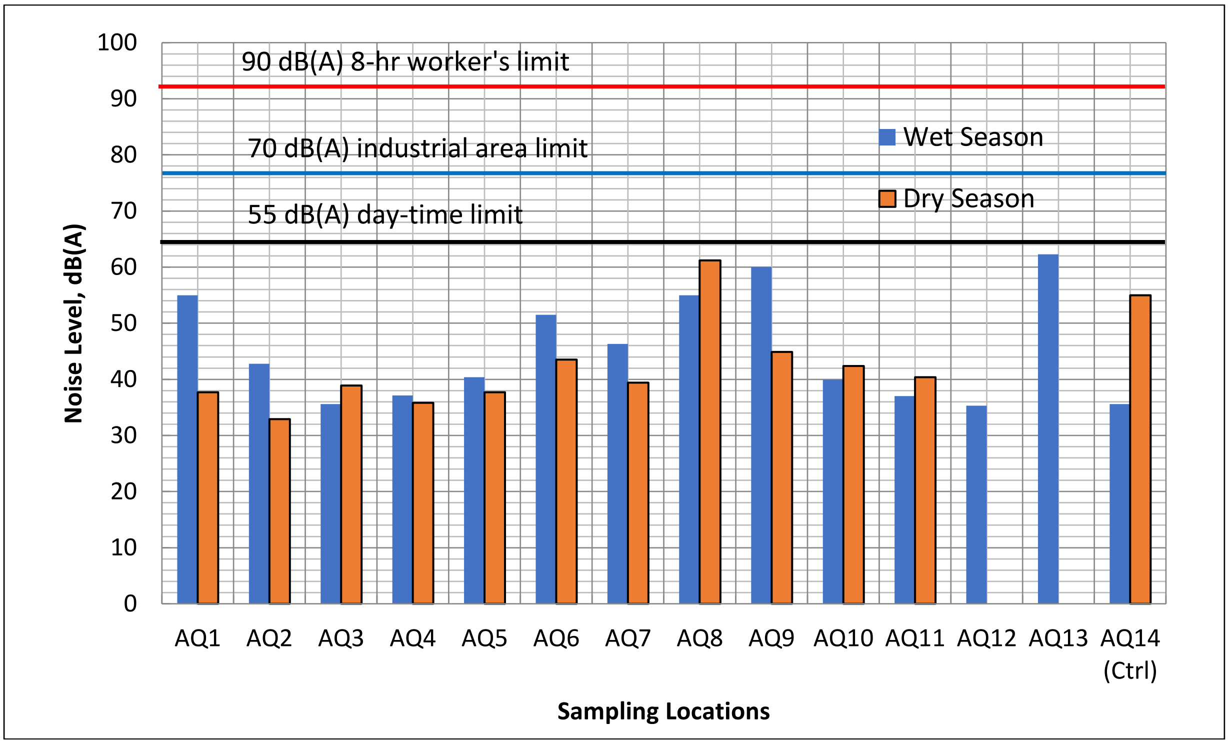


Figure 4.15: Background Noise Levels in the Proposed Project Area

Noise Level Comparison

Based on the AWBS, measured minimum and maximum noise levels in the project area ranged between 20.0 – 47.8 dB(A) and 39.7 – 79.8 dB dB(A) respectively for the wet season while in the present study it varied between 35.1 – 61.7 dB(A), for minimum levels and 39.8 – 79.3dB(A) for maximum levels indicating an increase in noise level in the project area.

4.3.5 Soil Characteristics

Physico-Chemical Characteristics

The physico-chemical characteristics of the prescribed soils – surface (0 – 15cm) and subsurface (15 – 30cm) are presented in this sub-section and summarized in Table 4.7.

Soil pH

Soil pH is fundamental to the understanding of soil systems. It is an indicates soil reactions in the soils (Moore and Loeppert, 1987; SSSA, 2001), soil properties involved in plant growth and soil exchangeable cations. Most arable crops suit the range of slightly acidic to slightly alkaline soil pH – 6 to 7.5. A pH value lower than 5.5 is undesirable and requires ameliorative lime treatment.

Table 4.7 shows that all the soils across the sampled area exhibited both acidity and alkalinity. The huge spatial variation in soil pH across the Free Zone may be due to the introduction of soils from various sources to sandfill and reclaim land across the zone.

Electrical Conductivity

Soil electrical conductivity (EC) is the ability of soil to conduct electric current. It is influenced by the concentration and composition of dissolved salts in soil. The moderate electrical conductivity correlates the background concentrations.

Soil Texture / Particle Size Analysis

Soil particle size distribution (PSD) investigations carried out on samples obtained shows that the soils sampled in the area is predominantly sandy in both surface and subsurface soils. The textural triangle for limits of sand, silt, and clay contents of soils around the project area shows that the soils contain a higher percentage of sand (>69%) across the sampled locations at both the topsoil and subsoil depth.

Anion and Cations

Anions and cation concentrations determine the nutrient status of the soil. The anions measured include Cl^-, SO_4^{2-}, PO_4^{3-} and NO_3^-. These parameters vary in concentration across each sampled location (Table 4.7). Cl^- was highest while PO_4^{3-} was least encountered anions. The excahngable cholrides in the study area follow the order Na>Ca>Mg>K. The high occurrence of sodium and chloride could be linked to influences from the marine environment.

Total Organic Carbon (TOC)

Total organic carbon is a measure of the carbon contained within soil organic matter. TOC influences many soil characteristics including colour, nutrient holding capacity, nutrient turnover and stability, which in turn influence water relations, aeration and workability.

Heavy Metals

The soil heavy metals measured are iron (Fe), copper (Cu), chromium (Cr), zinc (Zn), cadmium (Cd), lead (Pb), arsenic (As), manganese (Mn) and nickel (Ni). The summary of the result of heavy metal concentration across the sampled locations is presented in Table 4.7.

Table 4.7: Physicochemical Properties of Soil in the Project Area

PARAMETERS	Wet season								Dry season							
	Topsoil (0-15 cm)				Sub-Surface (15-30 cm)				Topsoil (0-15 cm)				Sub-Surface (15-30 cm)			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
pH	3.10	8.90	6.63	1.40	3.10	8.40	6.19	1.67	4.1	8.6	7.24	1.10	4.7	8.21	6.89	1.31
Conductivity (µs/cm)	40.20	570.00	127.32	111.46	16.30	364.00	104.55	86.53	37	338	125.23	67.74	36	334	127.16	84.08
TOC (%)	0.14	1.50	0.58	0.25	0.20	0.90	0.49	0.18	0.1	1.3	0.34	0.24	0.1	0.9	0.38	0.21
THC (mg/kg)	0.10	1.30	0.43	0.29	0.10	0.70	0.25	0.12	0.1	1.6	0.52	0.37	0.005	0.7	0.20	0.13
Sand (%)	80.60	100.00	96.13	5.13	69.40	99.70	95.69	6.19	85.1	99.4	96.51	3.64	86.5	99.6	97.02	2.98
Silt (%)	0.00	17.20	3.28	4.75	0.00	22.50	3.54	5.25	0.5	14.6	3.06	3.49	0.3	18.2	2.66	3.35
Clay (%)	0.00	3.40	0.64	0.71	0.00	12.10	0.74	1.70	0	1.6	0.42	0.38	0	1.4	0.45	0.36
Nitrate (mg/kg)	5.00	13.30	8.63	1.80	3.70	11.00	7.63	1.92	3.2	14.32	8.28	2.57	3	11	6.32	2.08
Sulphate (mg/kg)	19.50	69.30	49.12	12.98	0.50	60.90	38.73	19.34	10.5	61	31.46	16.85	0.5	50	27.97	14.40
Phosphate (mg/kg)	0.10	10.50	2.46	3.37	0.05	10.50	2.23	3.49	0.05	9.5	1.92	2.63	0.1	9.5	1.92	3.05
Chloride (mg/kg)	47.62	3378.60	185.85	469.83	30.60	205.80	91.04	41.88	73.5	3678.6	210.91	507.67	35.8	305.8	127.74	64.45
Ammonia(mg/kg)	3.80	35.00	11.64	7.58	3.80	25.00	8.97	5.06	2.1	33	9.98	6.97	2.7	21	7.53	4.60
Magnesium (mg/kg)	0.03	1.33	0.37	0.41	0.03	1.33	0.34	0.42	0.02	1.65	0.40	0.51	0.01	1.15	0.33	0.39
Calcium (mg/kg)	0.06	1.61	0.87	0.45	0.06	1.54	0.96	0.45	0.08	1.47	0.76	0.45	0.02	1.9	0.95	0.47
Sodium (mg/kg)	<0.001	4.45	2.53	1.13	<0.001	4.45	2.65	1.01	1.01	5.7	3.00	1.63	1.2	14.45	6.47	5.43
Potassium (mg/kg)	<0.001	<0.003	-	-	<0.002	<0.002	-	-	<0.002	<0.003			<0.002	<0.003		
Arsenic	<0.05	<0.05	<0.05	<0.05	0.05	-	<0.05	<0.05	<0.01	<0.05	-	-	<0.01	<0.05	-	-
Cadmium (mg/kg)	<0.001	<0.05	<0.001	<0.05	-	-	<0.001	<0.05	<0.001	<0.03	-	-	<0.001	<0.05	-	-
Chromium (mg/kg)	0.05	0.32	0.05	0.32	0.15	0.07	0.05	0.33	0.05	0.3	0.14	0.05	0.005	0.3	0.12	0.06
Copper (mg/kg)	0.01	4.70	0.01	4.70	2.06	1.74	0.02	5.20	0.01	3.7	1.21	1.45	0.07	3.2	1.45	0.64
Iron (mg/kg)	3.50	96.60	3.50	96.60	49.72	36.48	25.40	81.50	4.35	95.5	50.24	35.72	30.02	97.4	70.37	19.32
Nickel (mg/kg)	<0.01	0.05	<0.01	0.05	0.02	0.01	<0.01	0.05	<0.01	0.05	-	-	<0.01	0.03	-	-
Lead (mg/kg)	<0.01	0.01	<0.01	0.01	-	-	<0.01	0.01	<0.01	0.01	-	-	<0.01	0.01	-	-
Zinc (mg/kg)	0.03	3.12	0.03	3.12	1.14	0.88	0.05	2.52	0.02	2.19	0.61	0.61	0.05	1.52	0.69	0.54
Manganese (mg/kg)	<0.001	2.05	<0.001	2.05	1.82	0.21	<0.002	2.05	<0.002	1.5	-	-	<0.002	1.7	-	-

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)

Soil Microbiological Properties

The micro-organisms of concern were fungi and bacteria and soil macro-fauna. They are an important role in the transformation of organic matter and in the transformation of soil nutrients.

Results of Hydrocarbon Utilising Bacteria (HUB in cfu/mg), Hydrocarbon Utilising Fungi (HUF in cfu/mg), Total Heterotrophic Bacteria (THB in cfu/mg), Total Fungi (TF in cfu/mg) and Coliform analysis are shown in Table 4.8 below.

Table 4.8: Summary of Microbiology in the Project Area

Parameters	Wet Season				Dry Season			
	Top Soil (0-15 cm)		Sub-Surface Soil (15-30 cm)		Top Soil (0-15 cm)		Sub-Surface Soil (15-30 cm)	
	Min	Max	Min	Max	Min	Max	Min	Max
THB × 10^3 (cfu/g)	1.0	4.08	0.10	3.3	1	4.1	0.1	3.08
THF × 10^2 (cfu/g)	1.1	4.5	1.0	5.0	1	4.7	1	5
HUF × 10^1 (cfu/g)	ND	3.9	1.0	4.3	0.5	4.5	0.5	4.3
HUB × 10^2 (cfu/g)	0.5	8.8	1.0	8.8	ND	8.8	0.5	8.7
Coliform × 10^2 (cfu/g)	2.0	7.7	1.1	7.1	1	6.7	0.1	7

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)

Comparison with Previous Site Data

Current site measurements were compared to existing site data gathered in 2013. There are no significant changes in the physical and chemical properties of the soil between 2013 and the current site investigations in 2020. (Table 4.9).

Table 4.9: AWBS, 2013 vs Present EIA, 2021 Soil Quality (Wet Season)

Parameters		Surface Soil Samples (Previous)			Surface Soil Samples (Present)			Sub-Surface Soil Samples (Previous)			Sub-Surface Soil Samples (Present)		
		Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Clay		0.03	1.73	0.57	0.00	17.20	3.28	0.03	1.87	0.61	0.00	12.10	0.74
Silt		1.00	6.1	3.27	0.00	3.40	0.64	1.00	5.5	3.14	0.00	22.50	3.54
Sand		93.2	98.3	96.1	80.60	100.00	96.13	94.1	97.8	96.1	69.40	99.70	95.69
pH		7.38	8.33	7.85	3.10	8.90	6.63	7.14	8.37	7.88	3.10	8.40	6.19
EC (µS/cm)		31	292	94.78	40.20	570.00	127.32	33	297	95.20	16.30	364.00	104.55
TOC (%)		0.14	0.43	0.29	0.14	1.50	0.58	0.17	0.53	0.32	0.20	0.90	0.49
THC	(mg/kg)	0.11	1.36	0.30	0.10	1.30	0.43	0.08	1.36	0.28	0.10	0.70	0.25
Cl		15	30	22.90	47.62	3378.60	185.85	18	32	25.23	30.60	205.80	91.04
NO_3		5.78	15.4	9.5	5.00	13.30	8.63	5.78	15.4	10.1	3.70	11.00	7.63
SO_4		7.13	20.12	14.10	19.50	69.30	49.12	9.01	19.21	13.38	0.50	60.90	38.73
PO_4		0.01	1.98	0.35	0.10	10.50	2.46	0.02	1.29	0.31	0.05	10.50	2.23
Mg		0.00	0.81	0.13	0.03	1.33	0.37	0.009	0.914	0.17	0.03	1.33	0.34
K		0.00	0.00	0.00	<0.001	<0.003	<0.003	0.000	0.000	0.00	<0.002	<0.002	<0.002
Na		0.40	4.90	2.40	<0.001	4.45	2.53	0.01	4.70	2.34	<0.001	4.45	2.65
Ca		0.69	1.82	1.32	0.06	1.61	0.87	0.78	1.99	1.40	0.06	1.54	0.96
Pb		0.00	0.00	0.00	<0.01	0.01	0.00	0.00	0.00	0.00	<0.01	0.01	0.01
Cu		0.00	0.83	0.15	0.01	4.70	2.06	0.00	0.91	0.12	0.02	5.20	2.54
Fe		1.07	15.98	6.44	3.50	96.60	49.72	2.109	49.71	7.64	25.40	81.50	57.61
Mn		0.00	0.00	0.00	<0.001	2.05	1.82	0.00	0.00	0.00	<0.002	2.05	1.72
Cd		0.00	0.00	0.00	<0.001	<0.05	0.00	0.00	0.00	0.00	<0.001	<0.002	<0.001
Ni		0.00	0.07	0.02	<0.01	0.05	0.02	0.01	0.05	0.02	<0.01	0.05	0.02
Zn		0.01	0.31	0.14	0.03	3.12	1.14	0.01	0.33	0.16	0.05	2.52	1.13

4.3.6 Aquatic Ecosystem

A. Groundwater Physico-chemical Characteristics

The comparative results for groundwater (Table 4.10) for both seasons and relevant acceptable standards are presented thus: -

Table 4.10: Summary of physico-chemical characteristics of the groundwater samples within the project area in Dry and Wet seasons.

Parameter	Wet Season		Dry Season		AWBS	NSDQW
	Min - Max	Mean ± SD	Min - Max	Mean ± SD	Mean	
Temp (°C)	27.07 - 29.14	27.57 ± 0.55	27.9 - 32	29.26 ± 0.96	28.91	Ambient
pH	6.2 - 8.2	7.18 ± 0.53	5.77 - 8.1	6.84 ± 0.82	6.72	6.5-8.5
Conductivity (mS/cm)	0.08 - 0.36	0.18 ± 0.09	0.04 - 0.27	0.12 ± 0.07	0.17	1000
Turbidity (NTU)	2.19 - 57.9	37.14 ± 13.25	0.94 - 14.13	7.49 ± 4.01	0.92	5
DO (mg/L)	5.83 - 16.45	8.86 ± 3.03	8.35 - 19.09	13.33 ± 3.45	9.98	-
TDS (g/L))	0.05 - 0.23	0.12 ± 0.06	0.023 - 0.16	0.07 ± 0.04	0.11	500
Salinity (ppt)	0 - 0.2	0.10 ± 0.06	0.1	0.10 ± 0.00	0.09	
BOD	2.6 - 7.5	4.44 ± 1.37	3.6 - 6.8	4.69 ± 0.93	4.48	-
COD	102 - 220	127.57 ± 37.65	112 - 250	144.86 ± 40.57	726.86	-
Chloride (mg/L)	21 - 63	43.43 ± 13.03	50.1 - 85.2	68.05 ± 9.29	51.57	250
Nitrate (mg/L)	3.01 - 6.6	4.80 ± 1.47	0.2 - 1.9	1.25 ± 0.43	3.97	50
Phosphate (mg/L)	0.05 - 0.65	0.33 ± 0.20	0.15 - 0.8	0.48 ± 0.19	0.30	-
Sulphate (mg/L)	11.16 - 16.5	12.71 ± 1.56	12.2 - 26.5	19.71 ± 5.01	12.11	100
Total Hardness (mg/L)	0.017 - 7.13	1.71 ± 2.37	0.06 - 6.12	1.73 ± 1.93	1.89	150
THC (mg/L)	0.01 - 1.06	0.36 ± 0.46	<0.01	<0.01	0.22	-
Calcium (mg/L)	<0.001 - 1.61	0.48 ± 0.46	<0.001 - 0.88	0.49 ± 0.28	0.48	-
Magnesium(mg/L)	<0.001 - 1.65	0.32 ± 0.65	<0.0002	<0.0002	1.73	0.20
Sodium(mg/L)	6.95 - 21.3	12.29 ± 4.15	16.95 - 25.5	21.20 ± 2.68	16.00	200
Iron (mg/L)	<0.003 - 1.215	0.19 ± 0.43	0.01 - 0.15	0.11 ± 0.04	0.31	0.3
Manganese (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.002	0.2
Zinc (mg/L)	<0.001	<0.001	<0.002	<0.002	<0.001	<3
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Chromium (mg/L)	0.001 - 0.003	-	0.001 - 0.002	-		0.05
Copper (mg/L)	0.02 - 0.07	0.05 ± 0.01	0.04 - 0.08	0.06 ± 0.01	0.04	1
Arsenic (mg/L)	<0.001	-	<0.001	<0.001		0.01
Nickel (mg/L)	0.01 - 1.51	0.44 ± 0.59	0.031 - 0.61	0.28 ± 0.18	0.33	0.02
Lead (mg/L)	<0.01	<0.01	<0.01 - <0.01	-	<0.01	-

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

NSDQW: National standards of drinking water

Min: Minimum Max: Maximum SD: Standard Deviation

Temperature

The average groundwater temperature measured across the sampled locations within the monitoring period was 27.57 ± 0.55°C in the wet season while for dry season, was 29.26 ± 0.96°C.

pH

The groundwater pH values recorded in both seasons across the site were all within the NSDWQ limits of 6.5 - 8.5, except at OKE1 in wet season vand ALA2, IDO1, IDO2 and ITO1 in dry season. The higher pH values recorded in the dry season could be because of rain-fed freshwater percolation during the wet season.

Turbidity

Water turbidity is a measure of its cloudiness using the intensity of light passing through it as suspended or colloidal matter reduces transmittance (McKee and Wolf, 1963). The turbidity recorded for the groundwater sources sampled exceeded the NSDWQ permissible limits (5 NTU) at all the sampled stations except at ALA1, ALA2 and IDO1 during both seasons respectively.

Total Dissolved solids

Total dissolves solids (TDS) in water consist of dissolved mineral salts that change the physical and chemical properties of the water. The TDS values recorded during this study were within the NSDWQ limits. The potability of water with a total dissolved solids (TDS) level of less than about 0.6 g/L is generally considered to be good (WHO, 2017).

Oxygen Parameters - DO, BOD and COD

Dissolved oxygen (DO) concentration has a significant effect on ground water quality by regulating the valence state of trace metals and by constraining the bacterial metabolism of dissolved organic species. Healthy water generally have dissolved oxygen concentrations within 6.5-8 mg/L (WHO, 2013). While high DO level in makes drinking water taste better, it could speed up corrosion in water pipes. All sampled groundwater are from dug wells and not a piping system, hence there is no issues with high DO.

DO is inversely related with Biochemical oxygen Demand (BOD) and chemical oxygen demand (COD). The range of the BOD values recorded across the site was relatively low. These BOD values do not indicate a pure and portable water source but moderately usable source.

Electrical Conductivity (EC)

Electrical conductivity of a liquid medium depends on the presence of ions, their total concentration, valence relative concentration and the temperature of water. The most desirable limit of EC in drinking water is prescribed as 0.25 mS/cm (WHO 2004). The results excced this limit indicating higher presence of impurities and chemicals in the water source.

Salinity
Salinity is a measure of the total amount of dissolved salts in a water body. The anions and cations that make up the salinity of a water body include chloride, sodium, sulphate, magnesium, calcium, and potassium. Measured salinity values ranged between 0.0 and 0.2ppt in the wet season while a uniform value of 0.1 ppt was recorded across the sampled stations in dry season.

Chloride
Chloride occurs in varying concentrations in all-natural water. The chloride content normally increases as the mineral content increases. Chlorides are important in detecting the contamination of groundwater by wastewater. Chloride concentrations in excess of about 250 mg/litre can give rise to detectable taste in water, but the threshold depends upon the associated cations. The fourteen sampled sources recorded low chloride ranges in both seasons; all within acceptable limits.

Nitrate
Nitrate represent the most oxidized form of nitrogen. It is one of the most common groundwater contaminants in rural areas. It is regulated in drinking water primarily because excess levels can cause methemoglobinemia, or "blue baby" disease. The concentrations recorded in both seasons across the sampled groundwater sources were well within the maximum permissible limit of WHO (10mg/L).

Sulphate
Sulphate is a major anion in groundwater system and varies from 1 to 2000 ppm depending upon the topography and geologic conditions of the area The measured sulphate concentrations were within WHO drinking water standard in both seasons.

Basic Metals -Ca, Mg, Na
Calcium and Magnessium impacts the property of hardness to water. The geology of the water source is largely the source of hardness, although some industrial effluents if they find a means to percolate could contribute to hardness. The recorded concentration of calcium in both seasons were below WHO limit of 200 mg/L. Magnesium values were above the acceptable drinking water standard (0.2mg/L) at OKU1, IDO1 and OKE2 in wet season.
The sodium ion is ubiquitous in water. Most water supplies contain less than 20 mg of sodium per litre. Marine intrusion, mineral deposits, seawater spray, and sewage effluents, significant quantities of sodium to water. Salty tastes are observed in water with sodium concentrations greater than 180mg/L. The values recorded across the sampled locations were below 180 mg/L.

Heavy Metals
Heavy metals are among the major contaminants of groundwater sources. Some of these heavy metals are essential for the growth, development, and health of living organisms, whereas others are non-essential as they are indestructible and most of them are categorized as toxic species on organisms. The heavy metal analyzed in the sampled

groundwater sources includes Arsenic (As), Cadmium (Cd) Chromium (Cr), Copper (Cu), iron (Fe), Manganese (Mn), Zinc (Zn), Lead (Pb) and Nickel (Ni).

The result of heavy metal characteristics of the groundwater sources sampled in both seasons within the LFZ project host communities is presented in Table 4.10. There is no exceedance of regulatory limits for all the heavy metals tested.

Microbiological Properties

The groundwater samples were analysed for heterotrophic bacteria (including coliforms), fungi and hydrocarbon utilizing bacteria and fungi. The results are presented in Table 4.11 below. The result shows that the ground water samples were entirely free from HUF. However, the loads of THB, HUB, THF and total coliform varied across the sampled groundwater sources which indicates the presence of microbial counts in the water source.

Table 4.11: Summary of Microbial Characteristics of the Groundwater Samples Within the Project Area

Parameter	Wet Season		Dry Season		NSDQW
	Min - Max	Mean ± SD	Min - Max	Mean ± SD	
THB (cfu/ml) x 10^2	1 - 4.2	2.48 ± 0.90	1 - 3.5	1.98 ± 0.83	-
Coliform (cfu/ml) x 10^1	1 - 4.5	2.66 ± 1.16	1.1 - 3.5	2.16 ± 0.78	-
HUF (cfu/ml)	ND	ND	ND	ND	-
HUB (cfu/ml) x 10^1	0.5 - 1.8	1.23 ± 0.33	1 - 2.7	1.72 ± 0.54	-
THF (cfu/ml) x 10^1	0.5 - 1.7	1.10 ± 0.34	0.5 - 2.7	1.25 ± 0.64	-

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)
NSDQW: National standards of drinking water, Min: Minimum, Max: Maximum, SD: Standard Deviation

B. Surface Water Properties

The main surface water bodies in the Zone are the Lekki Lagoon (freshwater) and the Atlantic Ocean (marine water). The results of some physical, chemical and microbiological parameters of surface waters of the study area are presented in Table 4.12 and Table 4.13.

Temperature

Surface water temperature is often time influenced by the time of the day and amount of heat absorbed from the sun. The mean measured temperatures in wet and dry season in the Atlantic and Lagoon environment were within the WHO (35°C) recommendations.

pH

The pH of water is a measure of the acid–base equilibrium and, in most natural waters, is controlled by the carbon dioxide–bicarbonate–carbonate equilibrium system.

Most aquatic organisms have a narrow pH tolerance range of 6.5 – 8.5 which also reflects the recommended limit set by FMEnv and WHO. Acidic waters can cause toxic heavy metals to be released into the water. The measured pH values for the Lekki Lagoon and Atlantic Ocean are basic as is expected of marine water body (Badejo *et al.,* 2014).

Electrical Conductivity (EC)

Electrical conductivity, which is a measure of the ionic richness of water bodies was high in the marine water samples and low in brackish water for both seasons. The measured EC is related to the soluble salt content of the water samples.

Table 4.12: Summary of Physico-Chemical Characteristics of Lekki Lagoon Surface Water Samples.

Parameter	Wet Season		Dry Season		AWBS	Limits	
	Min - Max	Mean	Min - Max	Mean		FMEnv	WHO
Temp (°C)	26.41 - 27.63	27.02 ± 0.41	30.04 - 31.47	30.46 ± 0.53	31.03 - 31.84	30	35
pH	7.84 - 8.48	8.12 ± 0.20	6.88 - 7.76	7.11 ± 0.31	7.03 - 7.95	6.5-8.5	6.5-8.5
Conductivity (mS/cm)	0.513 - 0.65	0.61 ± 0.05	0.136 - 0.27	0.23 ± 0.05	0.17 - 0.43	NS	NS
Turbidity (NTU)	34.5 - 62.7	44.14 ± 9.44	8.15 - 16.5	11.72 ± 2.99	0.00	NS	NS
DO (mg/L)	10.24 - 14.79	12.22 ± 1.45	10.05 - 15.74	13.51 ± 2.20	6.48 - 11.92	>3.5	7.5
TDS (g/L))	0.329 - 0.42	0.39 ± 0.03	0.081 - 0.18	0.15 ± 0.04	0.11 - 0.28	0.5	0.5
Salinity (ppt)	0.2 - 0.3	0.29 ± 0.04	0.1 - 0.1	0.10 ± 0.00	0.10 - 0.20		
BOD	3.6 - 10.2	6.04 ± 2.30	6.1 - 7.5	6.63 ± 0.55	1.30 - 7.20	NS	10
COD	265 - 511	384.86 ± 102.5	20 - 32	24.86 ± 4.06	35.00 - 2180.00	20	NS
Chloride (mg/L)	172.9 - 207.4	189.20 ± 12.6	101.1 - 109.9	105.14 ± 3.01	31.00 - 60.00	250	200
Alkalinity (mg/L)	-	-	8 - 16	12.00 ± 2.65			
Nitrate (mg/L)	56.3 - 78	65.20 ± 7.70	3.6 - 13.7	6.51 ± 4.33	3.61 - 5.93	-	-
Phosphate (mg/L)	7.5 - 8.4	8.08 ± 0.29	0.01 - 0.04	0.02 ± 0.01	0.03 - 0.62	10	10
Sulphate (mg/L)	0.01 - 0.08	0.03 ± 0.03	8 - 15	11.14 ± 2.41	10.15 - 12.90	5	NS
Total Hardness (mg/L)	20 - 29	25.00 ± 3.27	35 - 45	41.14 ± 3.44	0.01 - 7.26	500	200
THC (mg/L)	0.7 - 0.91	0.79 ± 0.07	2.3 - 4.02	3.13 ± 0.67	0.11 - 1.06	NS	NS
Calcium (mg/L)	9.2 - 16.2	12.04 ± 2.43	7.85 - 9.02	8.36 ± 0.36	0.16 - 0.68	200	NS
Magnesium	0.1 - 0.16	0.13 ± 0.03	3.4 - 4.06	3.72 ± 0.25	1.69 - 1.77		
Sodium	12.1 - 15.4	14.04 ± 1.10	-	-	6.61 - 29.21	200	
Iron (mg/L)	0.42 - 0.49	0.46 ± 0.02	0.01 - 0.11	0.07 ± 0.04	1.09 - 1.28	1	0.1
Manganese	0.105 -	0.11 ± 0.01	0.14 - 0.26	0.20 ± 0.06	<0.002	0.05	NS

Parameter	Wet Season		Dry Season		AWBS	Limits	
	Min - Max	Mean	Min - Max	Mean		FMEnv	WHO
(mg/L)	0.121						
Zinc (mg/L)	0.12 - 0.18	0.16 ± 0.02	<0.001	<0.001	<0.001	5	5
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.002	0.01	NS
Chromium (mg/L)	<0.001	<0.001	0.022 - 0.05	0.04 ± 0.01		0.05	0.05
Copper (mg/L)	0.11 - 0.13	0.12 ± 0.01	0.001 - 0.01	0.01 ± 0.00	0.05 - 0.08	0.1	0.05
Arsenic (mg/L)	<0.001	<0.001	<0.001	<0.001		0.1	0.01
Nickel (mg/L)	0.58 - 1.66	0.96 ± 0.43	0.02 - 0.05	0.04 ± 0.01	0.06 - 1.05	1.0	0.1
Lead (mg/L)	<0.01 - <0.03	-	<0.001	<0.001	<0.01	0.05	0.05

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)
NS; Not stated SD- Standard Deviation Min – Minimum Max-Maximum

Table 4.13: Summary of physico-chemical characteristics of the Atlantic surface water samples.

Parameter	Wet Season		Dry Season			Limits	
	Min - Max	Mean				FMEnv	WHO
Temp (°C)	24.84 - 25.7	25.13 ± 0.34	29.06 - 29.49	29.29 ± 0.17	29.16 - 29.69	30	35
pH	8.45 - 8.93	8.69 ± 0.16	8.71 - 8.9	8.78 ± 0.07	8.10 - 8.33	6.5-8.5	6.5-8.5
Conductivity (mS/cm)	42.9 - 100	66.79 ± 21.39	92.7 - 97.1	94.47 ± 1.69	25.90 - 42.00	NS	NS
Turbidity (NTU)	43.9 - 50.4	48.13 ± 2.43	18.2 - 29.7	24.79 ± 4.08	0.00	NS	NS
DO (mg/L)	4.38 - 18.68	9.84 ± 5.20	5.85 - 8.38	7.40 ± 0.85	5.02 - 13.03	>3.5	7.5
TDS (g/L))	12.85 - 60	36.54 ± 16.68	52 - 56.3	55.44 ± 1.53	14.70 - 25.60	0.5	0.5
Salinity (ppt)	36.4 - 70	50.21 ± 14.06	60.8 - 67.3	65.57 ± 2.60	15.70 - 26.90		
BOD	6.5 - 10.4	8.10 ± 1.31	7.5 - 10.6	8.77 ± 1.11	3.30 - 11.50	NS	10
COD	550 - 680	604.86 ± 41.69	550 - 690	637.86 ± 44.71	1700.00 - 8720.00	20	NS
Chloride (mg/L)	994 - 12350	9877.7 ± 3990.8	12300 - 14500	13449.14 ± 724.04	10.25 - 2002.00	250	200
Alkalinity (mg/L)	-	-	74.4 - 89.3	84.09 ± 4.97			
Nitrate (mg/L)	75.4 - 83.2	80.66 ± 2.63	0.6 - 1	0.77 ± 0.14	3.49 - 5.81	-	-
Phosphate (mg/L)	0.4 - 0.8	0.57 ± 0.13	0.1 - 0.2	0.15 ± 0.05	0.07 - 0.62	10	10
Sulphate (mg/L)	0.05 - 0.1	0.07 ± 0.03	316 - 494	406.57 ± 75.92	10.44 - 10.96	5	NS
Total Hardness	312 - 474	392.00 ± 69.20	8.5 - 15.1	10.94 ± 2.10	28.91 -	500	200

Parameter	Wet Season		Dry Season			Limits	
	Min - Max	Mean				FMEnv	WHO
(mg/L)					52.63		
THC (mg/L)	0.51 - 0.65	0.59 ± 0.05	0.12 - 0.3	0.20 ± 0.06	0.11 - 0.21	NS	NS
Calcium (mg/L)	7.2 - 14.2	10.19 ± 2.15	0.5 - 0.8	`0.62 ± 0.10	0.41 - 6.04	200	NS
Magnesium	0.05 - 0.15	0.10 ± 0.04	5.5 - 7.8	6.66 ± 0.99	4.91 - 9.13		
Sodium	0.3 - 0.65	0.45 ± 0.11	-	-	26.25 - 31.55	200	
Iron (mg/L)	0.32 - 0.67	0.48 ± 0.11	0.35 - 0.7	0.53 ± 0.12	0.32 - 7.00	1	0.1
Manganese (mg/L)	<0.001	<0.001	<0.001 - <0.001	<0.001	<0.002	0.05	NS
Zinc (mg/L)	<0.001 - 0.15	0.06 ± 0.06	0.05 - 0.12	0.07 ± 0.034	0.10 - 0.11	5	5
Cadmium (mg/L)	<0.01	<0.01	<0.01	<0.01	0.08 - 0.09	0.01	NS
Chromium (mg/L)	<0.001	<0.001	<0.01	<0.01		0.05	0.05
Copper (mg/L)	0.1 - 0.15	0.12 ± 0.03	0.1 - 0.2	0.15 ± 0.04	0.03 - 0.07	0.1	0.05
Arsenic (mg/L)	<0.001	<0.001	<0.001	<0.001		0.1	0.01
Nickel (mg/L)	1.15 - 1.61	1.40 ± 0.19	1.2 - 1.71	1.45 ± 0.19	0.21 - 1.79	1.0	0.1
Lead (mg/L)	<0.03 - <0.05	-	<0.01 - <0.03	-	0.78 - 0.96	0.05	0.05

Total Dissolved Solids (TDS)

The average TDS concentration in the lagoon samples was 0.39 ± 0.033 (g/L) in wet season and 0.15 ± 0.04g/L in dry season across the seven sampled stations on the Lekki Lagoon. However, in the Atlantic source, the TDS average concentration was 36.54 ± 16.684g/L in wet season and 55.44 ± 1.54g/L in dry season. Average concentrations of the marine samples were above limit.

Salinity

Salinity is a measure of the total amount of dissolved salts in a water body. The anions and cations that make up the salinity of a water body include chloride, sodium, sulphate, magnesium, calcium and potassium. Measured salinity value was high in the marine water compared brackish water samples in both seasons.

Total Hardness

Hardness is expressed as milligrams of calcium carbonate equivalent per litre. Water containing calcium carbonate at concentrations below 60 mg/l is generally considered as soft; 60–120 mg/l, moderately hard; 120–180 mg/l, hard; and more than 180 mg/l, very hard (McGowan, 2000). The respective mean obtained at the marine and fresh water sources were all within acceptable limit.

DO

Dissolved oxygen (DO) is a measure of how much oxygen is dissolved in the water - the amount of oxygen available to living aquatic organisms. Concentration of oxygen below 2mg/L (FMEnv) may lead to death of most aquatic organisms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration, the greater the stress. DO levels were observed in both seasons for both sources to be enough to support life both in both marine and fresh water sources (>2mg/L).

Biological Oxygen Demand

Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. If less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive. BOD in the marine and fresh water sources had a range of 6.5 - 10.4 mg/L and 3.6 - 10.2 mg/L in wet season and 7.5 - 10.6 mg/L and 6.1 - 7.5 mg/L in dry season respectively.

Anions

Nitrate, phosphate, chloride, sulphate and ammonia constitutes the tested anions in the two surface water sources. All the tested anions were within the permissible limits of FMEnv.

Exchangeable Cations

The major cations dissolved in water bodies are calcium, magnesium, sodium and potassium, and of these, calcium and sodium are normally dominant. Calcium and magnesium constitute the major elements responsible for water hardness. Hardness is based on the concentration of calcium and magnesium salts, and often is used as a measure of potable water quality.

Heavy Metals

The measured heavy metals in this study are Fe, Zn, Mn, Cd, Cr, Cu, As, Ni and Pb. Mn, Cd, Cr and As in the marine environment and Cd, Cr and As fresh waters sampled were below the detection limits during wet season. The respective marine and freshwater samples concentrations recorded were all within permissible limit except nickel in both marine and fresh water in the wet season and in the marine water in dry season. Comparison between previous study and present study is presented in Table 4.13

Microbiological Properties

The findings (Table 4.14) indicated a rich and diverse stock of microorganisms in the surface water samples from the Atlantic Ocean and Lekki Lagoon. A high microbial load is expected in open water sources.

Table 4.14: Summary of Physico-Chemical and Microbial Characteristics of the Surface Water Samples Within the Project Area

Parameter	Wet Season		Dry Season		Limits	
	Atlantic	Lekki Lagoon	Atlantic	Lekki Lagoon		
	Min - Max	Min - Max	Min - Max	Min - Max	FMEnv	WHO
THB *(cfu/ml)*	4.5 - 6.7(x 10^2)	4 - 6.5(x 10^2)	3.5 - 6.5(x 10^2)	1.5 - 1.83(x 10^2)	NS	NS
Coliform *(cfu/ml)*	2.1 - 3.5.6(x 10^1)	2.2 - 4.2(x 10^1)	1.5 - 3.1(x 10^1)	1 - 2.2(x 10^1)	200	NS
HUF *(cfu/ml)*	1.5 - 3.3(x 10^1)	1 - 2.3(x 10^1)	1.1 - 3(x 10^1)	1.05 - 1.35(x 10^2)	-	-
HUB *(cfu/ml)*	1.5 - 2.9(x 10^1)	1.5 - 2.5(x 10^1)	1.8 - 3.5(x 10^1)	ND	-	-
THF *(cfu/ml)*	1.5 - 2.3(x 10^1)	1 - 1.7(x 10^1)	1.3 - 2.6(x 10^1)	3.1 - 4.2(x 10^1)	-	-

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

C. Sediment Properties

The sediment samples were recovered from the same locations for surface water samples in the Lekki Lagoon (freshwater) and the Atlantic Ocean (marine water). The results of some physical, chemical and microbiological parameters of the sediments are presented in Table 4.15.

Table 4.15: Summary of physico-chemical and microbial characteristics of the sediment samples within the project area in both seasons.

Parameter	Wet Season		Dry Season	
	Atlantic	Lekki Lagoon	Atlantic	Lekki Lagoon
	Min - Max	Min - Max	Min - Max	Min - Max
pH	6 - 6.5	6.4 - 6.9	6.2 - 6.7	5.5 - 5.67
Conductivity (μs/cm)	3610 - 4441	3520 - 4070	5110 - 6841	171 - 323
TOC (%)	0.05 - 0.16	1.01 - 1.09	0.15 - 0.3	1.47 - 1.83
THC (mg/kg)	5.1 - 8.25	0.001 - 0.001	6.1 - 8.75	145.95 - 169.97
Sand (%)	98.4 - 99.6	36 - 48	97.4 - 99	23.5 - 29.9
Silt (%)	0.2 - 0.9	50 - 61	0.6 - 1.9	31.7 - 38.4
Clay (%)	0.2 - 0.7	1 - 5	0.2 - 0.7	37.5 - 39.7
Chloride (mg/kg)	15611.25 - 41312.5	2254 - 2649.5	18611.25 - 44312.5	177.54 - 230.4
Nitrate (mg/kg)	1.1 - 4.2	6 - 9.5	3.1 - 4.5	10.1 - 27
Calcium (mg/kg)	0.3 - 0.8	188.5 - 240	4.4 - 14.2	122.7 - 170.3
Phosphate (mg/kg)	0.1 - 0.3	0.1 - 0.42	0.03 - 0.32	0.29 - 0.57
Sulphate (mg/kg)	55 - 175	315 - 420.5	60 - 198	185 - 303
Magnesium	3.05 - 13.2	1.02 - 1.51	1.21 - 1.6	51.75 - 76.65

Parameter	Wet Season		Dry Season	
	Atlantic	Lekki Lagoon	Atlantic	Lekki Lagoon
	Min - Max	Min - Max	Min - Max	Min - Max
Sodium	1.2 - 2.1	1.05 - 1.8	2.19 - 4.15	55.4 - 104.04
Potassium	2.05 - 4.15	0.1 - 0.25	0.4 - 1.56	1.35 - 3.2
Arsenic	0 - 0	<0.05	0.01 - 0.01	0.005 - 0.013
Chromium	0.2 - 1.51	0.1 - 0.4	0.03 - 0.1	0.12 - 0.23
Cadmium	0.01 - 0.01	<0.05	0.01 - 0.01	<0.05 - <0.05
Copper	0.01 - 0.01	7.2 - 9.8	0.15 - 0.35	2.1 - 3.45
Manganese	0.65 - 1.1	4.05 - 5.15	0.4 - 0.88	40.1 - 50.06
Iron	0.05 - 0.3	230 - 248	81 - 146	145.7 - 191
Zinc	0.01 - 0.1	2.5 - 3.8	0.85 - 1.2	13.8 - 22.8
Lead	0.3 - 1.1	0.05 - 0.12	0.05 - 0.15	0.35 - 0.65
Nickel	75 - 136	0.3 - 0.6	0.47 - 1.3	11.59 - 17.45
THB (cfu/g)	0.01 - 0.07(x 10^3)	1.1 - 1.24(x 10^3)	1.05 - 1.31(x 10^3)	1.3 - 1.63(x 10^4)
THF (cfu/g)	1.5 - 3.7(x 10^2)	3 - 4.8(x 10^2)	1.2 - 3.5 (x 10^2)	3.3 - 6.3(x 10^3)
HUB (cfu/g)	1.5 - 3.7(x 10^1)	6 - 8.6(x 10^1)	4 - 8.5 (x 10^2)	2 - 5.3(x 10^3)
HUF (cfu/g)	1.1 - 1.41(x 10^2)	ND	1.1 - 2.1 (x 10^1)	1.45 - 1.83(x 10^2)
Coliform (cfu/g)	1 - 4.1(x 10^2)	5.1 - 7.3(x 10^2)	1 - 2.3 (x 10^2)	1 - 2.2(x 10^1)

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

Heavy metals

The trace metals encountered in the bottom sediment may reflect the concentrations found in resident aquatic organisms such as fish and other aquatic organisms through bioaccumulation. This could present a human health concern. Heavy metals analyzed includes Mn, Ni, Cr, Cd, Cu, As, Fe, Zn and Pb.

The result, as presented in Tables 4.15 shows long-term geo chemical accumulations. This is evident with the very high presence of Nickel (range 75 - 136 mg/kg) in the bottom sediments of the Marine water source.

Although higher concentration of heavy metals in the bottom sediment is expected as the bottom sediment normally acts as a sink (reservoir) for heavy metals in the water column.

Sediment Microbiology

The findings (Table 4.15) indicated a rich and diverse stock of microorganisms in the sediment samples from the Atlantic Ocean adjourning the LFZ and the distant control sample as well. The recorded coliforms in the ocean were considerably high, with values ranging from 1.0 x 10^2 Cfu/g to 3.1 x 10^2 Cfu/g around the LFZ compared to 3.3 x 10^2 Cfu/g in the distant control (Appendix 4.2).

The microbial communities in the sediment samples of the lagoon in wet season, is indicative of the abundance of microflora except for hydrocarbon utilizing fungi which was entirely absent. With respect to the hydrocarbon utilizers, the bacteria flora has a count range of 6.0 x 10^2 Cfu/g to 8.6 x 10^3 Cfu/g in the sampling sites as well as 6.9 x 10^2 Cfu/g the control sediment. The coliform count in the Lekki Lagoon sediment was lower than the count in the control station (Appendix 4.2).

4.3.7 Hydrobiological Studies

a. Hydrobiology Status of the nearby Atlantic Ocean

I. Phytoplankton abundance and diversity in the Atlantic Ocean

The findings from the phytoplankton community assessment are indicative of a diverse stock of primary producers. Despite the very large dispersal of biota caused by the large volume and turbulence in the ocean, a total of 1,370 individuals of phytoplankton were recorded across the six sampling points and control in the wet season (Table 4.16). The major taxa recorded were the Division Bacillariophyta, Cyanophyta, Chlorophyte and Dinophyta, making up 65%, 22%, 9% and 4% of the total phytoplankton abundance respectively (Figure 4.16). The Division Bacillariophyta alone recorded 11 different Orders with at least 24 phytoplankton species.

The species number and total abundance per sampling location was relatively high. The community structure analysis indicated moderate to high species diversity with Shannon-wiener and margalef index values in the sampling sites while species were equitably distributed across taxa with high evenness index at the sampling sites and control site.

The dry season phytoplankton community assessment equally reflects a rich stock of biota with a slightly lower diversity than in the wet season. A total of 1,011 individuals were recorded across the sampling and control sites. The observed taxa included Division Bacillariophyta, Cyanophyta, Chlorophyte and Dinophyta (Figure 4.17).

The community structure analysis indicated moderate to high species diversity with Shannon-wiener and Margalef index equitability index range high at the sampling sites and control station (Table 4.17).

Table 4.16: Phytoplankton abundance and community structure in the Atlantic Ocean (September, 2020)

	Sampling stations						Control
Phytoplankton Taxa	SW1	SW2	SW3	SW4	SW5	SW6	SWC
Total species diversity (S)	22	28	25	23	23	22	25
Total abundance (N)	165	253	196	178	224	166	188
Shannon-Wiener Index (Hs)	2.88	3.18	3.11	3.01	3.06	2.96	3.10
Equitability Index	0.82	0.86	0.90	0.88	0.93	0.87	0.89
Margalef Index (d)	4.11	4.88	4.55	4.25	4.07	4.11	4.58

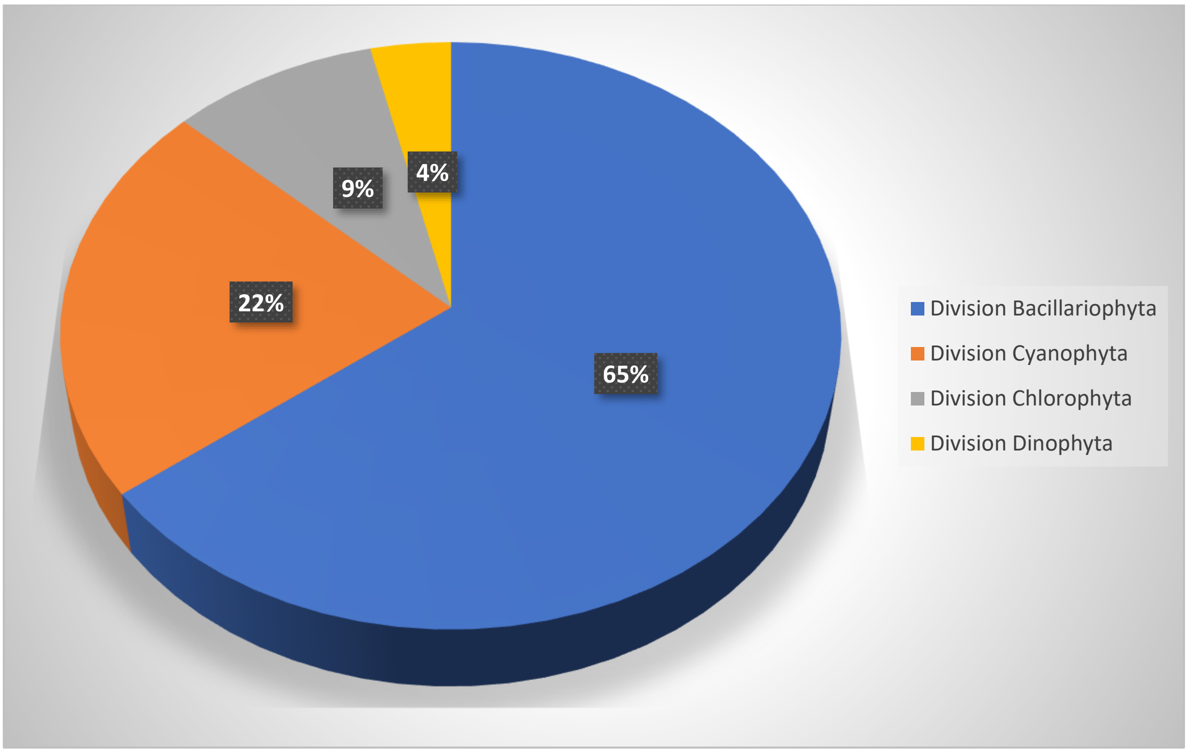


Figure 4.16: Relative Percentage Distribution of Phytoplankton in the Atlantic Ocean

Table 4.17: Phytoplankton Abundance and Community Structure in the Atlantic Ocean During the Dry Season (Feb, 2021)

	Sampling stations						Con
Phytoplankton Taxa	SW1	SW2	SW3	SW4	SW5	SW6	SWC
Number of Species (S)	26	25	24	20	17	24	23
Number of Individuals (N)	171	147	157	137	127	126	146
Shannon-Wiener Index (Hs)	3.141	3.035	3.041	2.85	2.712	3.033	2.974
Equitability Index	0.964	0.943	0.957	0.865	0.886	0.865	0.851
Margalef Index (d)	4.862	4.809	4.549	3.862	3.303	4.756	4.414

SW: Surface water

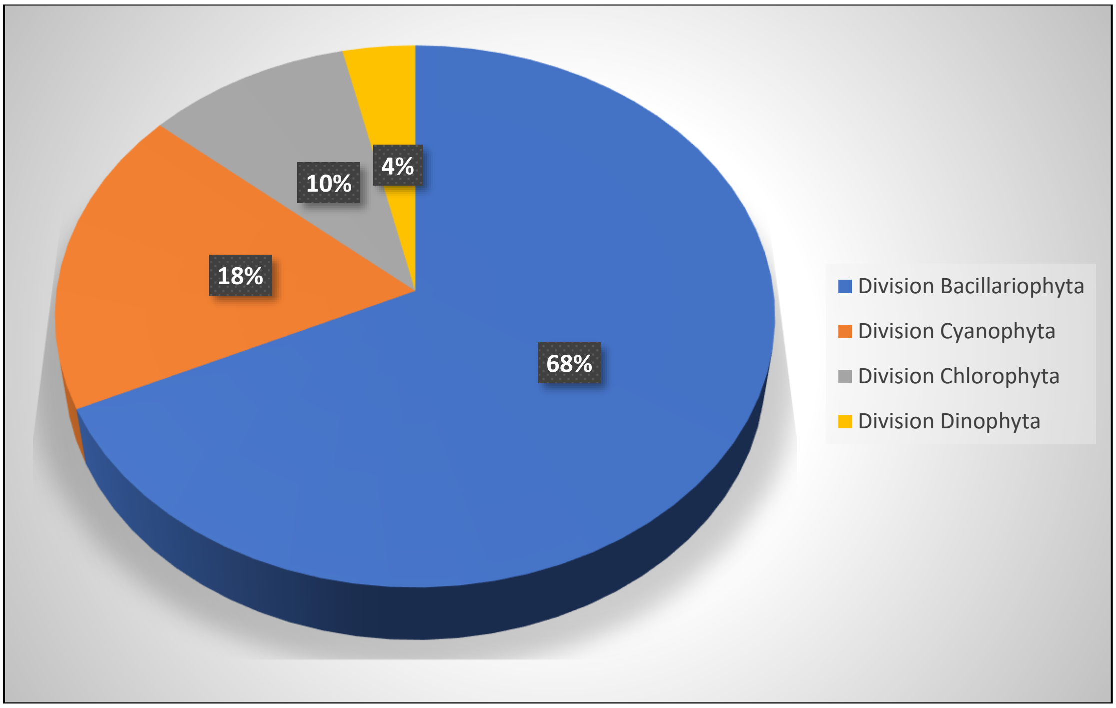


Figure 4.17: Relative Percentage Distribution of Phytoplankton in the Atlantic Ocean During the Dry Season (Feb, 2021)

II. Zooplankton abundance and diversity in the Atlantic Ocean

In the wet season, the active phytophagous community in the Atlantic Ocean was evident in a zooplankton population numbering 1,169 across the sampling sites and control. This large numbers are also inclusive of fish eggs, larvae, brachyllura, cirripede and zoe larvae (Table 4.18). In terms of the taxa distribution, a very diverse range was recorded. These includes Phylum Crustecea, Chaetognatha, chordata, Rotifera, Mollusca and juvenile stages (Figure 4.18).

With respect to the zooplankton community structure in the Atlantic Ocean, moderate to high species diversity were recorded. Moreover, species were evenly distributed per taxa but not as evenly as the phytoplankton recorded in the Atlantic during this survey.

In the dry season, there was also abundance of zooplankton in the sea water. A total of 48 individuals were reported, almost half of what was recorded in the wet season. However, there was no marked difference between the number of zooplankton recorded in both seasons. The taxa observed include the Pylum Crustecea, Chaetognatha, Chordata, Foraminifera, Rotifera, Mollusca and juvenile stages (Figure 4.19). Higher percentages of juvenile forms were recorded compared to the wet season.

Moderate species diversity was recorded in the dry season. Shannon-wiener diversity index and Margalef's index values were high for sampling sites and control site (Table 4.19).

Table 4.18: Zooplankton abundance and community structure in the Atlantic Ocean (September, 2020)

Zooplankton Taxa	Stations						Contr
	SW1	SW2	SW3	SW4	SW5	SW6	SWC
Total species diversity (S)	18	22	18	19	19	21	20
Total abundance (N)	152	156	148	154	191	204	164
Shannon-Wiener Index (Hs)	2.67	2.83	2.71	2.59	2.77	2.78	2.79
Evenness Index	0.80	0.77	0.84	0.70	0.84	0.76	0.81
Margalef Index (d)	3.38	4.16	3.40	3.57	3.43	3.76	3.73

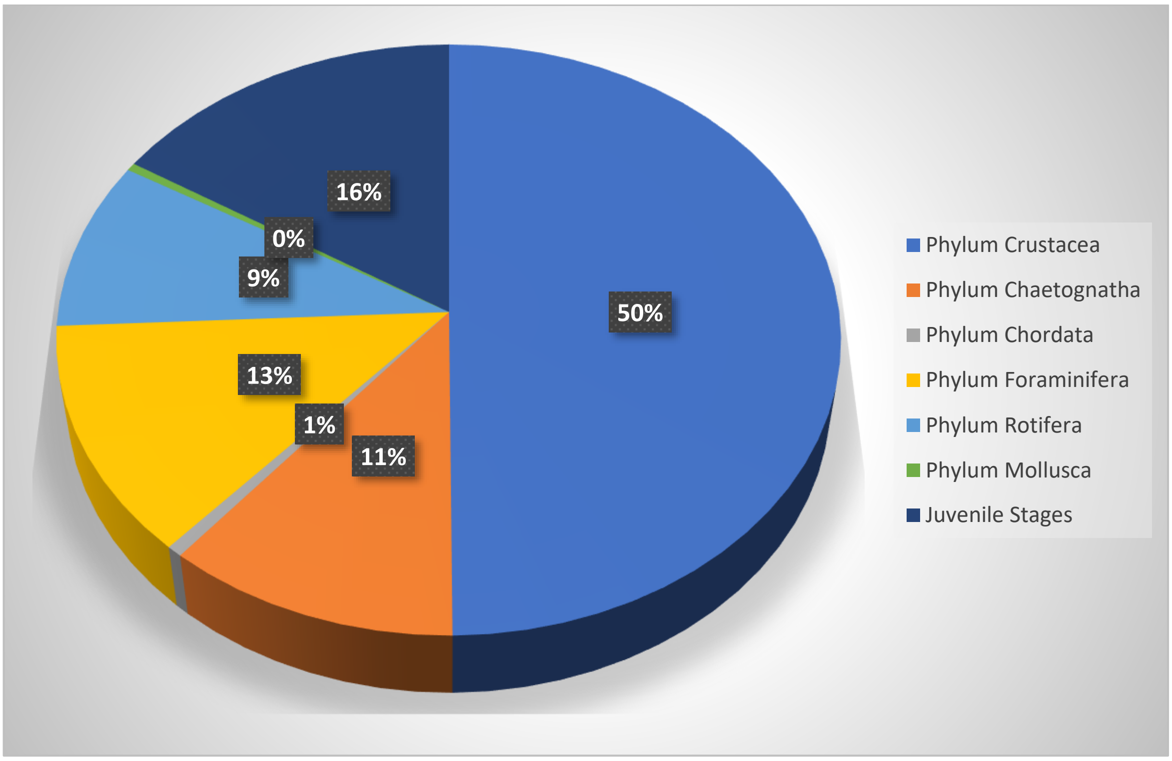


Figure 4.18: Relative percentage distribution of the zooplankton taxa in the Atlantic Ocean in the wet season (Sept, 2020)

Table 4.19: Zooplankton abundance and community structure in the Atlantic Ocean during the dry season (Feb, 2021)

Zooplankton Taxa	Stations						Cont
	SW1	SW2	SW3	SW4	SW5	SW6	SWC
Number of Species (S)	17	10	13	16	13	15	14
Number of Individuals (N)	108	79	68	99	78	110	106
Shannon-Wiener Index (Hs)	2.57	2.15	2.46	2.57	2.36	2.57	2.47
Evenness Index	0.77	0.86	0.90	0.82	0.82	0.87	0.85
Margalef Index (d)	3.42	2.06	2.84	3.26	2.75	2.98	2.79

SW: Surface water

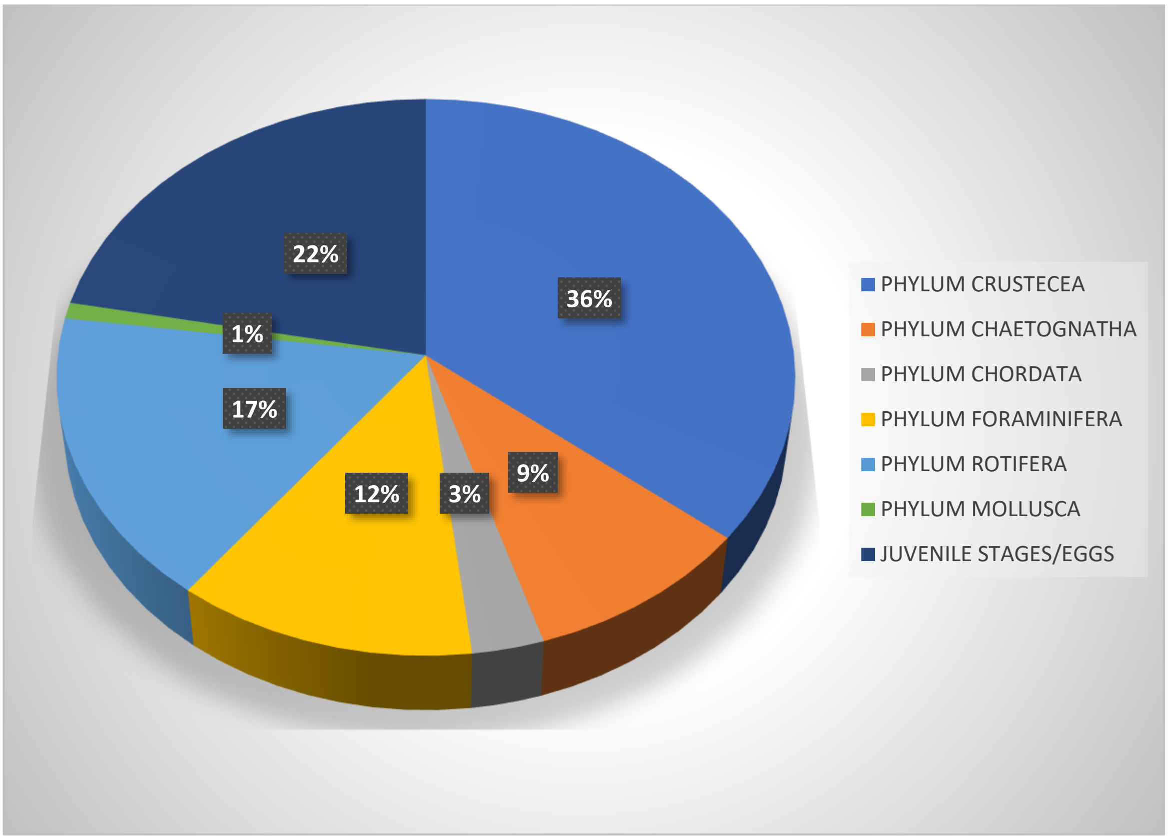


Figure 4.19: Relative percentage distribution of the zooplankton taxa in the Atlantic Ocean during the dry season (Feb, 2021)

III. Macrobenthic fauna abundance and diversity in the Atlantic Ocean

Sediment ecology study in the Atlantic oeann revealed that despite the dredging and various anthropogenic modifications in the coastal Atlantic Ocean, considerable macrobethic fauna community still thrives here.

In the wet season, a total of 283 individuals benthic macrofauna was recorded across the six sampling points and the control site (Table 4.20). A total of four taxa were recorded including Phylum Annelida, Arthropoda, Brachiopoda and Mollusca (Figure 4.20). The community structure analysis indicated a moderate species diversity.

In the dry season, a total of 267 individual microbenthic fauna were observed in the sediment samples from the proposed project area and the control station. A total of four taxa were recorded including phylum Annelida, Arthropoda, Brachiopoda and Mollusca, with the latter being the most dominant (Figure 4.21).

In terms of the number of species per sampling location recorded is presented in Figure 4.34. More microbenthic fauna was recorded in the sea bottom during the dry season. This may be associated with reduced inflow from inland waters and reduced turbulence associated with the wet season. The community structure analysis indicated a low to moderate species diversity (Table 4.21).

Table 4.20: Macrobenthic fauna abundance and community structure in the Atlantic Ocean (September, 2020)

TAXA	Sampling locations						Cont
	SD1	SD2	SD3	SD4	SD5	SD6	SDC
Number of Species	9	8	10	12	8	9	10
Number of Individuals	52	32	37	54	31	33	44
Shannon Weiner's Index	2.02	1.70	2.06	2.33	1.83	1.99	2.10
Evenness Index	0.84	0.69	0.79	0.86	0.78	0.82	0.81
Margalef's Index	2.03	2.02	2.49	2.76	2.038	2.29	2.38

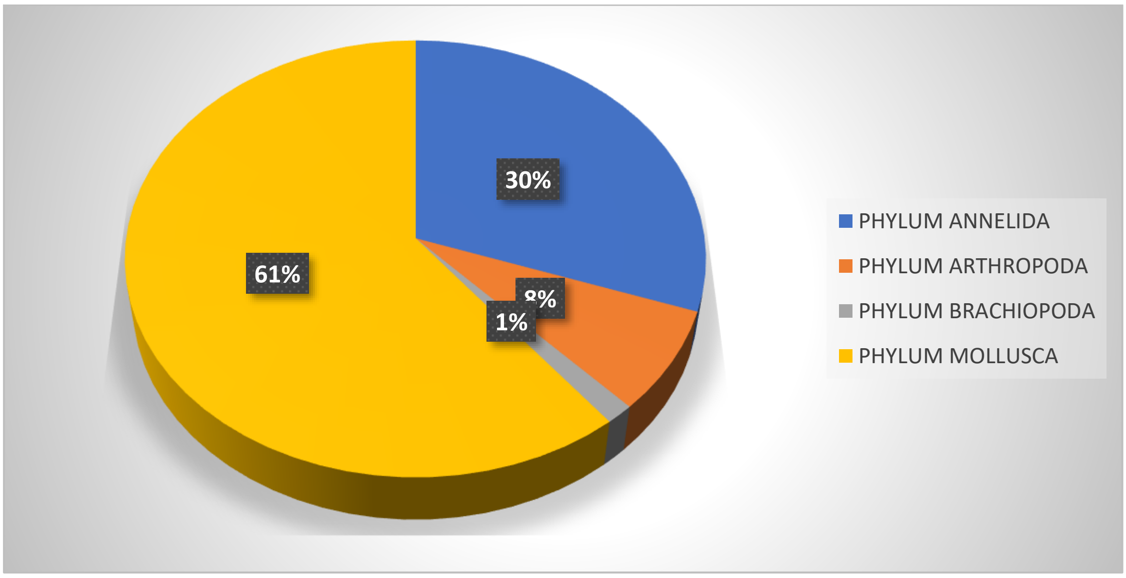


Figure 4.20: Relative percentage distribution of microbenthic fauna taxa in the Atlantic Ocean in the wet season (Sept, 2021)

Table 4.21: Macrobenthic fauna abundance and community structure in the Atlantic Ocean during the dry season (Feb, 2021)

TAXA	Sampling locations						Control
	SD1	SD2	SD3	SD4	SD5	SD6	SDC
Number of Species (S)	17	10	13	16	13	15	14
Number of Individuals (N)	108	79	68	99	78	110	106
Shannon Weiner's Index	2.57	2.15	2.46	2.57	2.36	2.57	2.47
Evenness Index	0.77	0.86	0.90	0.82	0.82	0.87	0.85
Margalef's Index	3.42	2.06	2.84	3.26	2.75	2.98	2.79

SD: Sediment

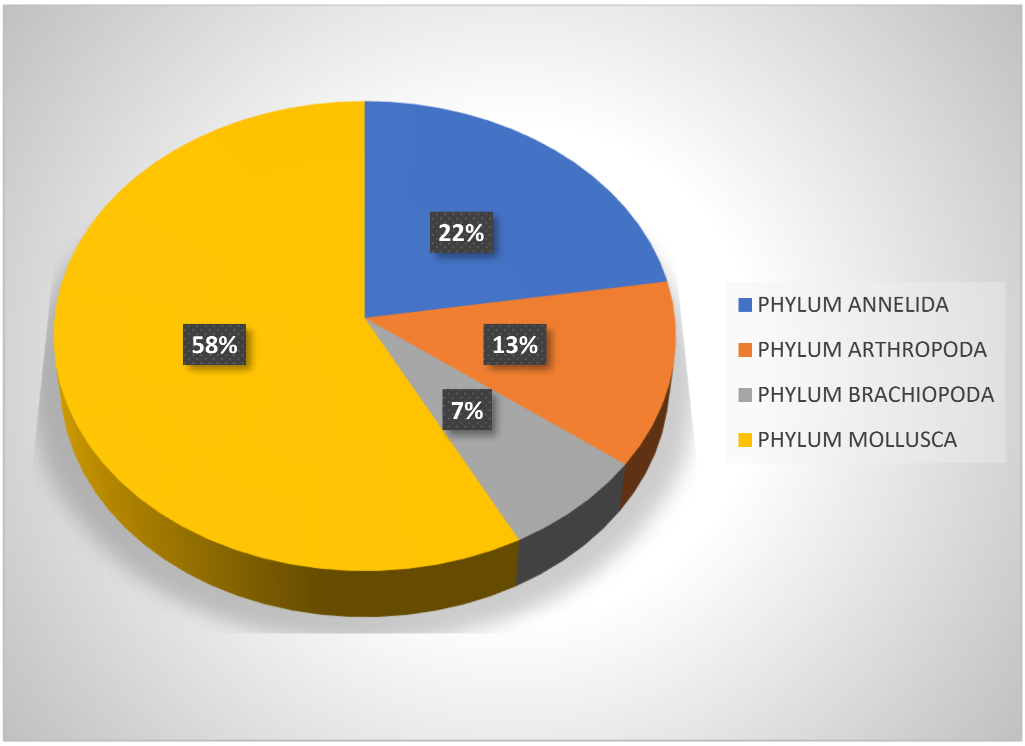


Figure 4.21: Relative percentage distribution of microbenthic fauna taxa in the Atlantic Ocean during the dry season (Feb, 2021)

b. Hydrobiology of the Lekki Lagoon

I. Phytoplankton abundance and diversity in the Lekki Lagoon

Lagoons are more stable and productive waters than the sea, as evident in the high phytoplankton abundance in the Lekki Lagoon. A total of 1,984 individuals belonging to 103 species were recorded in the lagoon indicating a very high productivity (Table 4.22). The Lekki Lagoon is relatively pristine and undisturbed with banks characterized by dense mangrove and riparian vegetation.

Phytoplankton observed in the wet season at the Lekki Lagoon categorised into Division Bacillariohyta, Chrysophyta, Cyanobacteria, Euglenophyta, Chlorophyte and Chraophyta (Figure 4.22).

During the dry season a total of 1,845 individuals of phytoplankton were observed which was slightly lower than the wet season (Table 4.23). The specific taxonomic assessment of the observed phytoplankton samples indicated the represence of Bacillariohyta, Chrysophyta, Cyanobacteria, Euglenophyta, Chlorophyte and Chraophyta (Figure 4.23).

The community structure analysis for the dry season, indicated that the Shannon-Wiener and Margalef's indices of diversity was high at bothe sampling and control site.

Table 4.22: Phytoplankton abundance and community structure in the wet season at Lekki Lagoon (September, 2020)

S/N	Phytoplankton Taxa	Sampling stations						Control
		SW1	SW2	SW3	SW4	SW5	SW6	SWC
Total number of Species (S)		62	49	51	83	55	53	61
Total number of Individuals (N)		255	221	211	450	283	264	300
Shannon- Weiner Index		3.89	3.65	3.72	4	3.69	3.73	3.81
Evenness Index (H/S)		0.79	0.79	0.81	0.66	0.73	0.79	0.74
Margalef Index (d)		11.01	8.89	9.34	13.42	9.57	9.33	9.33

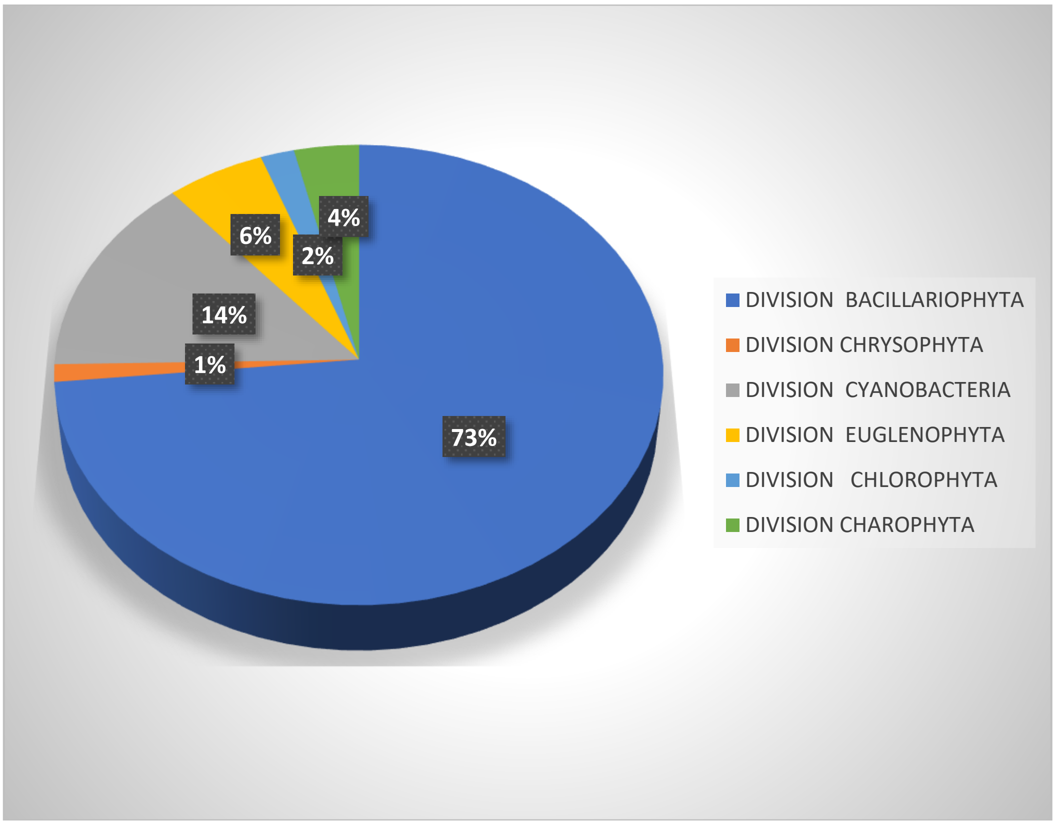


Figure 4.22: Relative percentage distribution of phytoplankton taxa in the Lekki Lagoon

Table 4.23: Phytoplankton abundance and community structure in the Lekki Lagoon during the dry season (Feb, 2021)

S/N	**Phytoplankton Taxa**	Sampling stations						Contr
		SW1	SW2	SW3	SW4	SW5	SW6	SWC
Total number of Species (S)		52	52	42	57	50	46	57
Total number of Individuals (N)		266	263	206	294	259	258	299
Shannon- Weiner Index		3.76	3.73	3.47	3.78	3.57	3.55	3.75
Evenness Index (H/S)		0.83	0.80	0.76	0.77	0.71	0.76	0.75
Margalef Index (d)		9.13	9.15	7.70	9.85	8.82	8.10	9.82

SW: Surface water

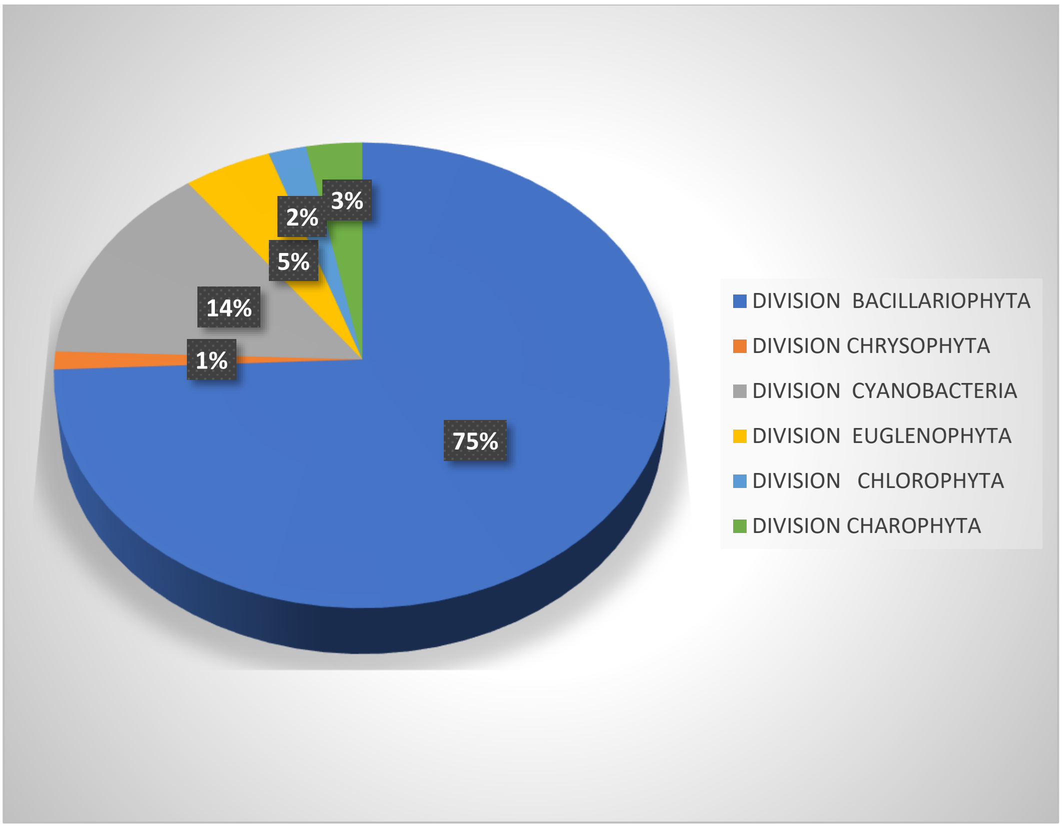


Figure 4.23: Relative percentage distribution of phytoplankton taxa in the Lekki Lagoon during the dry season (Feb, 2021)

II. Zooplankton abundance and diversity in the Lekki Lagoon

The Lekki lagoon also recorded a large and diverse stock of zooplankton species. Zooplankton, together with phytoplankton are important in regulating the oceans food webs and to a great extent the global climatic settings.

In the wet season, the total number of zooplankton recorded in the lagoon was 493, including 114 juvenile stages/eggs (Table 4.24). The specific taxa distribution included Phylum Arthropoda, Rotifera, Mollusca, Ciliophora and juveniles stages, (Figure 4.24). The high abundance of juvenile stages and eggs is notable, making up almost a quarter of the total observed species.

The zooplankton community structure analysis in the Lekki lagoon indicated moderate to high species diversity and a relatively evenly spread species numbers per taxa as shown by the Shannon-wiener and Margalef's indices.

In the dry season zooplankton are less dispersed than in the wet season with a total of 490 individuals reported (Figure 4.25). The community structure analysis indicated a moderate to high species diversity and a relatively evenly spread species numbers per taxa during the dry season.

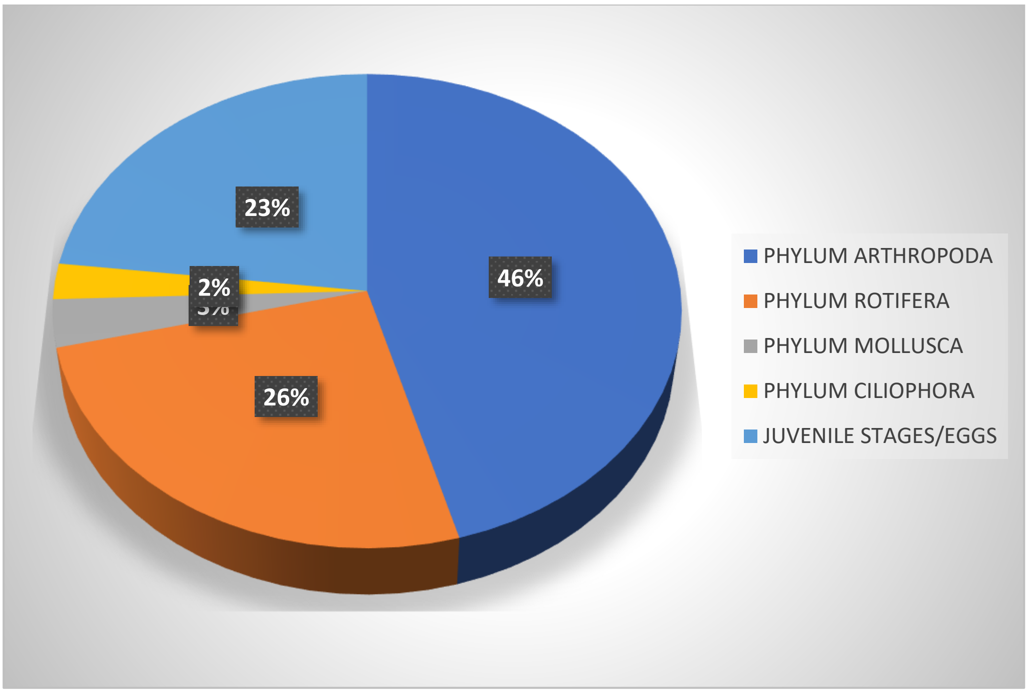


Figure 4.24: Percentage distribution of zooplankton taxa in the Lekki Lagoon

Table 4.24: Zooplankton abundance and community structure in the Lekki Lagoon during the dry season (Feb, 2021)

		Stations						Control
S/N	**Zooplankton Taxa**	SW1	SW2	SW3	SW4	SW5	SW6	SWC
Total number of Species (S)		17	19	18	19	18	14	20
Total number of Individuals (N)		75	81	63	77	69	66	59
Shannon- Weiner Index		2.66	2.63	2.62	2.71	2.65	2.47	2.74
Evenness Index (H/S)		0.84	0.73	0.76	0.79	0.79	0.85	0.77
Margalef Index (d)		3.71	4.10	4.10	4.14	4.02	3.10	4.66

SW- Surface water

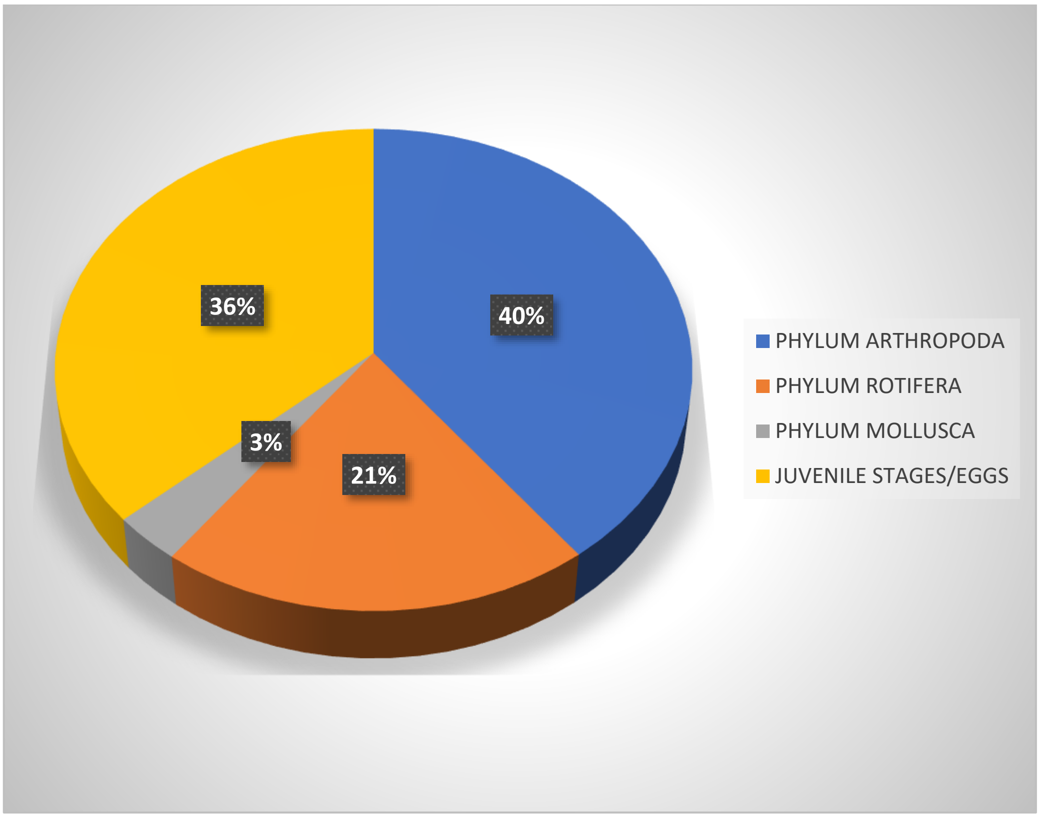


Figure 4.25: Percentage distribution of zooplankton taxa in the Lekki Lagoon during the dry season (Feb, 2021)

III. Macrobenthic fauna abundance and diversity in the Lekki Lagoon

The Lekki lagoon sediment was found to be rich in microbenthic fauna and this can be attributed to the relatively low levels of commercial sand mining in the area. This ensured that the substratum remains rich in fauna which perform various purification and support function in the aquatic ecosystem.

In the wet season, a total of 123 individual microbenthic fauna were recorded in the entire sample pool (Table 4.25) distributed across three taxa Phylum Mollusca, Annelida and Arthropoda (Figure 4.26).

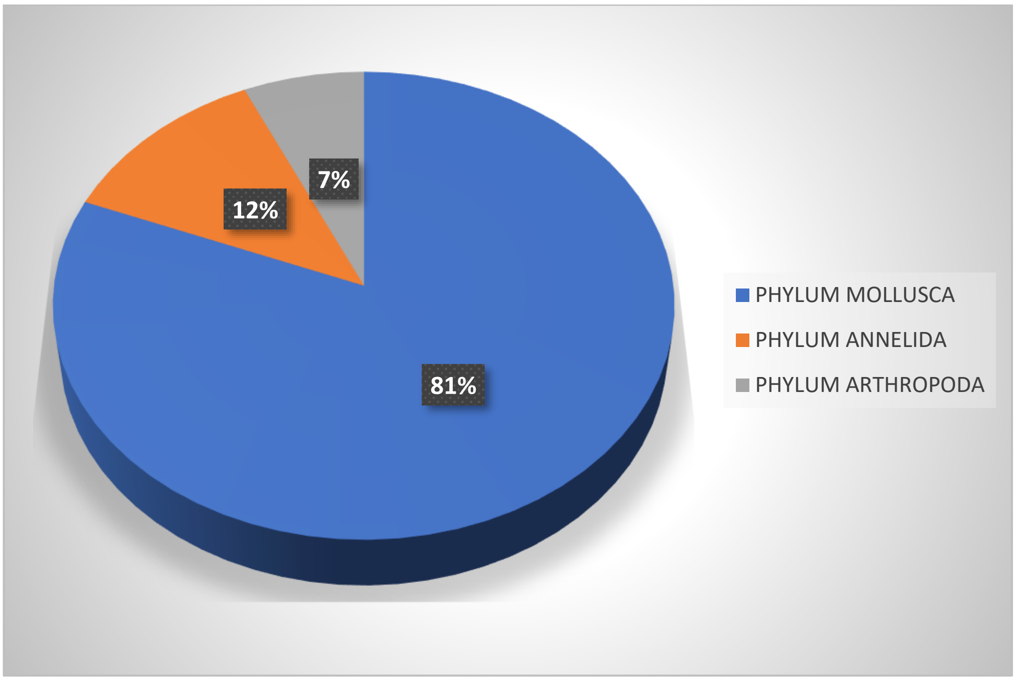
The community structure analysis showed that Shannon-wiener, Margalef's index and evenness index was high indicating a very high and consistent spread of species across respective taxa.

In the dry season, macrobenthic fauna assessment showed low level of species diversity and abundance with a total number of 143 individuals (Table 4.26). The taxa represented by species include Phylum Mollusca, Annelida and Arthropoda (Figure 4.27).

The community structure analysis showed that Shannon-wiener and Margalef's index values were low. The evenness index was also low indicating a relatively consistent spread of species across respective taxa in each sampling site/location.

Table 4.25: Macrobenthic fauna abundance and community structure in the Lekki Lagoon (September, 2020)

TAXA	Sampling locations						Control
	SD1	SD2	SD3	SD4	SD5	SD6	SDC
Total number of Species (S)	6	4	7	6	4	5	4
Total number of Individuals (N)	21	15	26	17	9	21	14
Shannon- Weiner Index	1.61	1.32	1.75	1.56	1.27	1.41	1.33
Evenness Index (H/S)	0.83	0.94	0.82	0.80	0.89	0.82	0.95
Margalef Index (d)	1.64	1.11	1.84	1.77	1.37	1.09	1.14

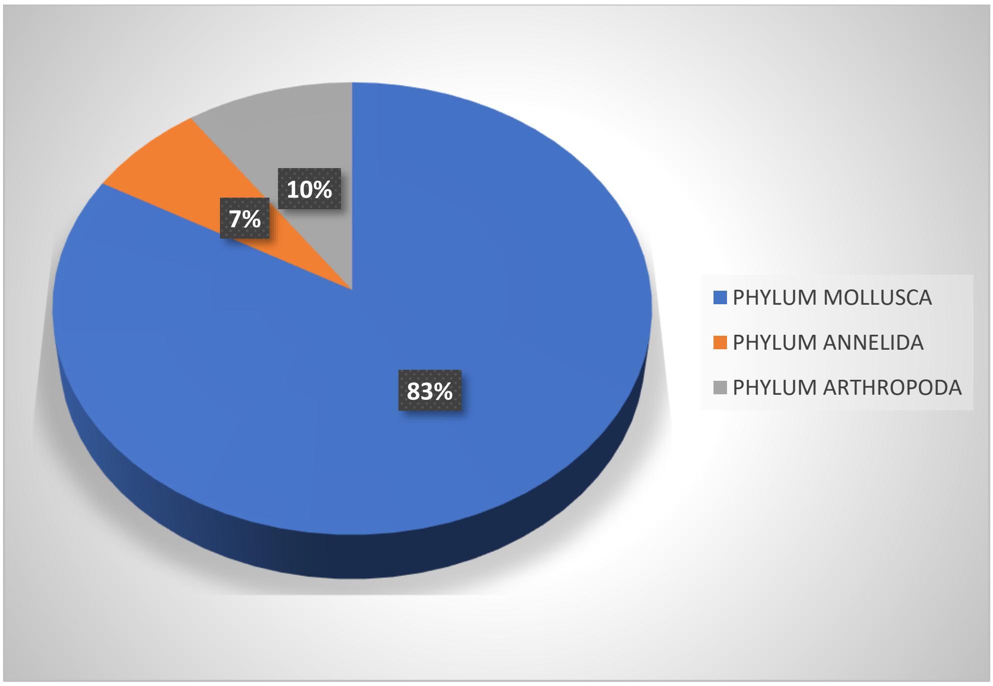


Figures 4.26: Percentage distribution of microbenthic fauna taxa in the Lekki Lagoon

Table 4.26: Macrobenthic fauna abundance and community structure in the Lekki Lagoon during the dry season (Feb, 2021)

TAXA	SD1	SD2	SD3	SD4	SD5	SD6	Control (SDC)
Total number of Species (S)	8	6	8	6	6	6	5
Total number of Individuals (N)	27	27	28	16	14	14	18
Shannon- Weiner Index	1.941	1.637	1.906	1.542	1.649	1.673	1.427
Evenness Index (H/S)	0.871	0.857	0.841	0.779	0.867	0.888	0.833
Margalef Index (d)	2.124	1.535	2.101	1.803	1.895	1.895	1.384

SD: Sediment



Figures 4.27: Percentage distribution of microbenthic fauna taxa in the Lekki Lagoon during the dry season (Feb, 2021)

4.3.8 Fisheries /Crustaceans Resources in the Atlantic Ocean and Lekki Lagoon

a. Wet Season

Fisheries survey was conducted to determine the fishes in and around the Atlantic Ocean and Lekki Lagoon using physical observations at fish landing sites as well as through interviews and literature indicated that fishing activities. The survey was carried out in the early mornings and evenings from dugout canoes in the camps around the Lagos lagoon. The fishing gears commonly used includes cast nets, set nets, drift nets, gill nets and hook-on line as well as fish fence. Fishing is carried out by migrant fishermen, while few indigenes also participate in fishing activities.

In total, 32 fish species distributed in 17 families were identified (Table 4.27 & Plate 4.1). This includes 29 fin fishes and 3 shell fishes/shrimps. In terms of fish species richness, the families Clupeidae, Mugilidae, Polynemidae and Carangidae were dominant. The least dominant were Cichilidae, Bagridae, Monodactylidae, Cynoglossidae, Osteodolossidae, Clariidae, Mochokidae, Eleotridae, Claroteidae, Sphyraenidae, Haemulidae, Channidae and Cyprinidae. The dominant families are naturally occurring non-invasive forms, implying that the water body's prevailing conditions have not favoured invasive life forms. Most of the fishes observed were either categorized as not evaluated (NE) or least concerned (LC) based on the IUCN red list ranking. Based on global research and findings using the IUCN red list ranking, *Cynoglossus senegalensis* and *Penaeus monodon* was found out to be categorized as Near Threatened (NT). Twenty (20) species were recorded from the Lekki Lagoon while eighteen (18) species were recorded in the Atlantic Ocean.

In the peak dry season sampling (February), the fisheries resources of the Atlantic Ocean and Lekki Lagoon did not alter significantly compared to the wet season (September) and this can be due largely to the fact that both water bodies have limited changes in salinity across the year. While the former is a always a salt water the latter remains completely fresh water with zero salinity even in the peak of the dry season. This implies that only stenohaline species (which cannot tolerate wide changes in salinity) can survive in these waters unlike in estuarine ecosystems such as the Lagos Lagoon which experiences marked salinity changes with season.

Apparently, the wet season, being the most dominant breeding season would record more species in terms of number and yield per effort compared to the dry season. None the less, the inter-seasonal differences were found to be minimal. In total, twenty-eight fin fishes and two shell fishes were recorded in the dry season, making a total of thirty (30 species) (Table 4.27).

Table 4.27: Checklist of fish species observed in the assessed Ibeju-Lekki Lagos lagoon water bodies (streams and ponds) associated with the Lagos Free Zone (LFZ) site in the wet (Sept. 2020) and dry (Feb. 2021) seasons

S/N	Family	Species	IUCN Status	Abundance	Location		Seasonality	
					Atlantic Ocean	Lekki Lagoon	Wet	Dry
	FISHES							
1	Bagridae	*Chrysichthys nigrodigitatus*	LC	Common		✓	P	P
2	Monodactylidae	*Psettias sebae*	LC	Uncommon	✓		P	P
3	Clupeidae	*Ethmalosa fimbriata*	LC	Common	✓		P	P
4	Cynoglossidae	*Cynoglossus senegalensis*	NT	Uncommon	✓		P	P
5	Osteodolossidae	*Heterotis niloticus*	LC	Uncommon		✓	P	P
6	Clariidae	*Clarias gariepinus*	LC	Common		✓	P	P
7	Mochokidae	*Synodontis nigeriata*	NE	Common		✓	P	P
8	Eleotridae	*Batanga lebritonis*	NE	Uncommon	✓		P	P
9	Polynemidae	*Polydactylus quadrifilis*	LC	Uncommon	✓		P	P
10	Cichilide	*Tilapia guineesis*	LC	Common		✓	P	P
11	Mugilidae	*Mugil cephalus*	LC	Common	✓	✓	P	P
12	Gymnachidae	*Gymnarchus niloticus*	LC	Uncommon		✓	P	A
13	Carangidae	*Chloroscombrus chrysurus*	LC	Uncommon	✓		P	P
14	Claroteidae	*Chrysichthys auratus*	LC	Common		✓	P	P
15	Mugilidae	*Liza falcipinnis*	LC	Common		✓	P	P
16	Clupeidae	*Sardinella maderensis*	LC	Common	✓	✓	P	P
17	Clupeidae	*Sardinella aurita*	LC	Common	✓	✓	P	P
18	Sphyraenidae	*Sphyraena barracuda*	LC	Common		✓	P	P
19	Haemulidae	*Brachydeuterus auritus*	LC	Common		✓	P	P
20	Carangidae	*Caranx hippos*	LC	Uncommon	✓	✓	P	P
21	Polynermidae	*Polydactylus quadrifilis*	LC	Uncommon	✓	✓	P	P
22	Channidae	*Channa marulius*	LC	Uncommon	✓		P	P
23	Cyprinidae	*Garra annandalei*	LC	Uncommon	✓	✓	P	P
24	Hemiramphidae	*Hemiramphus brasiliensis*	LC	Uncommon	✓		P	P
25	Malapteruridae	*Malapterurus electicus*	LC	Uncommon	✓			

							P	P
26	Moronidae	*Morone saxatilis*	LC	Common	✓		P	P
27	Characidae	*Alestes imberi*	LC	Common		✓	P	P
28	Cyprinidae	*Labeo snegalensis*	LC	Common		✓	P	P
29	Clupidae	*Pellonula* sp.	LC	Common		✓	P	P
	CRUSTACEAN							
30	Penaeidae	*Penaeus monodon*	NT	Common	✓		P	P
31		*Desmoscaris sp.*	LC	Common		✓	P	P
32		*Pedunculata* sp.	LC	Commom		✓	P	A

Data Deficient (DD), Near Threatened (NT), Not evaluated (NE) or Least concerned (LC), Present (P), Absent (A)
Source: GET Fieldwork – LFZ Project Area, September 2020 (Wet) February 2021 (Dry)

All but two observed species fell within the IUCN categories of Least Concerned or Not Evaluated. They were the sole fish, *Cynoglossus senegalensis* and the shrimp, *Penaeus monodon* which were both categorized as Near Threatened.

Moreover, mud- fishing using basket traps was common in the dry season with locals fishing in the ponds and lakes within the LFZ complex.

Plate 4.1: Samples of fisheries resources around project area

4.3.9 Vegetation Study

Generally, the physiognomy of the vegetation is predominantly wetland marshy ecosystem, best described as impacted mangrove ecosystem due to adjoined human settlements as well as construction and operation of factories observed within the study site.

The section around **Oke Segun and its environs** (6.4366 N, 4.01655 E and 6.4372 N, 4.01655 E, 6.43594 N, 4.01768 E and 6.43684 N, 4.01749 E.) is a terrestrial environment bounded in the South by the Atlantic Ocean. The vegetation in this area is a secondary type as a result of extensive bush clearing and landfills due to construction works. A large portion of the Oke Segun area is predominantly covered by grasses, and herbaceous species interspersed with some shrubs and trees (Plate 4.2). Generally, plant species found in the dry arable section of the study site are colonizing and invasive species, as well as some economic plants because of the human community.

A substantial part of the study site was covered by common species which sometimes appear homogenous as in the case of *Sida acuta*, *Aspilia africana, Chromolaena odorata*, *Imperata cylindrica, Elusine indica* and may be a mixture of different species growing together in a particular portion of the land with one of the species appearing dominant. A good example of this was observed in some sections where *Dryopteris filix-mas* is the dominant species growing together with other common species like *Panicum maximum* and *Sida acuta*.

The extensive bush clearing had led to the lost of the mature tree species and only a few young trees were observed as re-growth. Some of the conspicuous young tree species includes *Anthocleista vogelii*, *Trema orientalis, Ficus sur, Ficus exasperata* and *Spondias mombin.* It is important to mention that no farming activity was observed within the study site as at the time of visit because extensive construction of different Industries, Factories and Warehouses were ongoing. To this end, solitary stands of some crops were observed within the site. Crops like *Anacardium occidentale, Citrus aurantifolia, Musa sapientum, Manihot esculenta, Musa paradisiaca, Colocassia esculenta, and Talinum fruticosum* were observed in this site.

Most of the trees had been lost due to the extensive bush clearing and only a few young trees were observed as re-growth in the study site. Some of the conspicuous young tree species includes *Anthocleista vogelii*, *Acacia nilotica, Trema orientalis, Ficus sur, Ficus exasperata* and *Spondias mombin.*

Since the area has been impacted by human activities, economic plants, ornamentals, medicinal, and food crops were observed. This category of plants includes *Carica papaya, Talinum fruticosum, Mangifera indica, Vernonia amygdalina*, *Telferia occidentalis, Elaeis guineensis, Citrus sinensis, Citrus limon, Azadirachta indica, Musa paradisiaca, Musa sapientum* and *Terminalia catappa*.

It was observed that farming activities has reduced significantly, and solitary stands of some crops were observed within the site.

Plate 4.2: Vegetation Oke Segun in Project Area

This section of the project site around **Magbon Segun** (Wet Season: 6.4372 N, 4.0168 E and 6.4327 N, 4.0248 E, Dry season: 6.43604 N, 4.01708 E and 6.4369 N, 4.01685 E.) is mangrove swamp with *Raphia hookeri, Elaeis guineensis, Avicennia marina, Avicennia germinans*, and *Rhizophora mangle* forming the dominant species. Wetland grasses like *Sporobolus pyramidalis* and *Sacciolepis africana;* other herbaceous species including *Ipomea involucrata, Solanum nigrum, Luffa aegyptiaca, Alchornea cordifolia, Amaranthus spinosus*, *Phyllanthus amarus*, and *Xanthosoma saggitifolium* among others were common in this location (Plate 4.3).

It was observed that part of this section of the project site has been impacted with extensive bush clearing; therefore, some invasive species like *Amaranthus spinosus*, *Ipomea involucrata, Aspilia africana, Calopogonium mucunoides, Mucuna sloanei*, as well as grass species like *Elusine indica, Sporobolus pyramidalis*, and *Cyperus articulatus* were found to be very common in this area. Magbon community is an adjoining human settlement whose residents are majorly peasant farmers. This development has influenced the growth of some food crops around the area. Prominent among these are *Musa sapientum* and *Musa paradisiaca.*




Plate 4.3: Vegetation Magon Segun in Project Area

Vegetation around Lekuru (Wet season: 6.4308 N, 4.0226 E and 6.4360 N, 4.0176 E, Dry season: 6.4288 N, 4.0216 E and 6.4357 N, 4.0183 E) is quite similar to that observed in Magbon Segun. A substantial part of the site is a marshy wetland and has been greatly impacted due to ongoing construction works ((Plate 4.4). However, some fallow areas were observed to possess mangrove species like *Raphia hookeri, Avecinnia marina, Acrostichum aureum, Elaeis guineensis, Avicennia germinans*, *Rhizophora mangle, Alchornea cordifolia*, *Sporobolus pyramidalis*, and *Cyperus articulatus* forming the dominant species. Apart from the wetland, a smaller portion of dry arable land also exists in this area. Species like *Phyllanthus amarus, Chromolaena odorata, Sida acuta*, *Elusine indica*, and *Panicum maximum* were quite common.


Plate 4.4: Vegetation Lekuru in Project Area

The vegetation in Itoke area (Wet season: 6.4342 N, 4.0204 E and 6.4345 N, 4.0180 E; Dry season: 6.4442 N, 4.0209 E and 6.4385 N, 4.0187 E.) is basically a secondary type due to human impacts. Construction of access roads as well as factories were ongoing, hence substantial parts of the study site under review has been cleared of its original vegetation. As expected, Invasive species that are characteristic features of secondary vegetation are abundant in this area (Plate 4.5). A small stream exists on the Southeastern end of the area, and as expected, water plants as well as species associated with wetland formed dominant species in this region. Prominent among these are: *Chromolaena odorata, Aspilia africana, Ipomea involucrata, Mariscus alternifolius, Elusine indica, Triumfetta cordifolia, Ageratum conyzoides, Sida cordifolia, Imperata cylindrica, Centrosema pubescence, Chloris pilosa, Panicum maximum, Daniela oliveri, Sporobolus pyramidalis, Dialium guineense, Mimosa pudica, Momordica charantia* and *Alchornea cordifolia*. The water plants and wetland species found in this area includes: *Nymphea lotus*, *Dryopteris filix-mas*, *Xanthosoma saggitifolium*, *Eichhornia crassipes*, *Raphia hookeri, Lemna minor* among others.

Plate 4.5: Vegetation Itoke in Project Area

The vegetation type found **in Okunraye and its surroundings** (Wet season: 6.4308 N, 4.0226 E and 6.4353 N, 4.0185 E; Dry season: 6.4318 N, 4.0286 E and 6.4348 N, 4.0149 E). is lowland wetland with *Raphia hookeri, Elaeis guineensis, Avicennia germinans*, and *Rhizophora mangle* forming the dominant tree species, while the grass family were abundantly represented by *Sporobolus pyramidalis, Axonopus compressus,* and *Paspalum vaginatum*. Construction works are ongoing hence, most portions of the study site have been cleared of the primary vegetation. The vegetation re-growth present in these impacted portions include: *Sida cordifolia, Calopogonium mucunoides, Chromolaena odorata, Commelina diffusa, Emilia cordifolia, Euphorbia hirta, Ficus capensis,* and *Sida acuta* among others (Plate 4.6).

It is worthy of note that no farmland was observed in Okunraye study area. It was observed the entire area has been cleared of its primary vegetation and quite a lot of construction works are ongoing. Therefore, most agricultural crops that were observed years back when the EIA was conducted are now absent due to the stated reason.




Plate 4.6: Vegetation Okunraye in Project Area

Economic Plants

The human community located within the study site has influenced the presence of economic plants associated with the project area; these plants can be conveniently categorized according to their uses as food, cash, ornamental and medicinal plants. Major crops found in this site includes Carica *papaya* (pawpaw), *Citrus aurantifolia* (Lime orange), *Colocassia esculenta* (cocoyam), *Mangifera indica* (Mango)*, Azadirachta indica* (neem plant), *Anacardium occidentale* (cashew), *Citrus sinensis* (sweet orange), *Musa paradisiaca* (plantain), *Occimum gratissimum* (scent leaf), *Musa sapientum* (banana), *Cocos nucifera* (coconut) among others (Table 4.28 to Table 4.30).

General review of the entire project area

Table 4.28: Checklist of dominant plant species found in the project area

S/N	Plant Species	Habit	Density
1.	*Avicennia germinans*	Tree	Abundant
2.	*Avicennia marina*	Shrub	Abundant
3.	*Dryopteris filix-mas*	Herb	Abundant
4.	*Elaeis guineensis*	Palm	Abundant
5.	*Paspalum vaginatum*	Grass	Abundant
6.	*Raphia hookeri*	Palm	Abundant
7.	*Rhizophora mangle*	Tree	Abundant
8.	*Sida cordifolia*	Herb	Abundant
9.	*Sporobolus pyramidalis*	Grass	Abundant
10.	*Xanthosoma saggitifolium*	Herb	Abundant

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)

Table 4.29: A comprehensive list of Economic plants found in the project area.

S/N	Species	Common Name	Uses
1	*Anacardium occidentale*	Cashew	Fruit/Cash
2	*Azadirachta indica*	Neem plant	Medicinal
3	*Carica papaya*	Pawpaw	Fruit
4	*Celosia argentea*	Celosia	Vegetable
5	*Citrus aurantifolia*	Lime orange	Medicinal
6	*Citrus sinensis*	Orange	Fruit
7	*Cocos nucifera*	Coconut	Fruit
8	*Colocasia esculenta*	Cocoyam	Food
9	*Elaeis guineensis*	Oil Palm	Cash
10	*Mangifera indica*	Mango	Fruit
11	*Manihot esculenta*	Cassava	Food/Cash
12	*Musa paradisiaca*	Plantain	Food
13	*Musa sapientum*	Banana	Fruit
14	*Occimum gratissimum*	Scent leaf	Medicinal
15	*Spondias mombin*	Hog plum	Medicinal
16	*Talinum fruticosum*	Water leaf	Vegetable
17	*Telfaria occidentalis*	Ugwu leaf	Vegetable
18	*Terminalia catappa*	Almond	Fruit
19	*Vernonia amygdalina*	Bitter leaf	Vegetable

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)

Table 4.30: Checklist of plant species found in the project area

S/N	Plant Species	Density
1.	*Acacia nilotica*	Rare
2.	*Acalypha fimbriata*	Common
3.	*Ageratum conyzoides*	Common
4.	*Alchornea cordifolia*	Common
5.	*Alchornea laxiflora*	Common
6.	*Alstonia boonei*	Rare
7.	*Amaranthus spinosus*	Common
8.	*Anacardium occidentale*	Rare
9.	*Anthocleista Vogelii*	Rare
10.	*Andropogon tectorum*	Common
11.	*Anthocleista djalonensis*	Rare
12.	*Aspilia africana*	Common
13.	*Avicennia germinans*	Abundant
14.	*Avicennia marina*	Abundant
15.	*Axonopus compressus*	Common
16.	*Azadirachta indica*	Rare
17.	*Bambusa vulgaris*	Rare
18.	*Calopogonium mucunoides*	Common
19.	*Calotropis procera*	Rare
20.	*Canavalia ensiformis*	Common
21.	*Carica papaya*	Rare
22.	*Centrosema pubescence*	Common
23.	*Chloris pilosa*	Common

24.	*Chlorophytum indet*	Common
25.	*Chromolaena odorata*	Common
26.	*Citrus aurantifolia*	Rare
27.	*Citrus sinensis*	Rare
28.	*Cleome ciliata*	Common
29.	*Cocos nucifera*	Common
30.	*Colocasia esculenta*	Rare
31.	*Combretum hispidum*	Rare
32.	*Commelina diffusa*	Common
33.	*Commelina erecta*	Common
34.	*Cynodon dactylon*	Common
35.	*Cyperus articulatus*	Common
36.	*Dialium guineense*	Rare
37.	*Dryopteris filix-mas*	Abundant
38.	*Eichhornia crassipes*	Rare
39.	*Elaeis guineensis*	Abundant
40.	*Elusine indica*	Common
41.	*Elytrophorus spicatus*	Common
42.	*Emila sonchifolia*	Common
43.	*Euphorbia hirta*	Common
44.	*Ficus carpensis*	Common
45.	*Ficus elastica*	Common
46.	*Ficus exasperata*	Common
47.	*Ficus sur*	Common
48.	*Glyphaea brevis*	Rare
49.	*Heliotropium indicum*	Common
50.	*Lemna minor*	Common
51.	*Luffa aegyptiaca*	Common
52.	*Luffa cylindrica*	Common
53.	*Mangifera indica*	Rare
54.	*Manihot esculenta*	Rare
55.	*Mariscus alternifolius*	Common
56.	*Mimosa pudica*	Common
57.	*Mitracarpus scaber*	Common
58.	*Momordica charantia*	Common
59.	*Morinda lucida*	Rare
60.	*Mucuna sloanei*	Common
61.	*Musa paradisiaca*	Rare
62.	*Musa sapientum*	Rare
63.	*Newbouldia laevis*	Rare
64.	*Nymphea lotus*	Common
65.	*Occimum gratissimum*	Rare
66.	*Opuntia dillenii*	Rare
67.	*Palisota hirsuta*	Rare
68.	*Panicum maximum*	Common
69.	*Paspalum vaginatum*	Abundant
70.	*Pennisetum purpurea*	Common
71.	*Pergularia daemia*	Common
72.	*Phyllanthus amarus*	Common
73.	*Physalis augulata*	Common

74.	*Pupalia lappacea*	Common
75.	*Raphia hookeri*	Abundant
76.	*Rhizophora mangle*	Abundant
77.	*Saccharum officinarum*	Rare
78.	*Sacciolepis africana*	Common
79.	*Sensevieria liberica*	Rare
80.	*Sida acuta*	Common
81.	*Sida cordifolia*	Abundant
82.	*Solanum nigrum*	Common
83.	*Spondias mombin*	Common
84.	*Sporobolus pyramidalis*	Abundant
85.	*Talinum fruticosum*	Common
86.	*Telfaria occidentalis*	Rare
87.	*Terminalia catappa*	Rare
88.	*Terminalia superba*	Common
89.	*Tremia orientalis*	Common
90.	*Tridax procumbens*	Common
91.	*Urena lobata*	Common
92.	*Vernonia amygdalina*	Rare
93.	*Vitex doniana*	Rare
94.	*Xanthosoma saggitifolium*	Abundant

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet), February 2021 (Dry)

Differences in Vegetation diversity and density between the Wet and Dry Seasons

The major difference observed between the wet and dry seasons data gathering was that extensive bush clearing had taken place before the dry season visit, hence most of the tree species had been lost. Also, within the arable sections of the study site, the herbaceous annuals had lost their luscious green colour they had during the wet season. Most plants in this category now looked brownish due the impact of the dry season. In a nutshell, there was no significant difference in the vegetation diversity but only in vegetation density due to extensive bush clearing that took place before the second visit.

Comparison of AWBS (2013) to Present EIA, 2021

It was observed that the vegetation composition in the study site remain relatively unchanged when compared with the last AWBS 2015. The reason is that the site falls within the marshy wetland ecosystem where the soil retain water almost throughout the year, hence the impact of dry season on vegetation cover and diversity is quite minimal. However, differences in terms of density were noted in some annual and ephemeral species like *Elusine indica*.

4.3.10 Wildlife Resources

The study area is a land mass of 842 ha in size, and it is within an iron fenced Zone with multiple gated entrances into the Lagos Free Zone facility at Ibeju-Lekki. The Zone is undergoing some developmental and operational activities (i.e different constructions ongoing at different places within the Zone), and is still accessible by the community people whereby they are allowed to farm, fish, hunt, etc. These activities coupled with existing industrial operations has impacted the ecology of the area leading to habitat fragmentation and loss of wildlife.

Based on observations and findings, the vegetation within the Zone remained mostly green and rich in species diversity as well. The proximity to the Lekki Lagoon and the Atlantic Ocean creates a unique ecosystem with low water table which recharges the vegetation making them lush and evergreen. The determines the fauna encountered in the project area which roam within the remaining corridor of dense raffia jungles and mangrove trees. More so, the built of area has lots of trees and lakes which are hotspots of various insects and birdlife. The physiognomy of the area did not vary significantly between the wet and dry seasons.

Invertebrate Species Diversity

A total of thirty-six (36) invertebrate species were found in the Zone (Table 4.40). The observed taxa include Phylum Arthropoda, Annelida and Mollusca, (Figure 4.28). The most dominant group of invertebrates were the Diptera, closely followed by the Hemiptera then followed by Lepidoptera, Isoptera, Orthoptera, Coleoptera, Odonata while the least are Polydesmida, Scopiones, Theridiidae, Mantodea, Cicadellidae, Decapoda, Phasmatodae, Scolopen dromorpha, Pulmunata, Haplotaxida, Hirudinidae and Hymenoptera.

The observed species were mostly Not Evaluated (NE) while a few species were Least Concerned (LC). However, Leeches considered to be near threatened were found in some ponds and seasonal wetlands in the area. The species were all oviparous but some of the Arthropods observed are hemi-metabolous, having an incomplete metamorphosis with no larvae or pupae stages in their lifecycle (Plate 4.7).

In terms of their feeding habits, they were either herbivorous or insectivorous. The herbivorous forms ranged from butterflies and bees which merely sucked on nectar and saps to beetles and grasshoppers which fed of plant foliage with their specialized mouth parts. This was notable as several plants had leaves with varying degrees of damaged by the insects.

Dung beetles, termites and ants with characteristic saprophytic lifestyles were also observed (Table 4.31). Termiteria/termite hills, Cricket hole, and some Ant Anthils were also observed across the landscape indicating a rich stock of arthropods which are involved in recycling nutrients as saprophyte.

Moreover, there were more species in the upland areas than in the coastal sections, although a good number of them were present in both landscapes associated with the project site. Overall, most of the species were common in occurrence, being sighted at least within every 100 m transect (Table 4.32).

Table 4.31: Checklist of the invertebrate species within the Lagos Free Zone Ibeju-Lekki Lagos during the wet season (2020)

S/N	Order/Family	Common Name	Scientific Name	Reproduction Method	Feeding habit	IUCN Status
Invertebrates						
Phyllum Arthropoda						
1	Diptera	Tse-tse-fly	*Glossina sp.*	Oviparity	Haematophagous	NE
2	Diptera	Black-fly	*Simulium sp.*	Oviparity	Haematophagous	NE
3	Diptera	Mosquito	*Anopheles sp.*	Oviparity	Haematophagous	NE
4	Diptera	Honey bee	*Apis mellifera*	Oviparity	Phytophagous	
5	Diptera	Sandfly	*Leishmania tropica*	Oviparity	Haematophagous	NE
6	Isoptera	Termites	*Macrotermes nigeriensis* Smeathman	Oviparity	Herbivorous	NE
7	Isoptera		*Macrotermes bellicosus* Smeathman	Oviparity	Herbivorous	NE
8	Diptera	House Fly	*Musca domestica*	Oviparity	Haematophagous	NE
9	Araneae	Spider	*Gatrocantha sp.*	Oviparity	Insectivorous	NE
10	Mantodea	Praying mantis	*Mantis religiosa*	Oviparity	Insectivorous	LC
11	Orthoptera	Varigated grasshopper	*Zonocerus variagatus*	Oviparity	Phytophagous	NE
12	Orthoptera	Short horned grasshopper	*Cytacanthacris naeruginosus*	Oviparity	Herbivorous	NE
13	Orthoptera	Field grasshopper	*Chorthippus* sp.	Oviparity	Herbivorous	NE
14	Scorpiones	Scorpion	*Pandinus imperator*	Oviparity	Insectivorous	NE
15	Odonata	Dragonfly	*Orthetrom branchiale*	Oviparity	Insectivorous	NE
16	Polydesmida	Giant African Olive Milipede	*Archispirostreptus sp.*	Oviparity	Herbivorous	NE
17	Coleoptera	Rhinoceros beetle	*Analeptes trifasciata*	Oviparity	Herbivorous	NE
18	Hymenoptera	Black mud wasp	*Delta emarginatum*	Oviparity	Insectivorous	NE
19	Isoptera	Giant Black Ant	*Camponotus vagus*	Oviparity	Omnivorous	NE
20	Isoptera	Red Ant	*Solenopsis Invicta*	Oviparity	Omnivorous	
21	Isoptera	Weaver Ant	*Oecophylla smaragdina*	Oviparity	Omnivorous	NE
22	Coleoptera	Dung Beetle	*Scarab* sp.	Oviparity	Omnivorous	NE
23	Coleoptera	Green Leaf Beetle	*Cicadella viridis*	Oviparity	Herbivorous	NE
24	Lepidoptera	Butterfly	*Papilio polyxenus*	Oviparity	Herbivorous	NE

25	Lepidoptera	Kattydid	*Microcentrum* sp.	Oviparity	Herbivorous	NE
26	Lepidoptera	Cabbage white	*Pieris rapae* Linnaeus	Oviparity	Herbivorous	NE
27	Orthoptera	Long winged cricket	*Gasteracantha versicolor*	Oviparity	Omnivorous	NE
28	Orthoptera	Giant African Cricket	*Brachytrupes membranaceus*	Oviparity	Omnivorous	NE
29	Hemiptera	Cotton Stainer	*Dysdercus cingulatus*	Oviparity	Herbivorous	LC
30	Lepidoptera	Red Lacewing Butterfly	*Cethosia biblis*	Oviparity	Herbivorous	NE
31	Scolopendromorpha	Centepede	*Scolopendra morsitans*	Oviparity	Carnivorous	NE
32	Hemiptera	Treehopper	*Stictocephala species*	Oviparity	Herbivorous	NE
33	Phasmatodae	Walking Stick	*Diapheromera species*	Oviparity	Herbivorous	NE
34	Decapoda	Crab	*Uca tangeri*	Oviparity	Omnivorous	NE
35	Hemiptera	Bugs	*Rastrococcus species*	Oviparity	Herbivorous	NE
36	Hemiptera	Bugs	*Icerya species*	Oviparity	Herbivorous	NE
37	Lepidoptera	Butterfly	*Acacia species*	Oviparity	Herbivorous	NE
38	Hemiptera	Aphids	*Aphidoidea sp.*	Oviparity	Herbivorous	NE
39	Cicadellidae	Leafhopper	*Cicadellidae sp.*	Oviparity	Herbivorous	NE
40	Odonata	Common citril	*Ceriagrion glabrum*	Oviparity	Insectivorous	LC
41	Isoptera	Common black wasp	*Orosius orientalis*	Oviparity	Insectivorous	NE
42	Theridiidae	Six-eyed sand spider	*Latrodectus* sp.	Oviparity	Insectivorous	NE
43	Theridiidae	Jumping spider	*Chrysolina banskii*	Oviparity	Insectivorous	NE
	MOLLUSCA					
44	Pulmunata	Giant African Land Snail	*Archachatina marginata*	Oviparity	Herbivorous	NE
45	Ampullariidae	Pila	*Pila Africana*	Oviparity	Herbivorous	LC
	ANNELIDA					
46	Haplotaxida	Earth Worm	*Eugenia Eugenia*	Oviparity	Herbivorous	NE
47	Hirudinidae	Leech	*Hirudo medicinalis*	Oviparity	Parasitic	NT

LC-Least Concern; NE- Not Evaluated, NT- Near Threatened

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)

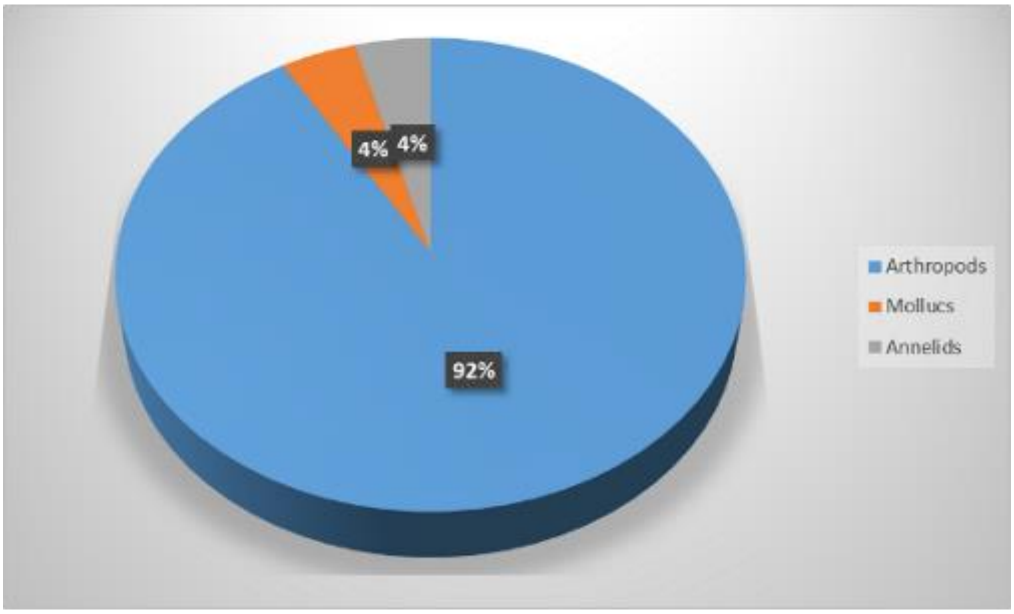


Figure 4.28: Relative percentage occurrence of invertebrate taxa at the LFZ and environs

Table 4.32: Relative location of the invertebrate species and their general level of occurrence

S/N	Common name	Scientific name	Presence in sampled locations		Level of occurrence
			Coastal	Upland	
1	Tse-tse-fly	*Glossina sp.*	P	P	Common
2	Black fly	*Simulium sp.*	P	P	Uncommon
3	Mosquito	*Anopheles sp.*	P	P	Common
4	Honeybee	*Apis mellifera*	A	P	Common
5	Sandfly	*Leishmania tropica*	A	P	Common
6	Termites	*Macrotermes nigeriensis* Smeathman	A	P	Common
7	Termites	*Macrotermes bellicosus* Smeathman	A	P	Common
8	House Fly	*Musca domestica*	P	P	Common
9	Spider	*Gatrocantha sp*	A	P	Uncommon
10	Praying mantis	*Mantis religiosa*	A	P	Uncommon
11	Varigated grasshopper	*Zonocerus variagatus*	A	P	Common
12	Short horned grasshopper	*Cytacanthacris naeruginosus*	P	P	Common
13	Field grasshopper	*Chorthippus* sp.	A	P	Common
14	Scorpion	*Pandinus imperator*	A	P	Uncommon
15	Dragonfly	*Orthetrom branchiale*	P	P	Common
16	Giant African Olive Milipede	*Archispirostreptus sp.*	A	P	Uncommon
17	Rhinoceros beetle	*Analeptes trifasciata*	A	P	Common
18	Black mud wasp	*Delta emarginatum*	A	P	Common
19	Giant Black Ant	*Camponotus vagus*	A	P	Common
20	Red Ant	*Solenopsis Invicta*	A	P	Uncommon

21	Weaver Ant	*Oecophylla smaragdina*	A	P	Uncommon
22	Dung Beetle	*Scarab* sp.	A	P	Common
23	Green Leaf Beetle	*Cicadella viridis*	P	P	Uncommon
24	Butterfly	*Papilio polyxenes*	P	P	Common
25	Kattydid	*Microcentrum* sp.	P	P	Common
26	Cabbage white	*Pieris rapae* Linnaeus	P	P	Common
27	Long winged cricket	*Gasteracantha versicolor*	A	P	Common
28	Giant African Cricket	*Brachytrupes membranaceus*	A	P	Uncommon
29	Cotton Stainer	*Dysdercus cingulatus*	A	P	Common
30	Red Lacewing Butterfly	*Cethosia biblis*	A	P	Common
31	Centepede	*Scolopendra morsitans*	P	A	Common
32	Treehopper	*Stictocephala sp.*	A	P	Uncommon
33	Walking Stick	*Diapheromera sp.*	A	P	Uncommon
34	Crab	*Uca tangeri*	P	A	Common
35	Bugs	*Rastrococcus sp.*	P	P	
36	Bugs	*Icerya sp.*	A	P	Common
37	Butterfly	*Acacia sp.*	A	P	
38	Aphids	*Aphidoidea sp.*	A	P	Common
39	Leafhopper	*Cicadellidae sp.*	A	P	
40	Common citril	*Ceriagrion glabrum*	P	P	Common
41	Common black wasp	*Orosius orientalis*	P	P	Common
42	Six-eyed sand spider	*Latrodectus* sp.	A	P	Uncommon
43	Jumping spider	*Chrysolina banskii*	A	P	Uncommon
44	Giant African Land Snail	*Archachatina marginata*	A	P	Uncommon
45	Pila	*Pila Africana*	P	A	Uncommon
46	Earth Worm	*Eugenia Eugenia*	A	P	Common
47	Leech	*Hirudo medicinalis*	P	A	Uncommon

A-Absent, B-Present. *Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)*


Plate 4.7: Invertibrates in Project Area

Vertebrate Species Diversity

Non-Avian Forms

The findings from the field survey indicated a total of thirty (30) and twenty- three (23) vertebrate species were found in the Zone in the wet and dry seasons respectively (Table 4.33). The observed taxa include members of the Phylum Amphibia, Reptilia, and Mammals. Mammals are the most dominant non-Avian vertebrates observed in both seasons.

The species observed were mostly Viviparous except for the Anura, *Bufo regularis* which is Oviparous. Moreover, the observed species in the dry season include omnivores, carnivores, and herbivores with diverse lifestyle selection. They exhibited a diverse range of food selection in relation to their respective niches, dentition, and other behavioural repertoire.

The farmers and workers attested to their frequent sightings especially in the deeper sections of the swamp forests with limited human interactions and affirmed that they sighted more species in the dry season compared to the rainy/wet season. This may be due to the reduced vegetation cover and reduced food resources which necessitates foraging elsewhere in different forest patches for survival, hence increased sighting frequency. Competition for water and limited resources during this season and a need to stay in habitats which reduces the effects of the scotching sun also results in increased movements and sightings.

The species observed were mostly categorised as either Not Evaluated or Least Concerned based on the International Union for Conservation of Nature (IUCN) Red list. Among the observed non- avian vertebrates in the wet season are tortoise, *Kinixys erosa* which categorised as Data Deficient (DD) while the Straw- coloured Fruit Bad, *Eidolon helvum,* the bay duiker, *Cephalophus dorsalis* and Patas monkey*, Erythrocebus patas* are considered as Near Threatened (NT) species.

In dry season, species with Near Threatened status were the Mona Monkey, *Cercopithecus mona* and the Duiker, *Cephalophus dorsalis* while white- bellied pangolin, *Manis tricuspis* is Endangered (EN) due to widespread overhunting and illegal export as a wildlife of commercial interest. The project will not impact on IUCN species.

Table 4.33: Checklist of the vertebrate species within the Lagos Free Zone Ibeju-Lekki Lagos during the wet season (2020)

S/N	Taxa/ Scientific Names	Common Names	Scientific Name	Reproduction Method	Feeding	Iucn Status
	AMPHIBIA					
1	Anura	Efulen forest tree frog	*Leptopelis calcaratus*	Oviparity	Carnivorous	LC
2	Anura	Toad	*Bufo regularis*	Oviparity	Carnivorous	LC
3	Anura	Frog	*Rana temporaria*	Oviparity	Carnivorous	LC
	CLASS REPTILIA					
4	Larcelitia	Rainbow Lizard	*Agama agama agama*	Oviparity	Carnivorous	NE

5	Scincidae	Common garden skink	*Lampropholis guichenoti*	Oviparity	Carnivorous	LC
6	Colubridae	Western Rat Snake	*Elaphe obsoleta*	Oviparity	Carnivorous	LC
7	Crocodylidae	Nile Crocodile	*Crocodylus suchus*	Oviparity	Carnivorous	NE
8	Varanidae	Monitor Lizard	*Varanus niloticus*			NE
9	Elapidae	African cobra	*Naja pallida*	Oviparity	Carnivorous	NE
10	Chamaeleonidae	African chameleon	*Chamaeleo africanus*	Oviparity	Carnivorous	LC
11	Elapidae	West African green mamba	*Dendroaspis viridis*	Oviparity	Carnivorous	LC
12	Pythonidae	African rock python	*Python sebae*	Oviparity	Carnivorous	NE
13	Testudinidae	Tortoise	*Kinixys erosa*	Oviparity	Herbivorous	DD
	MAMMALS					
14	Rodentia	Giant Forest Squirrel	*Protoxerus stangeri*	Viviparity	Herbivorous	LC
15	Rodentia	African Ground Squirrel	*Xerus erytropus*	Viviparity	Herbivorous	LC
16	Rodentia	Gambian Pouched Rat	*Cricetomys gambianus*	Viviparity	Omnivorous	LC
17	Lagomorpha	West African Rabbit	*Poelagus marjorita*	Viviparity	Herbivorous	LC
18	Cercopithecidae	Mona Monkey	*Cercopithecus mona*	Viviparity	Omnivorous	NT
19	Rodentia	Grass Cutter	*Thryonomys swinderianus*	Viviparity	Herbivorous	LC
*20	Artiodactyla	Cow	*Bos taurus*	Viviparity	Herbivorous	NE
21	Pteropodidae	Straw-coloured fruit bat	*Eidolon helvum*	Viviparity	Omnivorous	NT
22	Bovidae	Roan antelope	*Hippotragus equines*	Viviparity	Herbivorous	NE
23	Manidae	White-bellied pangolin	*Manis tricuspis*	Viviparity	Canivorous	EN
24	Rodentia	African grass rat	*Arvicanthis niloticus*	Viviparity	Herbivorous	LC
25	Rodentia	African giant rat	*Cricetomys gambianus*	Viviparity	Omnivorous	LC
26	Cervidae	Barbary red	*Cervus elaphus*	Viviparity	Herbivorous	NE

		deer	*barbarus*			
27	Bovidae	Bay duiker	*Cephalophus dorsalis*	Viviparity	Omnivorous	NT
28	Bovidae	African buffalo	*Syncerus caffer*	Viviparity	Herbivorous	NT
29	Bovidae	Reedbuck	*Redunca redunca*	Viviparity	Herbivorous	LC
30	Cercopithecidae	Patas monkey	*Erythrocebus patas*	Viviparity	Omnivorous	NT

DD-Data Deficient, LC-Least Concern, NE- Not Evaluated, NT- Near Threatened
Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

Domesticated/ Farm animals

The observed domesticated animal was cattle (Table 4.34). Herdsmen were often seen with their free ranging cattle foragaing on low lying pasture on fallow lands (Plate 4.8). There were large areas of pasture for grazing due to easy access in the land filled areas.

Just as with the wet/rainy season, the vailable vegetation in the dry season still provided enough foilages to support hearder's cattle in the area. The cattle density was however much reduced in the dry season. Unlike in the rainy season where sighting was common, in the dry season, it is ocassional and the cattle density was much reduced. Only ocassional sighting of footprints and dung are reminders of the presence and activities of herders in the area during the dry season

Plate 4.8: Mammals in the Project Area

Aves/Birds Species Diversity

Aves are characteristically unique vertebrates whose evolution of feathers and wings make them particularly adapted to arboreal lifestyle. Their lifestyle selection is particularly predicated on the abundance of tall trees and thick bushes depending on the species. This however is a major point of conflict were developmental activities and avian species diversity and sustainability.

The findings from the present study indicated the presence of a least twenty-five species of birds belonging to diverse taxa in both wet and dry seasons. The abundance of the birds in the area despite the current industrial activities may be due largely to the fact that LFZ management left out large portions of vegetation especially those in the coastal areas. This has ensured non-fragmentation of the habitats and consistent availability of tall trees and diverse vegetation to support the teeming bird life in the area.

Most of the observed avian species in the wet season are resident, with only the Black kite, *Milvus migrans* being the only purely migrant species recorded. Two species, *Egretta alba* and *Aquila rapax* observed were both resident and migrant in nature. There were increasing sightings of raptors such as the Black kite, Harrier hawk and even Pied crows, perhaps due to dwindling food resources available in the peak of the dry season as potential preys take cover from the heat of the sun (Plate 4.9). Spur-winged *Lawpings, Vanellus spinosus* were a common sight around lakes and ponds where they huddle together in the muds to cool off and search for available preys. Others such as the Double-spurred Francolin, *Francolinus bicalcaratus* take advantage of the season to breed.

In the dry season, the birds still found refuge in the remaining forest patches and thickets as well as ornamental trees and buildings in the facility. The artificial and modified lakes in the complex also helped to retain drinking water which attracts birds in their numbers especially making enumeration a much easier task.

Most of the species are either classified Least Concern or Not Evaluated by IUCN Redlist. However, a Vulnerable (VU) owl species, was recorded as well in wet season while two notable species *Scotopelia ussheri* and *Aquila rapax* are Vulnerable (VU), requiring conservation efforts to help stabilize and increase their population in the wild.

Table 4.34: Checklist of the Aves species within the Lagos Free Zone Ibeju-Lekki Lagos during the wet season (2020)

S/N	Common Names	Scientific Names	Scientific Name	Iucn Status
1	Bates's Swift	*Apus batesi*	Resident	LC
2	Palm swift	*Cypsiums pariuus*	Resident	NE
3	Pied Crow	*Corvus albus*	Resident	LC
4	Swamp Palm Bulbul	*Thescelocichla leucopleura*	Resident	LC
5	Village Weaver	*Ploceus cucullatus*	Resident	LC
6	Black Kite	*Milvus migrans*	Migrant	LC
7	Trumpeter Finch	*Bucanetes githagineus*	Resident	LC
8	Laughing Dove	*Streptopelia vinacea*	Resident	LC
9	Senergal Coucal	*Centropus senegalensis*	Resident	LC
10	Superb Sunbird	*Cinnyris superbus*	Resident	LC
11	Common Bulbul	*Pycnonotus barbatus*	Resident	LC
12	Eleonora's falcon	*Falco eleonorae*	Resident	LC
13	Savi's warbler	*Locustellaluscinioides*	Resident	LC
14	Bar-breasted firefinch	*Lagonostictarufopicta*	Resident	LC
15	African white- back vulture	*Gyps africanus*	Resident	LC
16	Pel's fishing owl	*Scotopelia ussheri*	Resident	VU
17	Great Egret	*Egretta alba*	Resident & Migrant	LC
18	Pin-Tailed Whydah	*Vidua macroura*	Resident	LC
19	Tawny eagles	*Aquila rapax*	Resident & Migrant	VU

20	Shining Drongo	*Dicrurus ludwigii*	Resident	LC
21	Spur-winged, lapwing	*Vanellus spinosus*	Resident	LC
22	African firefinch	*Lagonosticta rubricata*	Resident	LC
23	Oriole warbler	*Hypergerus atriceps*	Resident	LC
24	Green fruit pigeon	*Treon australis*	Resident	NE
25	African ban owl	*Tyto alba*	Resident	LC
26	African Harrier Hawk	*Polyboroides typus*	Resident	LC
27	Double-spurred Francolin	*Francolinus bicalcaratus*	Resident	LC
28	Principe Golden weaver	*Ploceus princeps*	Resident	LC

LC- Least Concerned, NE- Not Evaluated; VU-Vulnerable

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

Plate 4.9: Samples of Avifauna in Project Environment

4.3.11 Land Use

"Land Cover" refers to natural or man-made physical properties of the land surface (what the land is covered with) such as coniferous forest or impervious surfaces. Identified land cover types were further classed into land uses, which was further broken into categories. The study area is minor urban area experiencing rapid transformation in land use pattern due to industrialization. The following land use types were identified as follows:

Built-up Area

Urban or Built-up Land is comprised of areas of intensive use with much of the land covered by structures. Included in this category are cities, towns, villages, strip developments along highways, transportation, power, and communications facilities, and areas such as those occupied by mills, shopping centers, industrial and commercial complexes, and institutions that may, in some instances, be isolated from urban areas.

The project area falls within the Lekki Free Zone, off the Lekki-Epe Expressway, east of Lagos State. The area has seen a steady rise in development due to the promise of the master plan to develop the area by the Lagos State Government. Noticeable Landuse categories included the following:

Industrial, Manufacturing and CommercialIndustrial areas include a wide array of land uses from light manufacturing to heavy manufacturing plants. Identification of light industries focused on design, assembly, finishing, processing, and packaging of products can often be based on the type of building, parking, and shipping arrangements. Light industrial areas may be, but are not necessarily, directly in contact with urban areas; many are now found at airports or in relatively open country. Heavy industries use raw materials such as iron ore, timber, or coal. Included are steel mills, pulp and lumber mills, electric power generating stations, oil refineries and tank farms, chemical plants, and brick making plants. Stockpiles of raw materials and waste-product disposal areas are usually visible, along with transportation facilities capable of handling heavy materials.

The proposed project development site falls within the Lekki Free Zone (LFZ), which is an area set aside for commercial and industrial activities. However, the LFZ is being developed and far from completion, several other industries are under construction with others fully operational within the area and in proximity to the project site (Figure 4.29). Manufacturing is divided into small industry and industry based on the number of employees of the firm, since the number of occupants and the surface area are the two basic units of measurement of urban uses. Kellogg's is a major manufacturer of cereals and shares a common boundary with the project area to the west whiel Dangote Industries borders it to the east. To the far east of the project area is the Others included block molding manufacturing industries of small and medium scale found along the major access road.

Other commercial activities such as retail trade exist in the area. Retail Trade, as we know, is the activity of selling products directly to the consumer. Trading is a common socio-economic practice within the community with most families trading from their private houses in small and medium trading. Commodities sold range from drinking water (in sachets, bottles, etc.) to food items (e.g., foodstuff, mobile airtime, firewood, etc.).

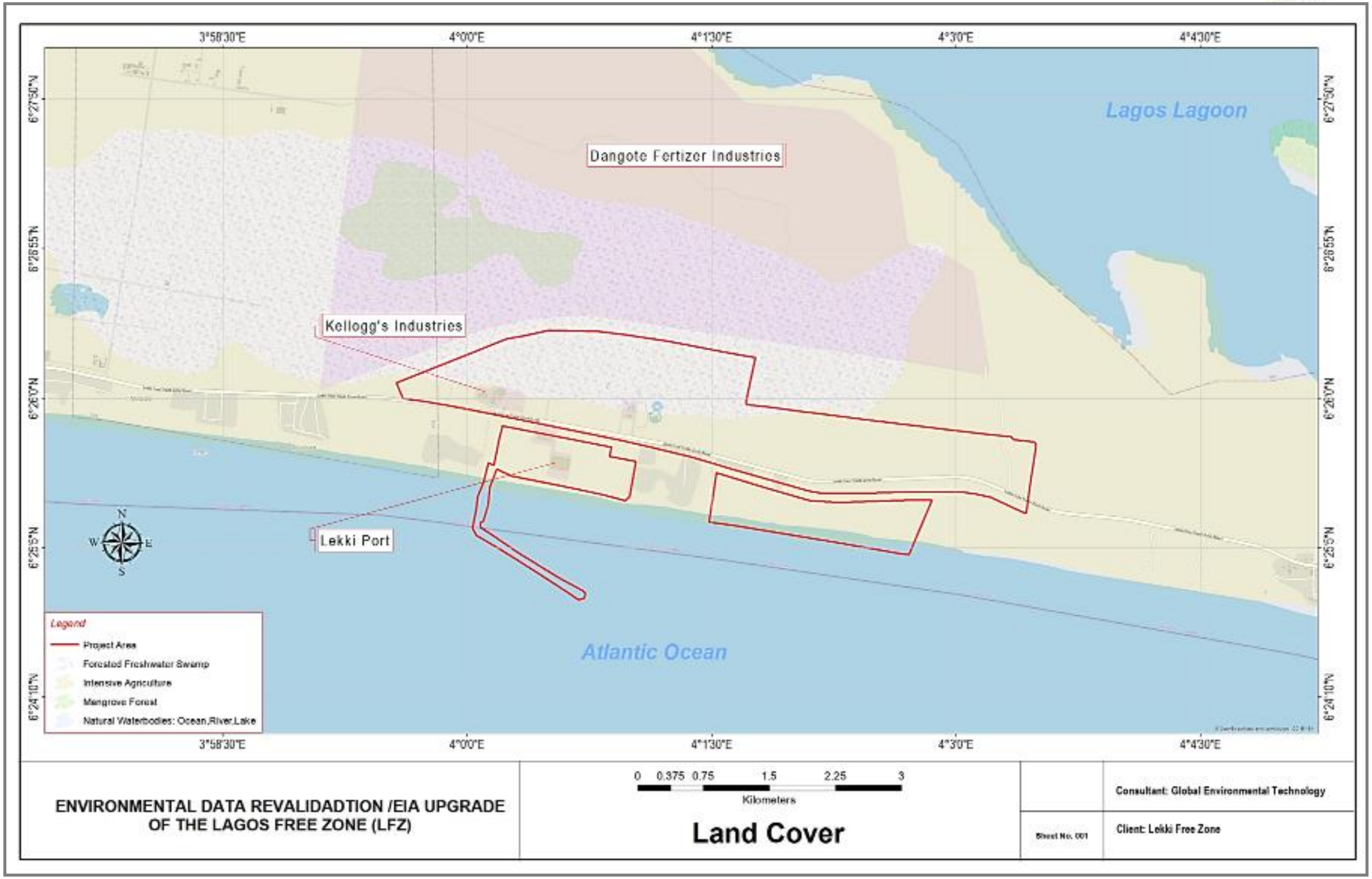


Figure 4.29: Landuse and Landcover in the Study Area

Several other businesses operate from specifically designed outlets such as line of stores where building materials and other such items can be found. Several schools were seen scattered within identified communities providing both primary and secondary levels of education.

Residential

The built-up category of residential includes those uses in which the primary activity is the provision of long-term accommodation (Plate 4.10). Residential land uses range from high density, represented by the multiple-unit structures of urban cores, to low density, where houses are on lots of more than an acre, on the periphery of urban expansion. The following types of residential uses observed include, single-family units and multi-family units. They are distributed in a nucleated pattern and characterized by bungalows which are mostly not painted.

Plate 4.10: A cross section of residential units within the Project area along the major road

Utilities

Nodes of the infrastructural networks (mains of natural gas and liquid fuels, electricity lines), as well as bus and lorry terminals, railway stations, airports, seaports and telecommunications centers, make up this category. The major utility found in the area is electricity lines. Electric poles and overhead cables were observed and connect the community to the national grid (plate 4.11). Other Utilities include underground water sources (boreholes) which the community uses as a major source of water for domestic uses. A few of these bore holes are community owned, while majority are privately owned.

Plate 4.11: Observed Electricity Infrastructure

Transportation

The category of transportation is analyzed based on the nature of use into the sub-category of transport services on the one hand, and parking areas for vehicles on the other. Major transportation routes and areas greatly influence other land uses, and many land use boundaries are outlined by them. The types and extent of transportation facilities in a locality determine the degree of access and affect both the present and potential use of the area.

Major transport service in the area is by private, commercial, or public vehicles (Plate 4.12). The commercial vehicles include buses, saloon cars or motorbikes for transporting people and goods between communities, with a handful of state-owned public transport system in place. Most people walk about making use of foot paths, which connect residential units and places of interests within and around the community.

Plate 4.12: Observed Transport category

Vegetation

Vegetation is a general term for the plant life of a region; it refers to the ground cover provided by plants and is by far the most abundant biotic element of the biosphere. Vegetation serves several critical functions in the biosphere, at all possible spatial scales.

Agricultural Land and Grazing

Pockets of farmlands are scattered over the spatial boundary of this study. These farmlands are cultivated by individual family units primarily for personal consumption. The farmlands are mostly within walking distance from their residential units and relatively small in size, e.g., plot or half a plot of land. The area equally provides lush green plants used by normadic tribes for grazing. Cattle dung was observed all over the project area. Several herds of cattle were observed, grazing the fields from a distance.

Natural and Semi Natural Vegetation

Natural vegetated areas are defined as areas where the vegetative cover is in balance with the abiotic and biotic forces of its biotope. Semi-natural vegetation is defined as vegetation not planted by humans but influenced by human actions (Plate 4.13). These may result from grazing; possibly overgrazing the natural phytocenoses, or else from practices such as selective logging in a natural forest whereby the floristic composition has been changed. Previously cultivated areas which have been abandoned and where vegetation is regenerating are also included.

The secondary vegetation developing during the fallow period of shifting cultivation is a further example. The human disturbance may be deliberate or inadvertent. Hence semi-natural vegetation includes vegetation due to human influences but which has recovered to such an extent that species composition and environmental and ecological processes are indistinguishable from, or in a process of achieving, its undisturbed state. The vegetative cover is not artificial, in contrast to cultivated and managed terrestrial areas, natural, and semi-natural aquatic or Regularly Flooded Vegetation; and it does not require human activities to be maintained in the long term.

Plate 4.13: Cross-section Natural and Semi Vegetation within and round the Project Area

Water Body

This refers to areas that are naturally covered by water, such as lakes, rivers, snow or ice. The closest water body is the Atlantic Ocean (marine), which is approximately 950 meters, south of the project area as crow flies. It is separated from the project area by the major access road and built-up areas.

The Lagos Lagoon (fresh water) is another major water body found north of the project site and approximately 4 km away. The lagoon was initially shallow but for recent sand mining in several areas of the lagoon and is not plied by ocean-going ships, but by smaller barges and boats. The lagoon receives the discharge of the Ogun River and the Osun River and empties into the Atlantic via Lagos Harbour, a main channel through the heart of the city, 0.5 km to 1 km wide and 10 km long.
Both water bodies offer several benefits to the locals found within and around the project area. Fishing and transportation being the obvious benefits in addition to source of water for domestic use.

4.3.12 Socioeconomics and Community Health Community

Interactions/Focus Group Discussions & Questionnaire Administration

Fieldwork for the socioeconomic and health impact assessment studies and data collection took place from Wednesday 19th August to Sunday, 23rd August 2020. All eight (8 nos.) stakeholder communities: Lekuru, Okunraye, Alasia, Oke-Segun, Magbon-Segun, Itoke, Lujagba and Idotun were visited for data collection, although the Consultants were not allowed access and interactions in the last two (Itoke and Idotun).

The socioeconomic study was based on a participative approach, involving the affected stakeholders as much and effectively as possible during data collection. Both qualitative and quantitative methods were employed for effective socioeconomic and community health data collection. Qualitative methods have to do with people's perceptions, how they view themselves and the world around them. For the Lagos Free Zone environmental data revalidation/EIA upgrade study, community-wide interactions, and discussions, focus group meetings/discussions (FGMs/FGDs) and key informant interviews (KIIs) were utilized to solicit necessary information, including opinion and perceptions about the activities of the existing industries and other proposed and anticipated enterprise companies (Plates 4.14 – 4.19).

Quantitative methods were also used to generate data, mostly at household level using questionnaire and the survey method. The administration of a set of structured questionnaires is a conventional method of data collection in the social sciences. As a survey instrument and primary data collection method, the questionnaire is structured to incorporate socioeconomic and environmental issues and included binary, optional and open-ended questions that solicited relevant information from the householder (See Appendix 1). One hundred and eighty-five questionnaires were administered to the population in the host communities. The sample size was proportional, ranging from 2 -3%, with a minimum of 30 and a maximum of 42 copies administered to the affected communities according to the physical and population sizes of each community (See Table 4.35). Questionnaires were administered face to face to community respondents after community-wide and focus group discussions. Respondents found literate were also allowed to self-administer the questionnaire, after clarifications on how to fill same. But time and logistics necessitated leaving behind some of the questionnaire to enable a larger reach and retrieval. Arrangements were put in place to retrieve same for analysis and use in the socioeconomic reporting. In all, one hundred and thirty-two copies of the questionnaire were returned completed and analysed for the socioeconomic report preparation, amounting to 71.4% % retrieval success. Copies of the survey instrument were not administered at the Idotun and Itoke communities neither were formal consultation meetings held because circumstances were not conducive as at the time of the field study.

Table 4.35: Pattern of questionnaire administration in the LFZ stakeholder communities

S/no	Name of Community	No. of Questionnaires administered	No. retrieved
1	Lekuru	30	20
2	Okunraye	42	26
3	Alasia	35	29
4	Oke-Segun	40	31
5	Magbon-Segun	38	26
6	Itoke**	Nil	N.A.
7	Idotun**	Nil	N.A.
8	Lujagba	Nil	N.A
	Total	**185**	**132**

Note: **Both communities were in crises mode as at time of study; consultants entered Itoke but could not conduct the study even though allowed some informal interactions and survey of the coastal area under serious coastal flooding and erosion impact, a principal grouse of the communities.

In addition to the field study, a desktop review was conducted reviewing the following documentations to aid the report preparation:

- NPC 2006 Population and Housing Census, Priority Tables, III, 2010
- NPC 2006 Population and Housing Census, Priority Tables II, 2010
- NPC 2006 Population and Housing Census, Priority Tables I, 2009
- Lagos State Household Survey, 2011
- Lagos State Literacy Survey, 2011
- Federal Republic of Nigeria Country Strategy Paper, 2012-2016
- Other Social Impact Assessment Reports (SEIA/SIA) for related projects and the LFZ study environment (e.g., Lekki Port EIA, Socioeconomic Impact Assessment (SEIA) Report for the EES-Based EIA of Stallionaire Depot Facility in Lagos State, Nigeria (Ojile, 2020a); Draft Socioeconomic Impact Assessment Report (SEIA) for the Mansonia Bay Reclamation Project at Oworonsoki, Kosofe LGA, Lagos State,(Ojile, 2020b); The Human Environment (Socio-Economic Aspects) o*f The* Environmental Impact Assessment (EIA) *For The* Food Processing Industries Within The Lekki FTZ (Ojile, 2007).
- Maps and available satellite imagery of the Lekki Free Trade Zone and proximate Lagos State environment

Ground-truthing was also undertaken to identify, and verify existing social infrastructures, their functionality, and capacity/adequacy and authenticate claims of community representatives/participants. These were subsequently photographed where necessary to aid report preparation (See attached plates).

Plate 4.14: Interactive session at Lekuru community

Plate 4.15: The Consultants also took time out with the women group in the interactive session@ Lekuru communty

Plate 4.16: Interactive session at Okunraye community with all fully COVID-19 compliant with PPE

Plate 4.17: Interactive Session at Alasia Community

Plate 4.18: Interactive Consultation Meeting at Oke-Segun Community

Plate 4.19: Consultants at Magbon-Segun community

Socioeconomic Data Analysis and presentation

To analyze both primary and secondary data, simple descriptive methods and summary statistics like mean, range, mode and percentages were used. Most of the data are presented in tables and graphs. Six major levels of aggregation and analysis are employed. These were the national, regional, state, LGA, community, household and individual respondent. The populations of the LFZ stakeholder communities were projected using results from 1991 (projected to 1996) and 2006 national population and housing censuses released by the National Population Commission (NPC, 2009, 2010). Two population projection methods (the linear extrapolation and exponential growth models) are often used in estimating the population. The linear extrapolation model assumes that population growth occurs in constant increments over time; while the exponential model assumes that the rate of growth is never constant but rather changes with time, growing faster as the population size increases. In other words, population often tends to grow exponentially rather than linearly. The exponential growth model was used in estimating the population of the communities. The formula is:

Exponential Growth Model: $P_n = P_o (1+r)^n$

Where:

P_o = population in the base year (in this case 2006)
r = annual growth rate of the population (as obtained from NPC)
n = time lapse, in years

The LFZ Human Environment: Socio-Economic and Community Health Baseline Conditions

Population and Socio-demographic Characteristics

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

Population size, growth and distribution

Lagos State has the smallest landmass of all the thirty-six states of Nigeria. It has an area of (3496 km^2 according to NPC, 2010) but its territorial size is further reduced by lagoons, rivers, creeks and swamps which constitute about 22% (or 779.56 sq. km) of the total land mass. Paradoxically, the state has the 2nd highest total population in Nigeria after Kano; according to the 2006 national census, there were 9,113,605 persons, up from the 1991 figure of 5,685,781 and thus constituted about 6.5 % of the country's total population and 33 % of the South-West geopolitical zone (NPC, 2010) (Figure 4.30).

The total population figure released for Lagos State has been most controversial. Several organisations, including the United Nations, and the Government of Lagos State have churned out figures and documents in variance with the NPC figures, most of which have been based on estimations and data on school enrolment, vehicular density, immunization records, and issuance of national identity cards or personal identification slips. A population figure of 17,553,942 (according to Social Security Welfare Exercise, 2006) was consequently published by the State Government on 5th February 2007, as its own guess estimates or ''parallel" census. The figures have been further projected to 20,546,999 in 2011 based on average population growth rate of 3.2%. With a land size of 3,577.28km^2, the state had a population density of 3510.9 persons per km^2, a frightening figure suggesting congestion, more than 23 times far and above the national average of 150 persons per km^2, and 10 times more than the average population density of 353 persons per sq.km in the southwest geo-political zone (NPC, 2010) (Table 4.36).

The Ibeju-Lekki LGA, the least populated LGA (0.4% of state total) in 1991 with approximately 25,000 total persons is now one of the most inhabited LGA in Lagos State. The national population commission (NPC) had projected that the LGA would have about 30,259 persons by 1996 but the actual growth rate as reported by the Lagos state government and National Population Commission (NPC) shows that Ibeju-Lekki, had the highest growth rate of 10.89% while Lagos Island had a growth rate of -1.67% (LAMATA, 2008). This means that people are gradually moving away from the city's commercial hub into more serene environments. This does not obstruct the continuous daily influx of people from the periphery into the city centre, which is the commercial nerve and hub of Lagos metropolis. Table 4.37 shows the population growth rate.

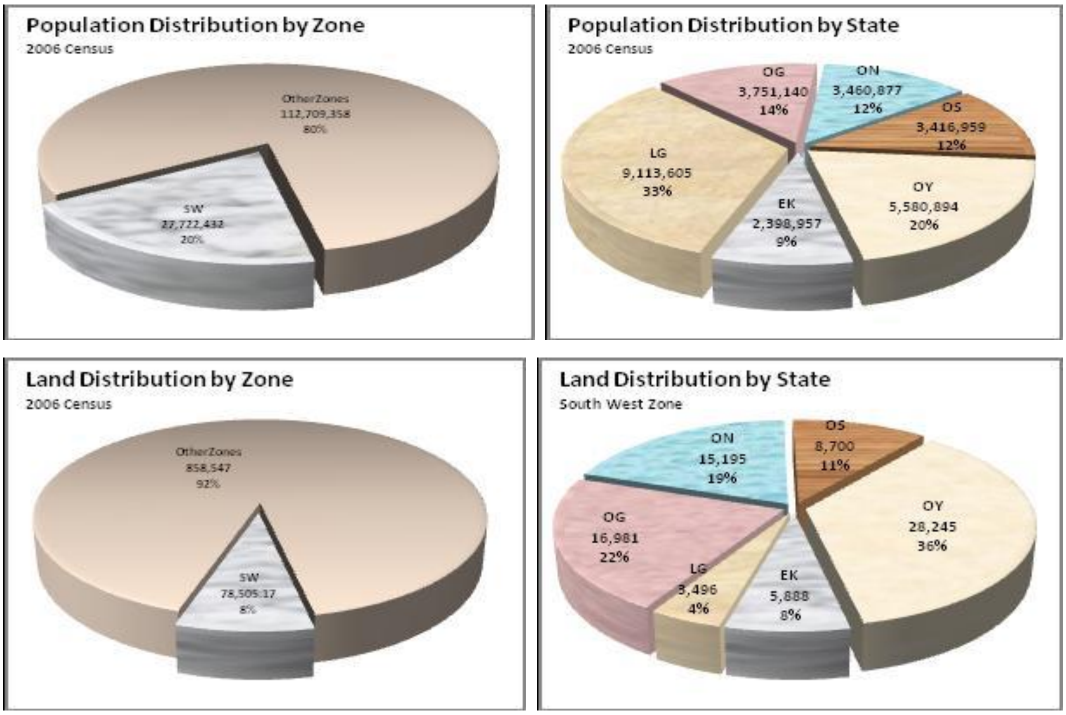


Figure 4.30: Population and land distribution by zone: South-West Geo-political Zone and Lagos State

Table 4.36: Population Characteristics of Ibeju-Lekki LGA and Lagos State

LGA/State	1991*			Area (km^2)	Pop. Density	2006			2011	2016/2018
	Males	Females	Total			Total	Males	Females		
Ibeju-Lekki	12,426	12,511	24,937			117,793	60,729	57,064	138,231	183,078*
Lagos State	3,010,604	2,714,512	5,725,116	3,496.449	3,510.9	9,113,605	4,719,125	4,394,480	10,694912	12,559598**

(Sources: 2006 National Population and Housing Census (NPC, 2010, 2009); NBS, 2012; 2018

*Figures for 2020

** Source: NBS, 2018: Demographic Statistics Bulletin; Nigeria Population Projection by State (2012-2016)

Table 4.37: Some LGA Population Growth Rate

Local Government Area (LGA)	1991 Population Census	LSG 2006	Annual Growth Rate	NPC 2006	Annual Growth Rate
Badagry	119,267	380,420	8.04%	241,093	4.80%
Epe	101,464	323,634	8.04%	181,409	3.95%
EtiOsa	151,589	983,515	13.28%	287,785	4.37%
Ibeju-Lekki	24,937	99,540	9.6%	117,481	10.89%
Lagos Island	269,575	859,849	8.04%	209,437	-1.67%

Source: Lagos State Transport Master Plan Progress Report (LSTMP) & Lagos State Government

According to the Population and Housing Census of 2006, however, the Ibeju-Lekki LGA with a total population of 117,793 constituted just 1.3 % of Lagos State's population. The LGA has a land size of 457.821 km^2, which translates to an average density of 257.3 people per square kilometres, a low density compared with some other LGAs in the State, but nonetheless high because there is still shortage of dry buildable land in the area.

The National Population Commission (NPC) had projected the LGA's population to 138,231 in 2011 (NBS, 2012). By the same projection, it was expected that the population of the Ibeju-Lekki area would have grown to over 180,000, based on the 2020 population growth projection. This will however, suggest a growth rate of 5.3 percent year from 1991 to 2006 and a declining growth of 3 percent from 2006 to the present (2020) for the Ibeju-Lekki LGA, which in reality may be an underestimation. The industrial growth the Lekki-Ibeju area has witnessed in the last decade has been phenomenal and along with it has come an influx of people looking for employment and other economic opportunities.

The results of the 2006 Population and Housing Census up till this date have not been broken down into the various constituent enumeration areas or, localities/settlements and communities. This circumstances notwithstanding, the number of persons living in project affected communities and settlements are estimated based on available 1991 populations projected to 1996 (the base year for projections). The populations of the LFZ stakeholder communities are as presented in Table 4.38 below. The population of the communities are projected to present (2020) using 1996 as base year and a 3.2% annual growth rate, recommended for Lagos State (NPC, 2010, 2009, FGN, 2007).

Communities/settlements like Lekuru, Alasia and Oke Segun were not captured as standalone localities as at the 1991 Census, so are not documented as such. So, at best, these were conjoined with other more permanent and nearby well-known settlements as ''Magbon-Segun & others'. The communities within the Ibeju-Lekki area remain rural agrarian-fishing settlements and are thus sparsely to moderately inhabited and populated. While the communities may have witnessed a growth rate of 2.4% comparable with that found for rural areas in Nigeria (PRB, 2014) between the years 1996 and 2020, the growth rate increased to 3.3% between 2011 and 2020, which appears to agree with the observations already made above.

By NPC's classification of settlements, none of the settlements in the Ibeju-Lekki LGA qualified as an urban area. All affected village communities of the Lekki FTZ area and the stakeholder communities are by all accounts, small rural villages. As a consequence, the settlements had low population distribution; even Ibeju considered one of the most developed communities had less than 3,000 inhabitants. The total combined number of persons presently resident in the 7 stakeholder villages of the LFZ is not more than 10,000, i.e., using the NPC's recommended projection rate, although could be higher. Although the FTZ study environment is located within the vicinity of the above-named 7 communities, effects could go beyond the immediate corridors up to 2-5km either way of these communities especially as the area is within the greater Lekki Master Plan area. The identified communities combined have a projected population of approximately 29,000. Going by their present physical size and un-attractiveness for immigrants (at least until more industrial firms are established to serve as pull-factors, and the communities possess social amenities to make them liveable), the estimated figures are realistic.

Table 4.38: Population of LFZ stakeholder communities

Community/ Locality	1991			1996	2006	2011	2020
	Male	Female	Total				
Magbon Segun & Others	124	135	259	314	430	504	669
Itoke/Idotun & Others	276	270	546	663	909	1063	1412
Idasho	119	128	247	300	411	481	639
Okunraye	321	288	609	739	1013	1185	1574
Total	**840**	**821**	**1,661**	**2,016**	**2,763**	**3,233**	**4,294**
Male/Female ratio	*49.7%*	*50.3%*					

Source: NPC 1991

Household Composition, Marital status and household size

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

Marital status and Age of respondents:

Returned responses from the administered questionnaires revealed that on average, a very high proportion of the sampled respondents were married (78.5%), with those at Lekuru, Okunraye and Magbon Segun having higher responses above the average (Figure 4.31). Respondents who are single are 11.5%; 26.7% of respondents at Oke-Segun community are of this status. The remainder percentage of respondents (10% on average) were divorced, separated and widowed, implying low proportion of vulnerable members of the population in the study environment. 50% of the married male respondents have on average one wife while over a third also have two wives (Figure 4.32).

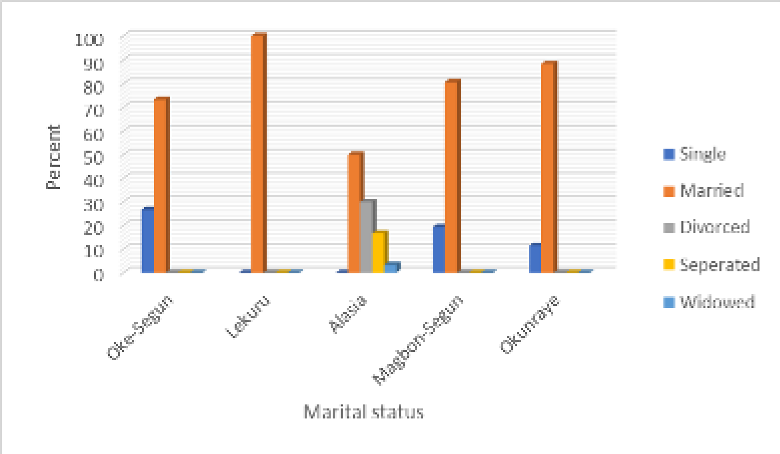


Figure 4.31: Marital Status of Respondents

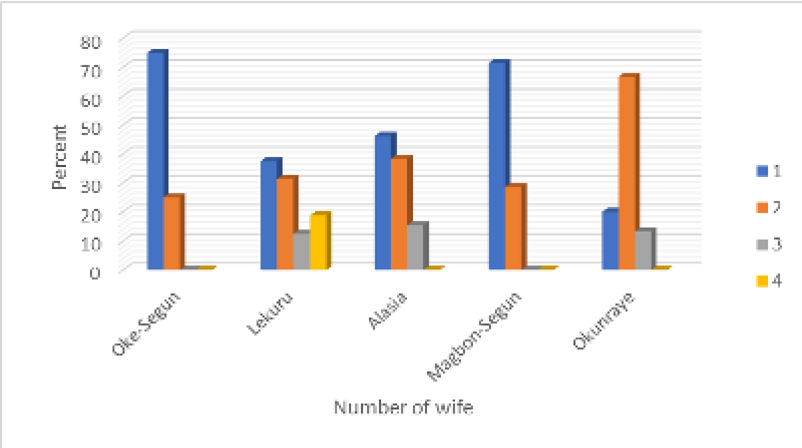


Figure 4.32: Number of wives married by male respondents

The proportion of married persons in the project area also tallied with the age of the respondents; over 90% of the respondents were aged 30 years and above. 63.7% of the respondents are aged 30 – 49 years, while 21.3% are aged 50-59 years. The aged members of the society (60 years and above) are about 8.9% of all respondents (Figure 4.33).

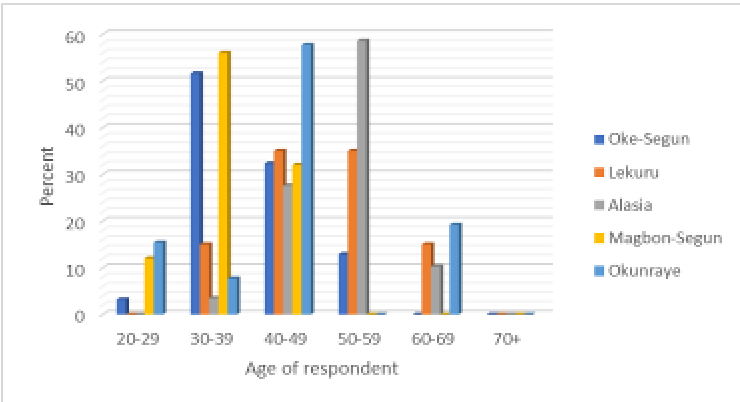


Figure 4.33: Age of Respondents

Household size:

The average number of children in the households in the LFZ study area is 5.5 and 52.6% of the children reported from the married households are males, while 47.4% % are females (Figure 4.34). In addition, questionnaire analysis revealed the households have an average of 2 dependents each to cater for. Average household size in the study communities amounted to 7.5 persons (Table 4.39 and Figure 4.35).

Table 4.39: Demographics of sampled households

Community	Sample Number of Households	Number of Household Members	Average Household Size
Oke Segun	31	240	7.7
Lekuru	23	170	7.4
Alasia	29	193	6.7
Magbon Segun	26	196	7.5
Okunraye	26	209	8.0
Total	**135**	**1009**	**7.5**

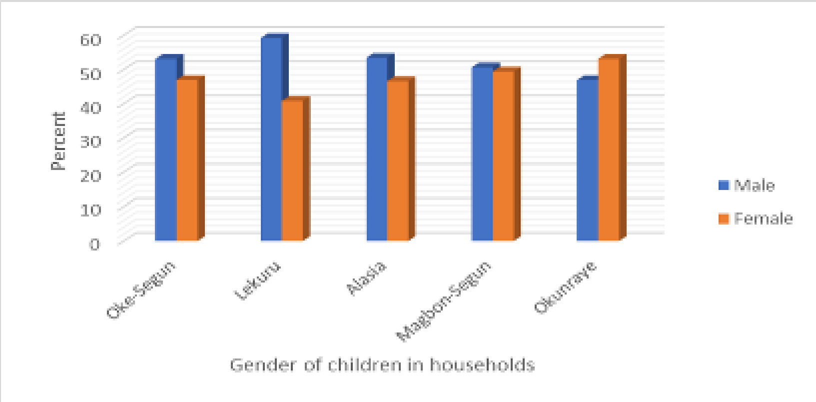


Figure 4.34: Sex Distribution of Chidren in Sampled Households aged <18 years

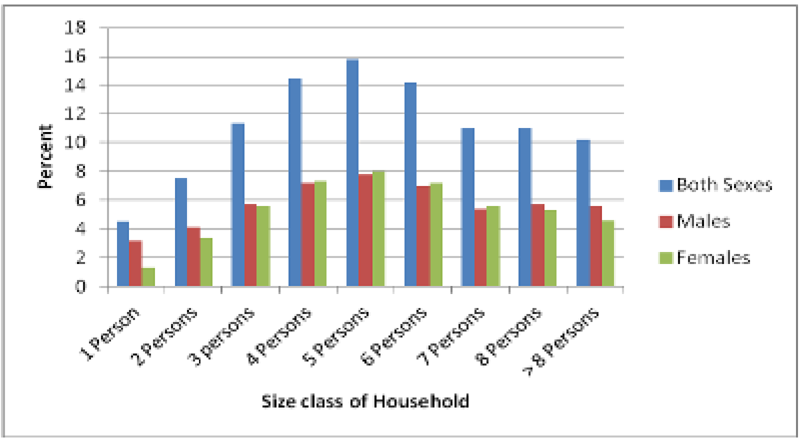


Figure 4.35: Distribution of Lagos State population by size class of households and sex (*Source: NPC, 2009, 2010*)

Population Structure: Age and sex distribution

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

a) Age and Sex Structure of Population

Age and sex are important demographic variables and are the primary basis of demographic classification. They are also important variables in the study of mortality, fertility, and nuptiality. In general, a cross-classification by age and sex is useful for the effective analysis of all forms of data obtained in surveys.

The household age structure and population distribution in the LFZ stakeholder communities have an overwhelming percentage of the population made up of persons below 19 years old, effectively classified as children (NPC, 2010, 2002). Specifically, over 70 percent of the household population is constituted of persons aged less than 19 years. Persons in the productive age bracket of 19-59 years constituted just under 30 percent (27.9% actual) while the aged (60 years and above) constitute such an insignificant proportion of the overall population in the study communities (approximately 1%) (Figure 4.36 and Figure 4.37). The communities therefore, have a high dependency ratio. The overall implications of the age profile are that the population is young and growing and places a heavy burden on the adult population. More importantly, the provision of educational facilities and health care services are paramount to accommodate this young population.

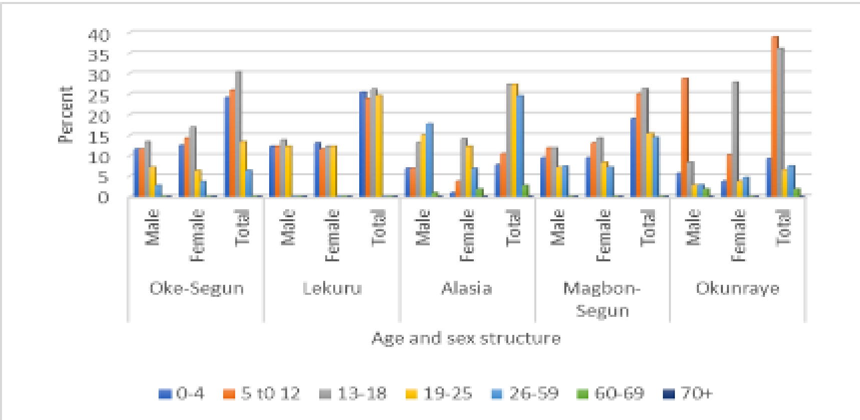


Figure 4.36: Age and Sex composition of population in LFZ study communities

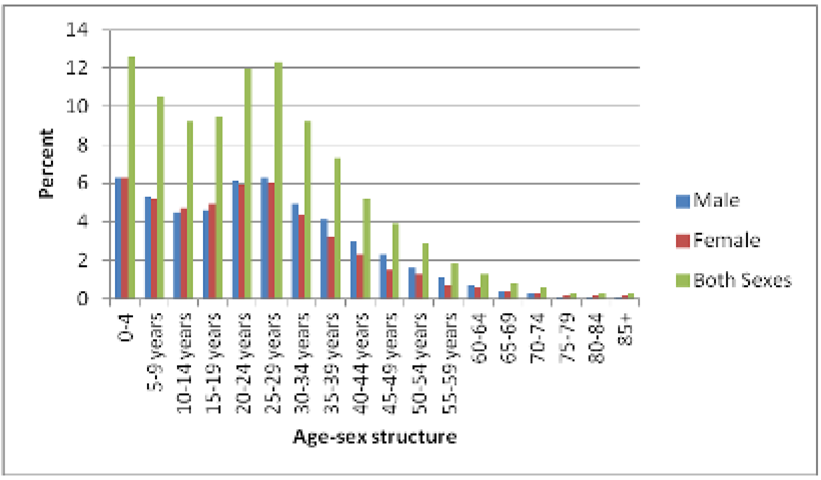


Figure 4.37: Population profile of Lagos State, 2006
Sources: NPC, 2009, 2010

The sex ratio, a useful demographic descriptor is the ratio of males to females in a given population, usually expressed as the number of males for every 100 females (Haupt and Kane, 2004). Gender distribution of the population in the project area community reveals a gender balance at the household level; 51% are males, while49% are females, meaning the overall sex ratio is close to 1:1 in the project area. Earlier, in the 1991 Population and Housing Census, there was a slight preponderance of the female gender (50.3%) in the households of the communities included in the LFZ study area compared to the males' 49.7 % (NPC, 1991). The gender gap has narrowed over the years.

The sex distribution in the affected Lekki-Ibeju LGA in 1991 and 2006 are now revised; it was 49.8% males to 50.2% females in 1991. In 2006, it was 51.6% for males and 48.4% for female, which is similar to the sex distribution of the population in Lagos State: 52 % to 48 % respectively (NPC, 2010). The LFZ study environment holds much promise with the commercial and industrial development of the area as an economic nerve centre of Lagos. These are pull factors and thus magnet for the population. In-migration and natural growth processes shall remain much of the population balancing equations.

During the field data gathering exercise, the females were found to be generally very well represented during community-wide meetings and group discussions. This is very much in accord with previous and earlier exercises within and around the LFZ environment and the western axis of Nigeria in general. There has been an increasing women's participation in opinion formation and leadership in matters of community development, even though, they are usually condescending when it comes to decision-making as it is the custom in most rural parts of Nigeria. It is thought that culture is responsible for this stance. Returned copies of the surveyed questionnaire however, retained the males' dominant representation (61.2%), compared to the females' 38.9 % (Figure 4.38).

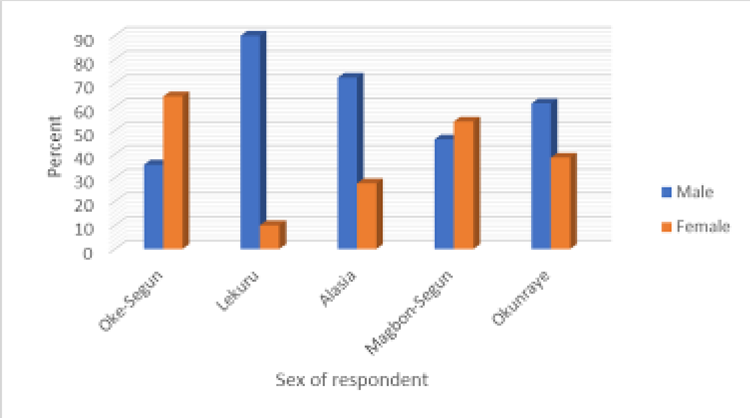


Figure 4.38: Sex of Respondents

b) Dependency ratio:

The dependency ratio relates the number of children (0-14 years old) and older persons (65 years or over) to the working-age population (15-64 years old). The unit of measurement is per hundred persons aged 15-64. The policy relevance and purpose of the Dependency ratios is to indicate the potential effects of changes in population age structures for social and economic development, pointing out broad trends in social support needs.

Relevance to Sustainable/ Unsustainable development: By relating the group of the population most likely to be economically dependent (net consumers) to the group most likely to be economically active (net producers), changes in the dependency ratio provide an indication of the potential social support requirements resulting from changes in population age structures. In addition, the ratio highlights the potential dependency burden on workers and indicates the shifts in dependency from a situation in which children are dominant to one in which older persons outnumber children as the demographic transition advances (that is, the transition from high mortality and high fertility to low mortality and low fertility). A high dependency ratio indicates that the economically active population and the overall economy face a greater burden to support and provide the social services needed by children and by older persons who are often economically dependent. A high youth dependency ratio, for instance, implies that higher investments need to be made in schooling and child-care.

Methodologically, the dependency ratio refers to the number of children aged 0 to 14 years plus the number of persons aged 65 years or over per 100 persons aged 15 to 64 years:

Dependency Ratio =100 x (Population (0-14) + Population (65+)) / Population (15-64).

The dependency ratio can be disaggregated into: (1) the youth dependency ratio, which is the number of children aged 0-14 per 100 persons aged 15-64, and (2) the old-age dependency ratio, which is the number of persons aged 65 or over per 100 persons aged 15-64. The dependency ratio, also referred to as total dependency ratio, is the sum of the youth and old-age dependency ratios. Some studies employ other age groups in calculating dependency ratios, for instance 0-19 years to represent the population of children or the population aged 60 or over to represent the population of older persons.

Limitations of the Indicators: The dependency ratio is an approximation to the ratio of net consumers to net producers. As a proxy for that ratio, the dependency ratio suggests that children under age 15 as well as persons aged 65 or over are economically dependent. In many populations, however, people do not stop being economically active at age 65, nor is it true that all persons aged 15-64 are economically active. Although older persons often require economic support from others, in many societies they have economic resources of their own and provide support to their adult children. Furthermore, as the period of training for a productive life increase, most adolescents and young adults remain in school and out of the labour force, effectively extending the period of young-age dependency well beyond age 15. Whenever available, direct estimates of net producers and net consumers can be used for a more precise assessment and analysis of economic dependency.

(i) Data needed to compile the indicator: The information on population classified by age that is necessary to calculate the dependency ratio is usually derived from censuses or demographic surveys. The United Nations recommends that countries undertake population censuses every 10 years. Since the last census of 2006, no other has been conducted in Nigeria. Even the 2006 Census had no complete release of relevant data such as those related to dependency ratios.

The LFZ project area have a very high dependency ratio typical of the Lagos State relatively high dependency pattern. The total overall dependency ratio for the study communities was 2.58. Thus, the average adult working in the study area takes care of at least 3 other persons.

Educational characteristics

Education is a key determinant of the lifestyle and societal status an individual enjoys. Studies have consistently shown that educational attainment has a strong effect on health behaviours and attitudes. Education in Nigeria has evolved over a long period of time, with a series of policy changes. As a result, there have been increases in the enrolment of children and in the number of educational institutions both in the public and private sectors.

The socioeconomic survey analysis revealed that a very large proportion of the sampled population has received some formal educational training indicating a sufficiently literate society. The modal educational attainment amongst the sampled respondents is the post primary (secondary), 61.3% of respondents possessed this qualification. Higher proportions of the respondents from Magbon-Segun (85%), Oke-Segun (84%) and Lekuru (74%) claimed to have secondary educational qualification. Less than one fifth (18%) of the surveyed participants also have the primary educational training with those from Okunraye having close to two-thirds of their members (65.4%) in possession of this education. None of the respondents at Lekuru reported of possessing primary educational qualification while 20.7%, 18% and 3.8% of respondents at Alasia, Oke-Segun and Magbon Segun respectively have obtained primary education. Respondents with tertiary educational qualification and, vocational/technical skills were low. On average, 9.4% of the sampled respondents have tertiary education but across the communities, this amounted to 12.9% at Oke Segun, 4.3% at Lekuru, 6.9% at Alasia and 11.5% each at Magbon Segun and Okunraye respectively. Respondents with vocational skills amounted to 6.3% on average and across the communities, the percentages are: 3.2% at Oke Segun; 17.4% at Lekuru; 6.9% at Alasia, zero at Magbon Segun and 3.8% at Okunraye respectively (Figure 4.39). Those without any formal educational (NFE) training were 0% at Oke Segun, 4.3% at Lekuru, 20.7% at Alasia each at Magboin Segun and Okunraye. This however, mean that questionnaire administration may have wittingly or by error of commission omitted the aged genre or category who may be possible respondents.

The low possession of both tertiary and vocational/technical education and/or skills reported among the sampled population imply the non-availability of manpower with the requisite qualification for employment in projects across the LFZ study environment. This may be the reason why unemployment and under-employment is common in the study communities. The possession of both post-secondary and vocational/technical trainings are good indicators of available manpower and employment opportunities for its indigenes in the the LFZ.

Although the percentages of respondents' spouses in possession of primary and secondary education are lower (16.3% and 19.4% respectively, on average), they seem to have more economic-empowering qualification of vocational and technical skills attainment; 48.8% possess vocational and technical skills (Figure 4.40).

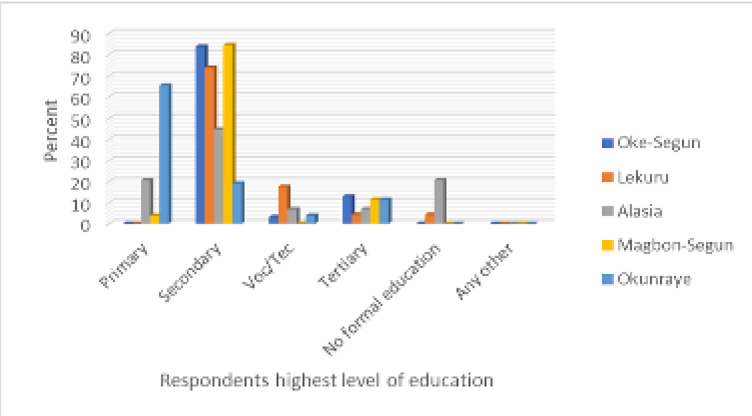


Figure 4.39: Educational Attainment of Respondents in LFZ Host Communities

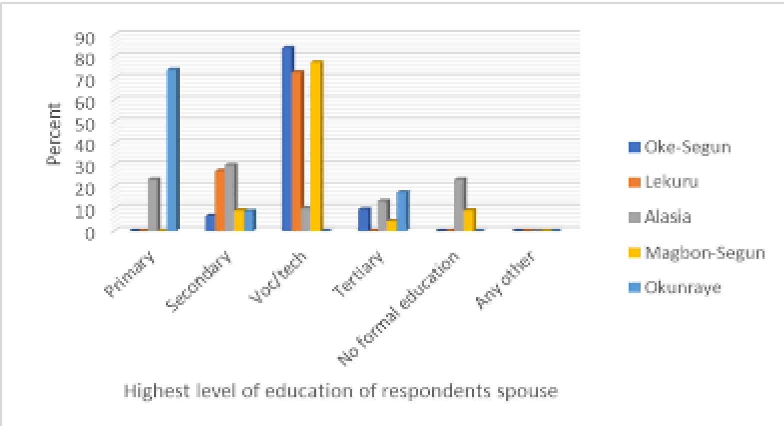


Figure 4.40: Educational Attainmnet of Respondents' Spouses

The educational status of respondents' children revealed that 50.7% % of the boys and 49.3% % of the girls presently attend various schools within and outside the project area**.** The analysis further showed that %41.1% of the children are in primary school, 38.8% are in secondary school, and 13.2% are in the process of acquiring vocational/technical training. However, the proportion in tertiary institutions was found low (6.9%) (Figure 4.41)

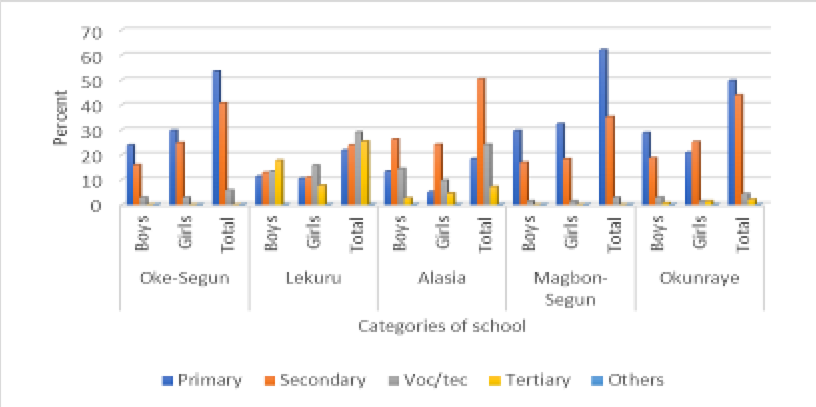


Figure 4.41: Educational Attainment of respondents children

The empirical analysis from the recent Lagos Household Survey (2011) reveals that 87% of the household members can read and write in English Language as against 84.7% recorded in year 2010 exercise signifying an improvement of 2.3%. Also, 4% of the respondents can only read in English while 9% can neither read nor write. Moreover, literacy level in other languages accounts for 75% depicting a slight increase of 3% over the 72% recorded in year 2010.

The study also sought school attendance rate at household level and the result obtained shows that 91% reportedly attended one formal school or the other as against 93% recorded in the last exercise while 9% signifies not to have attended any school (Figure 4.42)

Further analysis also reveals that the sampled respondents across the local governments in the State believes that the following areas of education requires Government urgent intervention:- Build more primary and secondary schools (100%), recruit more qualified teachers (100%), provide functioning libraries and laboratories (100%), build teachers capacities (100%), provide more classrooms in the existing schools (99%) as well as provide more free text books to cover all the subjects being taught in schools (99%).

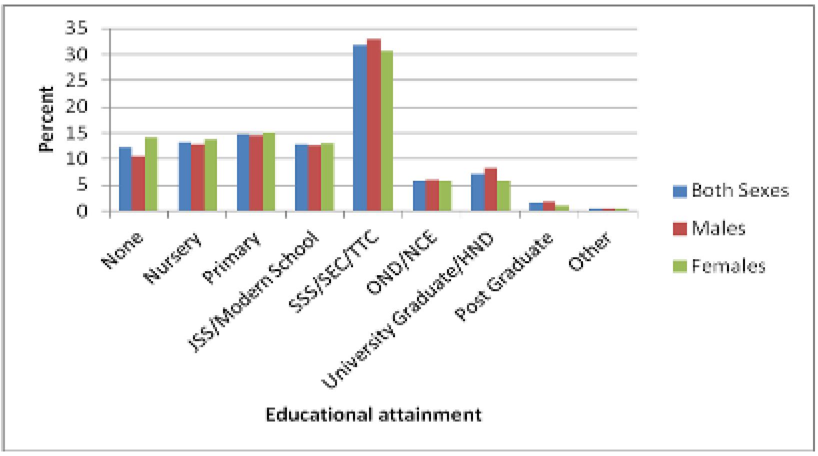


Figure 4.42: Educational Attainment of Respondents

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

Lagos is most times described as Nigeria's most industrialized State and prosperous city because most of the nation's wealth and economic activities are concentrated there. It accounts for over 60% of the Federation's total industrial investment. The largest concentrations of industries in Lagos State are in Ikeja, Alimoso and Kosofe Local Government Areas. Other specific locations of numerous industries include Apapa, Surulere, Shomolu, Mushin, Oshodi-Isolo, Agege, Amuwo-Odofin, and Ikorodu. The industries in Lagos State provide employment for over 1 million persons directly.

Primary agricultural production typifies the rural economy of Lagos State with industrial activities. There are other socio-economic undertakings with high employment activities. These include the Federal and State Civil Service, numerous white-collar-job establishments, wholesale and retail trading. The informal private sector also constitutes a significant portion of the economic activities. These include transporters, artisans (carpenters, masons, painters, auto-mechanics, etc) and labourers.

The livelihood of the Ibeju-Lekki project stakeholder communities depends much on their natural resource-based traditional occupations. As a people living by the ocean and amongst watercourses, fishing is the major occupation of adults (male and female) in the project area. Farming is also practiced, supplemented with agro-processing, however, this is mostly carried out at subsistence level.

Aside from the traditional occupation, other income generating activities identified include petty trading, contracting, transportation/driving, and technical and artisan works (tailoring, welding, motor mechanical works, electrical works, and carpentry). In addition, there are few company workers, civil servants and teachers in schools in the area. All of these other economic engagements in addition to several other economic changes have affected traditional agriculture, to the extent that the percentage of people involved in farming and fishing have diminished and this has worsened over the years.

All the indigenous people were traditionally known to carry out large scale fishing for a living, using both dugout canoes and engine-enhanced fibre boats that go to deep waters. Coastal and riverine resources such as fish and other pelagic resources such as crayfish are harvested. At any time of visit, fishers and their fishing nets and canoes could be seen anchored by the beachside, several could also be seen from the shore either returning from the Sea (Plate 4.20) or fishing.

Fishing is conducted all year round and mostly by men, while the women are typically engaged in fish processing which is sold either within the community or nearby towns e.g. Epe.

On average, respondents engaged in farming and fishing are 27.1% and 24.2%, respectively (Figure 4.43). At the community level, 81.8%, 46.1% and 7.7% of the respondents at Lekuru, Alasia, and Okunraye respectively, affirmed they are farmers, while responses at Oke Segun and Magbon Segun were zero. Furthermore, respondents who are fisherfolks in Okunraye, Alasia and Lekuru, amounted to 62%, 32.7% and 13.6% respectively. Average responses on those involved in trading, business/contracting and civil service were found low. Specifically, some 23.1% of those in Okunraye are into trading while the proportion is 15.3% at Alasia. The percentages at Lekuru and Magbon Segun are 4.5% and 4.3% respectively for trading while it was reported to be zero at Oke Segun.

The unemployed population and those who are students and apprentices together amounted to 33.7% of the sampled community respondents. 90.3% and 78.3% of sampled community members at Oke-Segun and Magbon-Segun claimed to be unemployed, which as it is a 'claim' and may not an absolute truth.

Overall, most respondents consider fishing and farming to be secondary occupation, employing 49.6% of the respondents. At the individual community however, 80%, 72.2% and 48.9% of the population at Lekuru, Okunraye and Alasia, respectively, are involved in fishing activity, which is more representative of the socio-economic landscape of the LFZ project area (Figure 4.44). On average, 20.9% of respondents are into technical and artisan works (carpenters, masons, etc.) while only 9.1 % take to trading as a secondary occupation. On ground however, 27.8% and 12.8% respectively of the resident population in Okunraye and Alasia are into trading activities.

Plate 4.20: Located by the Atlantic Ocean, the inhabitants of Magbon Segun, Itoke, Idotun and neighbouring communities in the Ibeju-Lekki area are into intensive fishing, using engine-powered boats

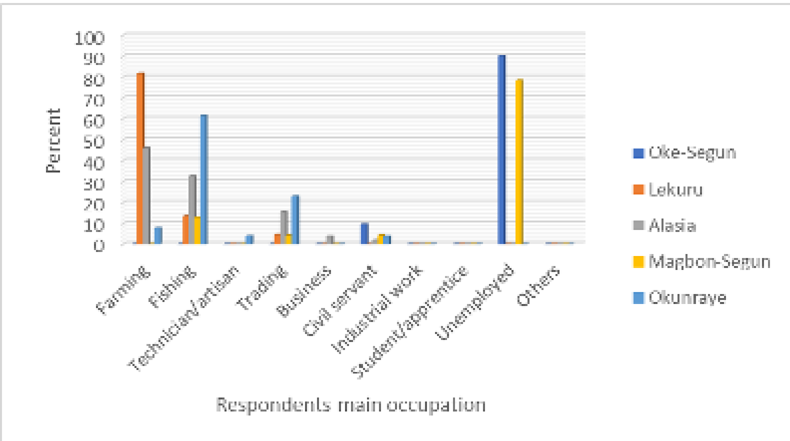


Figure 4.43: Primary Occupation of Respondents

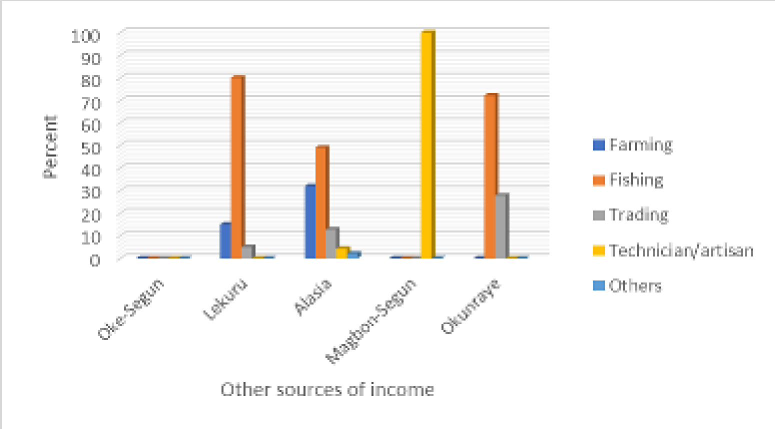


Figure 4.44: Secondary Occupation of respondents

Agricultural productivity and Constraints

Although a highr proportion of the respondents in the LFZ study area are engaged in fishing and farming, responses revealed a gradual withdrawal due to several reasons but chiefly because of the disproportionate harvests that is not commensurate with efforts invested. Participants at community group meetings and respondents alleged that agricultural production (particularly fisheries) has decreased considerably over the years due to several reasons.

Three principal constraints were particularly identified by respondents to reinforce the poor agricultural conditions and productivity in the study communities. This include ''insufficient land to cultivate" for those involved in farming (this has been a recurring complaint in previous studies conducted in the LFZ study area), ''inadequate/lack of capital", a characteristic of rural poverty, and the ''use of poor technology/local tools and methods" in agricultural production (fisheries). Money to procure additional boats and fishing gears and sail deeper since the shallow areas have now been taken over by the other developmental activities in the study area. Over 60 % of the fishers conduct their fishing activity in the Ocean while others fish in the Lekki Lagoon and Creeks nearby (Figure 4.45).

Community members averred that addressing rural poverty and unemployment will take into consideration these principal constraints to achieve success.

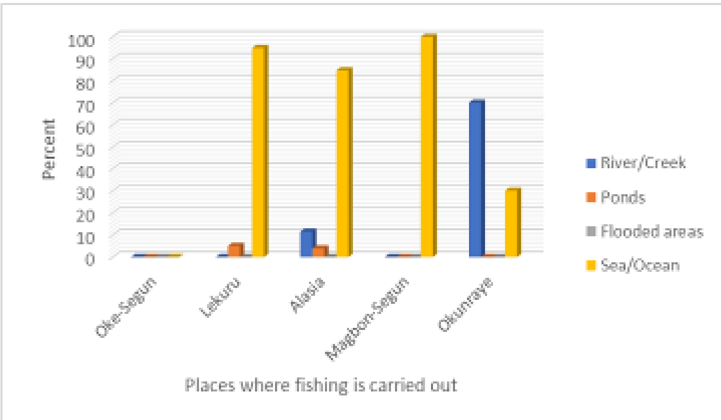


Figure 4.45: Places where fishing is carried out in study area

Income Distribution, Consumption and Expenditure Profile

Income distribution is one of the most important indicators of the regional welfare. Income level determines the ability to meet basic needs and provide information on the poverty rates in the area. It is also an important variable that influences socio-economic status of individuals and its distribution pattern has the potential of influencing other demographic variables.

The estimated monthly income of the resident population in the LFZ study area is shown in Figure 4.46. The income levels of a population are usually compared with the current minimum wage in Nigeria to ascertain the quality of life of the inhabitants. The current minimum wage in Nigeria was N18,000 per month until recently increased to N30,000, however, this is yet to be implemented in all States in the country. Volunteered incomes of respondents from the stakeholder communities varied from less than N20,000 per month to >N500,000. 35.8% of respondents earn less than N20,000, while respondents who earn N20,000 - N30,000 in a month are 14.6% (Figure 4.73). 10% of respondents earn N40,000 – N50,000 monthly while respondents with incomes above the N50,000 monthly are 11 %.

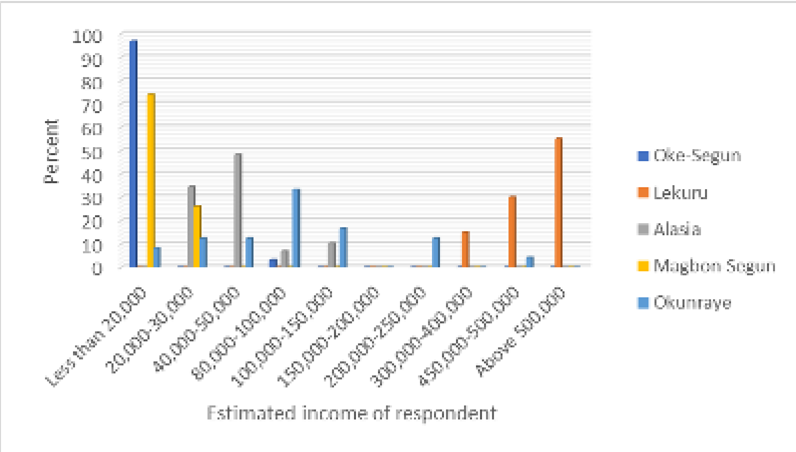


Figure 4.46: Income Level of Respondents

The income levels above compared well with previous studies of the environment. At Folu and the Magbon Segun-Itoke- IAdotun communities, income estimates of N80,000 in favourable landings and sometimes as much as N120,000-200,000 were put forward by fishermen (Ojile, 2011, 2007). About N80,000 is made from a single expedition, excluding fish for domestic use and N120,000 from crayfish. About N500,000 was also claimed possible in a month.

Fishing is conducted all year round except during storming weathers in July and August months. For those engaged in bigger fishing, October through June of the next year are most favourable times and involve the use of bigger boats and nets. Those disposed to smaller fishing (prawns, crayfish and smaller fish) go to sea between June and September. Their landings and income are consequently smaller; as much as N100,000 could be earned, while earning could be as low as N10,000 in bad weather. Cost of acquiring fishing equipment (engine and nets), lack of storage facilities for fisheries, piracy at sea and pollution and destruction of nets by oil leaks from platforms, pipelines and oil installations are major problems mentioned as militating against effective fishing in the study area.

Household consumption and expenditure pattern

Quantitative information on household consumption and expenditures profile of the population could not be obtained from administered copies of the questionnaire because the answers provided were not reliable. Results from a previous study in Lagos State revealed that 48.3% of household heads spent above N5,000 weekly on household expenses, while 41.4% spent between N4000 and N5,000 weekly (Figure 4.47). At the national level, some N22,265.5 was spent by households according to the 2009/2010 survey (NBS, 2012). Total households' expenditure in the urban areas was greater (N20,312) than rural (N19,737.8). Households' spending was 1.5 times higher in 2009-10 compared to 2003-04.

The breakdown of household income spending was consistent with what have been found as household spending priorities in other parts of Nigeria. Food alone consumes the bulk of the family income; listed by heads of households as the most important spending priority (75%). Contrary to regular expenditure in other studies however, and maybe in synch with modernity, one fifth of respondents claimed to spend more on clothing instead of providing good education for the children as a spending priority for heads of households on the family budget (Figure 4.48) The National Bureau of Statistics (NBS) 2009/10 Survey reported that households spend more on food compared to 2003-04: 51.4 % in 2003-04 vs. 57.2 % in 2009-10 (NBS, 2012).

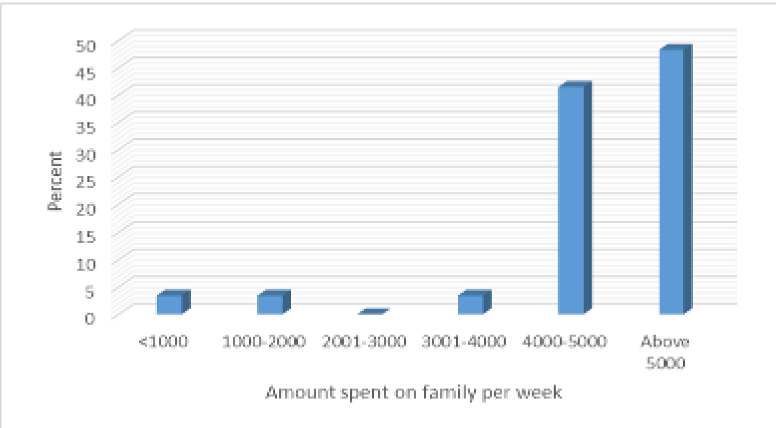


Figure 4.47: Weekly Expenditure of Households

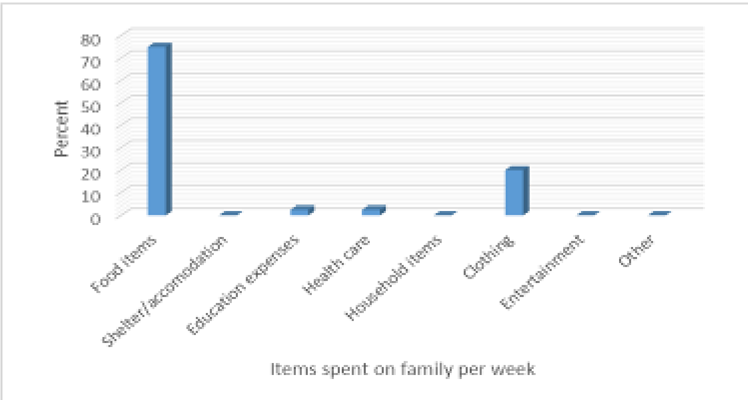


Figure 4.48: Items of Households' Weekly Expenditure

Considerable proportion of incomes of most rural households is spent on feeding, education, medical needs etc.

The Lagos Household Survey (2011) revealed that 58% of the sampled households spent less than N500 on daily consumption of various food items and beverages in a week compared to the 60% who spent the same amount of money for the same period in 2010, whereas 29% of the respondents spent between N501 and N1, 000 in a week in 2011 when compared to 31% in 2010.

Furthermore, the Lagos Household Survey (2011) also showed that 73% of respondents spent more than N3, 000 monthly. The Survey also revealed that the average monthly income of majority of the respondents (38%) was less than N20, 000.00 while 37% made between N21, 000.00 and N40, 000.00 monthly on the average. This indicated that 75% of the entire respondent households earned less than N40, 000.00 monthly on the average while 2% earned above N100, 000.00 monthly.

Land Use and Management: Landownership System and Tenure

Land Ownership System/Access and Tenure System

In the LFZ stakeholder communities, individual families own lands. Historically, one or a group of families who are then recognized as the original landowners founded every community. However, the obnoxious Land-use Decree of 1978 has divested lands from the original owners, especially those close to urban administrative centres. The Lagos FTZ was acquired by the Lagos State Government and had the original landowners settled ''nominally", paying unspecified amount for economic trees and crops on site as compensation. The LFZ, managers of Free Trade Zone Area paid duly for the acquired pieces of land for the Port and Harbour from the original families who owned them; Magbon Segun (9.998 ha) and Idotun (5.122 ha)

The Ibeju- Lekki LGA in most parts cannot be said to be endowed with vast lands, hemmed in as it were by the Atlantic Ocean at one side and a thick rainforest at the other side. The land is naturally sandy, not very fertile for the cultivation of crops and again liable to wet season flooding, making matters worse. The proximate village communities of the Lagos FTZ in particular bemoan this sad situation and had to formed a ''Landlord Village Communities of Six" made up of the landholding families. They meet regularly monthly at Itoke to decide on how to approach the authorities of the LFZ and other FZ in the area for adequate compensation for the loss of land. While compensation for already acquired land was evidently a sore point of complain (low rate), another 90 hectares of land which was then re-allocated to the landholding families/village communities are yet to receive the necessary letters of allocation, i.e. certificate of occupancy (C of O).

Religion, customs, beliefs systems and cultural heritage

Islam, Christianity and traditional African Religion are practiced in the FTZ study environment. Over one-half (56.9%) on average of the questionnaire respondents affirmed this religious mix as they practice the Islamic religion. The remainder 43.1 percent of the respondents are also of the Christian faith (Figure 4.49).

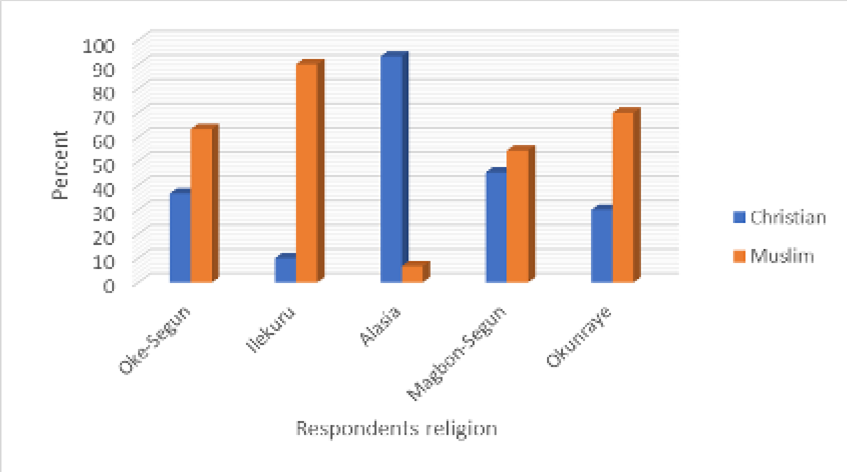


Figure 4.49: Religion of Respondents

The host communities in the LFZ study area harbours and treasures the ancient traditional and cultural institutions of their community. Like their traditional governing system, the peoples' cultural beliefs are similar, reflected more in their festivals which relate to either the fertility of the land and waters or the blessings of the ''gods''. The seasonal calendar falls within the dry season ''because neither the gods nor the Aworo (the worshippers) should be beaten by rain''. Several festivals are performed by the people of the study area but the popular among them are the *Ebi festivals, the Oro Festival, the Imale Masquerade Festival, Alaro, Efonise Festival,* etc.

Festivals, religious ceremonies and social events like child naming, housewarming and burial are occasions for singing, clapping and dancing in response to artistic use of traditional and contemporary musical instruments. They have traditional dances like sakara dance, apepe and woro. In the recent times, juju, apala, waka and fuji raggae musics are played in the communities.

Institutional arrangements, governance system and structures

Lagos State is divided into five Administrative Divisions, which are further divided into 20 Local Government Areas (LGAs): Agege, Alimosho, Ifako-Ijaiye, Ikeja, Kosofe, Mushin, Oshodi-Isolo, Shomolu *(these are under Ikeja Division)*; Apapa, Eti-Osa, Lagos Island, Lagos Mainland, Surulere *(Lagos Division)*; Ajeromi-Ifelodun, Amuwo-Odofin, Badagry *(Badagry Division)*; Ikorodu *(Ikorodu Division)*; Ibeju-Lekki and Epe (under *Epe Division*). The first 16 of the above LGAs comprise the statistical area of Metropolitan Lagos. The remaining four LGAs (Badagry, Ikorodu, Ibeju-Lekki and Epe) are within Lagos State but are not part of Metropolitan Lagos.

In 2003 many of the existing 20 LGAs were split for administrative purposes into Local Council Development Areas. These lower-tier administrative units now number 57: Agbado/Oke-Odo, Agboyi/Ketu, Agege, Ajeromi, Alimosho, Apapa, Apapa-Iganmu, Ayobo/Ipaja, Badagry West, Badagry, Bariga, Coker Aguda, Egbe Idimu, Ejigbo, Epe, Eredo, Eti-Osa East, *Eti-Osa West*, Iba, Isolo, Imota, Ikoyi, Ibeju, Ifako-Ijaiye, Ifelodun, Igando/Ikotun, Igbogbo/Bayeku, Ijede, Ikeja, Ikorodu North, Ikorodu West, Ikosi Ejinrin, Ikorodu, Ikorodu West, Iru/Victoria Island, Itire Ikate, Kosofe, Lagos Island West, Lagos

Island East, Lagos Mainland, Lekki, Mosan/Okunola, Mushin, Odi Olowo/Ojuwoye, Ojo, Ojodu, Ojokoro, Olorunda, Onigbongbo, Oriade, Orile Agege, Oshodi, Oto-Awori, Shomolu, Surulere and Yaba.

Although the traditional political and social systems vary in different parts of the Yoruba regions, each town usually has a leader *(Oba or Baale)*, who achieves his position in one of the three following ways: *inheritance, participation in title associations*, or *personal selection by an Oba/Baale already in power*. A council of chiefs usually assists the Oba/Baale in his decisions. Title associations, such as the Ogboni, also play an important role in assigning and balancing power within the cities (University of Iowa, Department of History, March 1999). Supplementing the traditional governance structures are other civil society institutions that participate in some forms of governance. These systems also help identify the critical stakeholders, with whom consultations are normally held for development projects, including those such as the FTZ infrastructure development within the Lekki/Ibeju area that involved so many industrial projects currently ongoing.

Two levels of political organizations are recognised in the LFZ study area; the formal governmental and the local/traditional administration, respectively. At the formal governmental level, the 8 stakeholder communities are under the local jurisdiction of the Ibeju-Lekki LGA which has its headquarters at Akodo.

Traditionally, the eight (8) LFZ stakeholder communities have their traditional governing systems organized into hierarchies of administration: the *Baale* at the apex, his council of chiefs/elders, family heads, the youth group, and the women's group respectively (Figure 4.50). The *Baale,* as the highest traditional stool in each village community oversees the daily affairs of the community on behalf of the *Oba.* The traditional administrative system deals more on issues relating to the peoples' culture and values. They are therefore the custodians of the peoples' cultures and values and are important and revered institutions in the settlement of land disputes, inter and intra community disagreements, etc.

Each *Baale* usually has an advisory body, the council of chiefs/elders and deputies who in the absence of the *Baale* effectively oversee the village affairs. Various committees are also constituted to take charge of common problems such as electricity and water. A youth group and women group are typically in charge of youth and women affairs, respectively, ineach community. Women are also members of the Council of Chiefs whose roles are usually advisory. The women chiefs have ceremonial roles and see to the general welfare of the market women (Iyaloja).

In terms of conflict resolution and redress, most people in the western region depend on Courts of Law to resolve disputes. A significant number of people also uses traditional councils. Other forms of governance include the meeting of parties and use of an independent arbitrator (NISER, 2002).

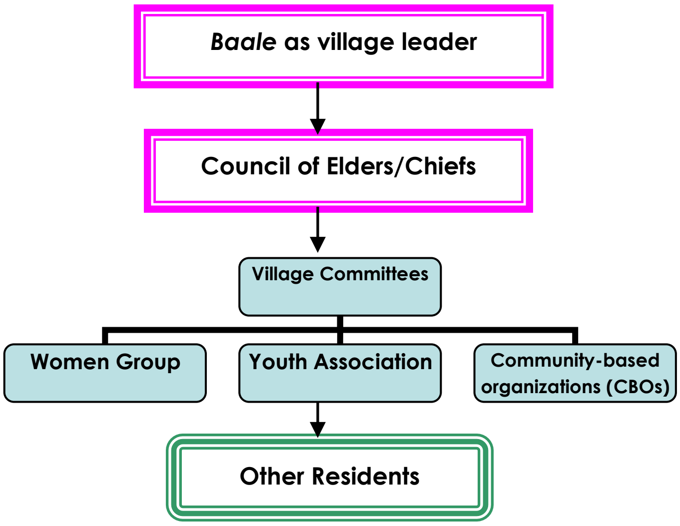


Figure 4.50: Typical Traditional Governing Structure in the Study Area

Table 4.40: Community Structure and Governance in the Study Area

Community	Community structure and governing system
Lekuru	▪ Community one of four relocated in 2013, from original land and earlier settled on land and road opposite Port & Harbour under construction ▪ Now settlement directly across road and opposite the Dangote Refinery Company ▪ The *Baale,* council of chiefs/elders, youth and women groups are organs of community administration ▪ Participants at community consultation/group meetings included all spectrum of community members (See Appendix 1 attached).
Okunraye	▪ One of the oldest settlements and communities around the LFZ study environment; claims of origin dated back to 400 years ▪ Migration root traced to Ile-Ife with founder called "Oluranye" and "Okunraye" later added; literally means 'plenty of space/land and peace of mind'. Community thus claims (unconfirmed) to have the largest share of land occupied in the LFZ ▪ Four (4 nos.) compounds make up community: *Ipatu, Idiroku, Igboshewe,* and *Igbofinrin*. ▪ Leadership structure includes the *Baale* (overall village head), *Baale-in-Council,* an overall youth chairman and EXCO, Women group with each of four compounds having own chairman and EXCO in place. ▪ Two major ruling houses in community: Oluderu and Iregolu ▪ *Baaleship* is by appointment from the two ruling houses and tenure is for life ▪ Tenure of youth and women group EXCOs is for two years as well ▪ The *Iyaloja* stool (trade women leader) is for life ▪ Attendants at consultation meetings including all of the above members of community leadership attached ▪ Besides the *Baale* and council, the CDA, youth and women groups and committees are organs of administration in community
Alasia	▪ One of four settlements relocated in 2013 (the other three included Imosa, Imopa and Lekuru villages) ▪ Claims both companies operating in the area and LFZ have not been good to community on grounds that "they have no plans for Alasia" among comity of

	stakeholders in the industrial zone. ▪ A chief and deputies, CDA, youth and women groups also on ground for harmonious administration and coordination of community. ▪ Close to 50 participants in attendance during community consultation and group meetings (See Appendix 2).
Oke-Segun	▪ One of the communities, settlement has same administrative organs as neighbouring communities ▪ The Baale and council of chiefs/elders, youth and women groups complement local administration ▪ *Baale,* community leaders/opinion formers were all in attendance during gropu meeting with community
Magbon-Segun	▪ Community made up of many families. ▪ The *Baale,* chiefs and committee constituted for different affairs are the organs of local administration. ▪ Magbon-Segun youth association and market women leaders for women affairs are other organs for effective community administration. ▪ Chief Mufutau Dauda (a long-standing *Baale* of community), and other community leaders and ordinary residents were in attendance during group meetings. (Appendix 1)
Idotun	▪ Idotun is a comparatively more developed village community in terms of size and presence of physical infrastructures ▪ Community is headed by a *Baale*, who is assisted by a deputy, then council of elders. ▪ Youth organisation and women group are also on ground as other organs of community administration. ▪ T.K. Adesanya, *Oludo of Idotun*, a government-recognised chief is *Baale* and few others met during Consultants' visit but ongoing crises didn't allow for consultation meetings.
Itoke	▪ A small village community with less than 100 buildings, 20 % of which are of block and corrugated iron zincs and majority of thatched materials. ▪ Baale is at apex of governance, usually appointed by community. ▪ Council of elder/chiefs assist with decision making. ▪ Chief Lateef Shokoya, *(Baale)*, was on ground during visit but same problem as with Idotun didn't allow for wider community meetings and consultations.
Lujagba	▪ A small village community with less than 50 buildings, 20 % of which are of block and corrugated iron zincs and majority of thatched materials. ▪ Baale is at apex of governance, usually appointed by community. ▪ Council of elder/chiefs assist with decision making.

Community and Public Infrastructures and Amenities

The availability of basic social infrastructure within the LFZ study area is discussed below.

Education

There are public primary and secondary schools in the LFZ study area but the number, distribution and status or infrastructural integrity (functionality and adequacy) is inadequate. There are three primary schools located at Idotun, Itoke and Okunraye, respectively, while Lekuru, Magbon-Segun, Oke-Segun and Alasia have none within their respective community.

These communities send their children and wards to the nearest neighbour, sometimes to far places and thus increase the cost of education. The RCM School at Idotun appeared to have enough structures having received the benevolence of the USAID/LEAP Programme previously in the past (Plate 4.21) (Community visited but not allowed interactions because of the crises that prevailed then, so could not assess present state of the schools). During site visit, community leaders complained that there were no writing desks and chairs for pupils while teachers were lacking. The school has over 400 pupils on enrolment but only 7 teachers, including the headmaster (HM). The school serves other neighbouring communities, including Magbon-Segun, which has no primary school. The primary school at Itoke is situated within a Church premises has pupils during site visit. In Okunraye, the primary school has dilapidated structures that need renovation.

At the post primary school level, there is only one in between the 7communities, and this is considered inadequate. The Community High School, founded in 1982 has its junior secondary (JSS1-3) located in Idotun and the senior secondary (SS1-3) at Magbon Segun. About 240 students were enrolled for the JSS, with more boys than girls and there are 5 teachers (the principal inclusive) and this is considered insufficient. The number of students' enrolment for the SSS section was lower than that of JSS, but exact figures could not be confirmed. Overall, the structures were poor and dilapidated (Plate 4.22 – Plate 4.24) and the rural environment was adduced as a primary cause of the few number of teachers.

Plate 4.21: Primary School Structures at Idotun, enhanced by USAID/LEAP

Plate 4.22: A Primary School at Magbon Segun

Plate 4.23: Primary School Structures at Okunraye Community

Plate 4.24: Back and side-views of the post primary school infrastructures for the Community High School (CHS), Idotun, showing the level of deterioration

Electricity and Energy Use

The LFZ stakeholder communities like most communities in Ibeju-Lekki and Lagos State are connected to the power national grid (TCN), except Alasia which is not connected to the national grid. The area is serviced by the Eko Electricity Distribution Company (EKEDC). However, the supply of electricity to the communities is erratic and irregular.

At the time of site visit, respondents stated that electricity had been cut off by a heavy-duty vehicle moving construction equipment to a different site (not LFZ).

Transportation and Communication facilities

Accessibility to the FTZ stakeholder communities although made easy through the presence of primary and secondary roads has become problematic in recent times because of the spate of industrial activities in the area that is not matched with improved transportation infrastructure. The host communities in the study area accessed via roads. Mainly the Lekki-Epe expressway and the Eleko-Ibeju road. The road has become busy due to many small vehicles and heavy-duty trucks plying the road and, in the process, causing congestion and safety issues at some points. The roads leading to all the village communities are also untarred earth roads. During the wet season, accessibility and movement within the communities could be restricted as the roads can become waterlogged since there are no drainages in the communities. Community participants at the different group and focus group meetings confirmed that flooding is a serious environmental problem in the wet season.

Recently, a government official during site inspection of the Port and Harbour Project in the LFZ noted that ''the Federal Government through the Federal Ministry of Transportation would work out modalities of rail connectivity to the port for easy evacuation and transfer of cargo to the different parts of the country. The official also promised to liaise with her counterpart at the Federal Ministry of Works and Housing on the issue of the road network at the corridor *to prevent the issue of congestion.*

The population is served by a mix of transportation modes – from cars and trucks to buses, motorbikes, bicycles and foot. As coastal communities, the use of boats for transportation and communication is also common. These are used for transport of people, goods and agricultural produce to the markets (Plate 4.25).

In addition, there is access to telecommunication facilities in the project area found to be greatly enhanced.

Plate 4.25: Untarred Roads within the LFZ Project Area

Recreation, Tourism, Security and Public Safety Facilities and Services

The LFZ study area have tourist and recreational attractions. Security and public safety issues are critical issues in any project development. It is the duty of governmental authorities at all tiers, federal, state and local to provide a safe and secure working environment for the population. To combat and prevent crime, there are divisional police stations at Akodo and Lekki, the Ibeju-Lekki LG Council area and the LDA (Local Development Area) respectively. In addition, increase in construction activities in the study area has given rise to the siting of security agencies in strategic positions in the neighbouring areas. The army and police are visible in the study area.

Community leaders, participants and respondents complained about the increased crime rate in the communities within the study area which may be due to an increase of migrants due to industrial and construction activities going on in the study area.

Over the years however, the level of crime may have reduced going by the results of the 2011 Lagos Household Survey. According to the survey result, crime rate in the State is still maintaining a relatively low trend. An overwhelming percentage (96%) of the households' members in the state were not victims of crime against his/her person or property in the past one year preceding the survey period as against 93% recorded in the last exercise while only 4% claimed to be victims of crime as against 7% in the 2010 survey exercise.

The result showed further that crime was mostly experienced elsewhere in the State as affirmed by 49%, 32% claimed to have experienced crime within the community, 10% experienced crime at home while 9% experienced crime in neighbourhood communities. Consequently, some 8% of the respondents perceived their communities to be "very Safe ", 61% perceived their communities to be "safe" as against 41% recorded in the last exercise, 23% perceived them to be "fairly safe" while only 8% felt their communities were "not safe" as against 11% recorded in 2010 in that category. Further examination revealed that 59% of households interviewed across the state signified that safety situation level was now "better", 35% said safety was "about the same" while only 6% believed that safety level was "worse or deteriorated".

4.3.13 Community and Environmental Health Related Issues

Water supply Facilities

Several indicators are useful in monitoring household access to improved drinking water. The source of drinking water is an indicator of whether it is suitable for drinking. Sources that are likely to provide water suitable for drinking are identified as improved sources. These include a piped source within the dwelling, yard, or plot; a public tap/standpipe or a borehole; a protected well or spring; and rainwater (WHO and UNICEF, 2010). Lack of easy access to a water source may limit the quantity of suitable drinking water available to a household, even if the water is obtained from an improved source. Water that must be fetched from a source that is not immediately accessible to the household may become contaminated during transport or storage. Especially in such situations, home water treatment can be effective in improving the quality of household drinking water.

As important as potable drinking water is to good quality of life, not all resident population of the LFZ host communities have access to modern potable water facilities. Water is sourced from existing shallow local hand-dug wells (Plate 4.26). Across the seven village communities surveyed (had full interactions with 5 only however), there was potable water at Okunraye, Lekuru, Oke Segun and Magbon Segun while others had non-functional public pipe-borne water facilities (Plate 4.28).

There are some other miniature boreholes provided through corporate social responsibility (CSR) by other companies operating in the area, which were adjudged as inadequate because they function intermittently and there were complains of saltwater intrusion. The borehole facility provided by the Lekki LCDA was complained to have low capacity and erratic power outage affects the utility of the facility.

In addition, there are two (2) water facilities located within the primary school premises at Idotun which was donated by the USAID/LEAP (borehole) and the Federal Rural Supply Water Programme of the Federal Ministry of Water Resources (mono-pump), respectively (Plate 4.27). It was mentioned that the use of both facilities are restricted to when the school is open for pupils. However, a local government council sponsored water facility was spotted in Idotun, but community leaders confirmed that it worked for only two months before it stopped working due to lack of maintenance and non-availability of a generator to pump water.

Plate 4.26: Hand-dug wells and mono-pumps are typical sources of domestic water supply for project affected population in the Lagos FTZ; Mini-water facilities (boreholes) provided by Dangote at Lekuru and Alasia have become non-functional in time (above, centre and right)

Plate 4.27: A Borehole and Water Tank and Mono-Pump Locate within the Primary School at Idotun, sponsored by USAID and FMOWR, respectively

Plate 4.28: Water Facility at Okunraye, provided by the FGN DRD-MOARD

However, the socioeconomic survey results showed that some 60% of the community respondents and households source water from public community water facilities (i.e., boreholes). 25% of the households' source water from hand-dug wells in the study environment especially in the dry season (Figure 4.51). In the wet season, 58% of respondents depend on community borehole and hand-dug wells, while 30.3% of respondents collect rainwater for their use. (Figure 4.52).

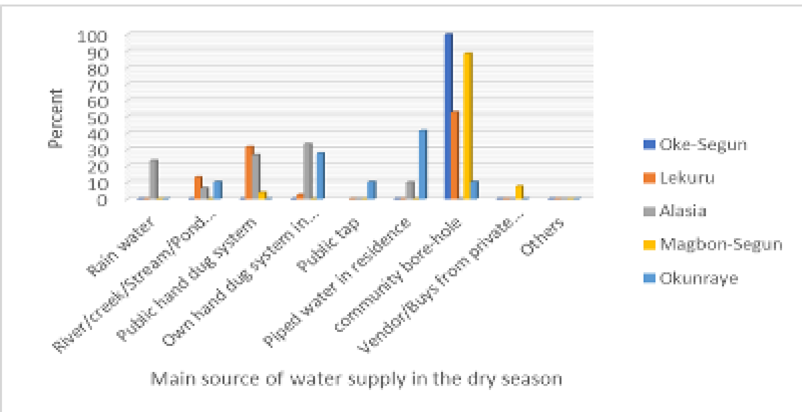


Figure 4.51: Source of Water for Households in the Study Area (Dry Season)

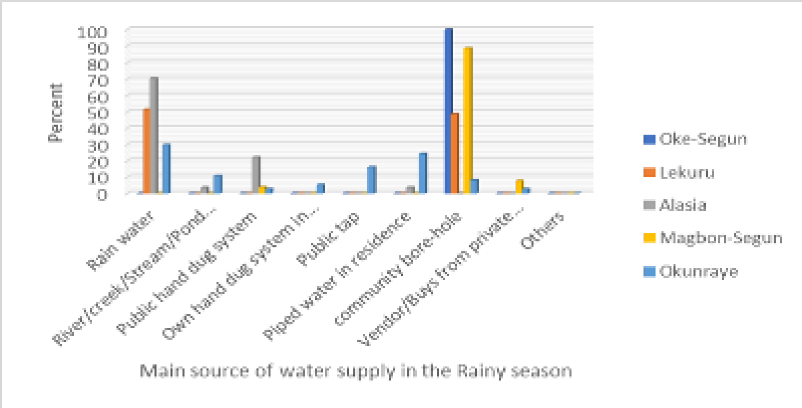


Figure 4.52: Source of Water for Households in the Study Area (Wet Season)

Basic Sanitation/Waste Management

Access to basic sanitation is conceptualized on the proportion of the total population with access to sanitary facility for human waste disposal in the dwelling or immediate vicinity. Responses from questionnaires showed that 20.3% of respondents have water closet (WC), 39.3% use pit latrine and 33.1% do open defecation in the LFZ study area (Figure 4.53).

Solid waste is rubbish (refuse), including various organic materials such as leaves and food remnants, and inorganic objects such as bottles, tins, and a variety of discarded objects but excluding excreta, generated by members of the household. Solid waste does not include the liquid waste from kitchen, bathroom, washing places and disposed of through sewage or gutter or thrown onto the street. Refuse disposal involves the collection, storage and disposal of household solid waste and the salvage and recycling of useful materials.

Proper sanitation and hygiene with respect to solid waste was observed to be good within the project environment; no solid waste was seen strewn along the streets/roads in the communities. Responses from administered questionnaires corroborate these observations. 52.6% of respondents dispose solid waste at designated community bush in the study communities. 20% also dispose of refuse using by burning in the open, while 10% of respondents dispose waste in nearby water bodies, which is usually washed ashore by strong waves. (Figure 4.54).

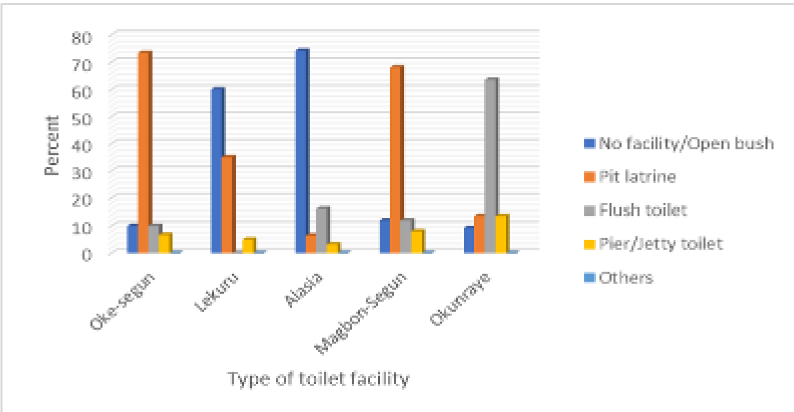


Figure 4.53: Type of Toilet Facility Used in the Study Area

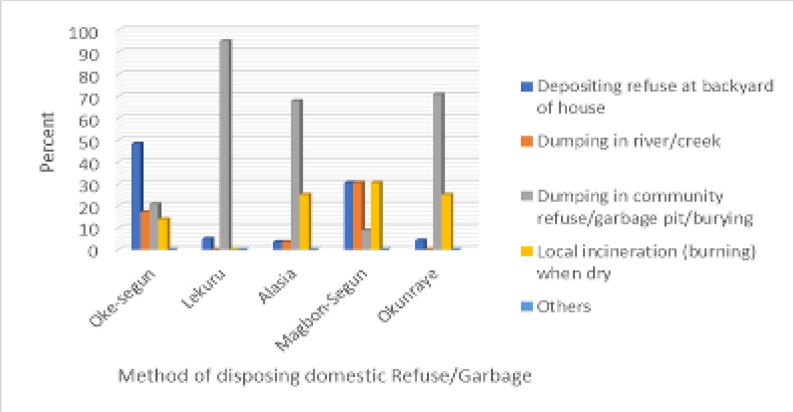


Figure 4.54: Method of Solid Waste Disposal

Housing Types/Quality and Ownership

The provision of good housing is an important aspect of environmental health. It represents a significant part of man's environment. Consequently, good housing should minimize physical and biological hazards in the environment, provide a good social environment and promote the health of the inhabitants. The housing type, pattern and structure in the LFZ study arearanges from rural to modern

As a result of development in the Ibeju-Lekki area, most of the buildings which were hitherto constructed with mud and palm fronds have either been replaced or are being converted to houses of concrete and corrugated iron sheets. Thus, it is common to find old housing stocks intermixed with emergent modern types (Plate 4.29). Almost all the resident population of the study area either own or live in their own houses.

Majority (70%) of the respondents live in houses constructed of concrete block or cement walls and have zinc roofing, while 29% own and live-in houses constructed of concrete wall but have thatch roofing materials. (Figure 4.55). The mode of ownership of the dwelling showed that 82% of respondents constructed the house while 18% bought the house.

Plate 4.29: Houses constructed of block with corrugated iron zincs dominate in Idotun village community (top) and housing type and quality in Magbon-Segun village community; note the admixture of modern block houses and those constructed of thatched materials

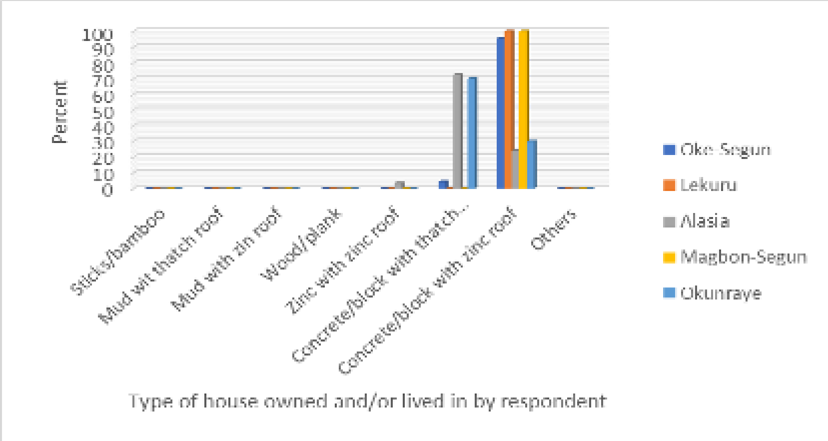


Figure 4.55: Housing Type and Quality in Study Area

Health Care Facilities, Morbidity Patterns and Health Management

The host communities within LFZ project area have limited access to primary health care facilities and services. There is no health centre at Lekuru; the afflicted including women seeking ante and post-natal care travel to nearby Akodo, the LGA headquarters where there is a General Hospital (GH). The Okunraye community has a Primary Health Centre (PHC) with provision for a staff quarter although it is considered too small for staff members (Plate 4.30). The PHC is manned by a Principal Nursing Officer (PNO) and has other 9-staff members (a nurse, a non-pensionable contract staff; 1 doctor who visits twice a week- Tuesdays and Wednesdays; 1 CHEW (Community Health and Extension Worker), also on contract; a pharmacist technician; 3 health attendants and 2 security officers). The PHC also has 5 beds for admission of pregnant women. Common ailments treated were febrile conditions, acute diarrhoea and hypertension.

Patronage of the PHC was confirmed to be low because pregnant women and mothers prefer to go to traditional birth attendants (TBAs) and only visit the PHC only when there are complications. As at the time of field visit, only 5 cases of ante-natal visits were on recorded for August 2020. However, the statistics revealed some 97 antenatal visits were recorded between January - August 2020.

For obstetrics, only 18 deliveries were recorded as at the time of site visit and no births or had been recorded for the month August 2020. Some of the challenges of the PHC is facing include, but not limited to are:

- Lack of electricity
- Lack of water
- Insecurity of people and equipment as the PHC has no fence.
- Inadequate accommodation for staff
- Upgrade of facilities

Idotun has a dispensary, while Oke Segun has a maternity home that services both Magbon Segun and Oke Segun. Itoke has no health care facility but leverages the ones situated at Idotun or Akodo.

The most common ailments are malaria, typhoid fever, cough and water-related diseases such as cholera which afflict the children mostly, and stroke for the adults. Generally, the people consider themselves and their environment relatively healthy.

Several respondents claimed to be aware of several health care facilities and services available, especially cprimary health centre, government hospital and traditional health care (Figure 4.56). Furthermore, 38.6% of respondents preferred visiting the nearest primary community health centre whenever any member of the family is sick. (Figure 4.57) For instance 30.2% of respondents patronise traditional care givers when sick, 22.6% prefer visiting the pharmacy/chemist store for self-medication. These choices are dependent on the financial capacity of the individual. In general, visits to healthcare facilities are not frequent, however, data provided is unreliable.

For births, 77.9% of respondents or their spouses visit the hospital and PHC for birth delivery, while 22.1% prefer the services of traditional birth attendants (Figure 4.58). Over 80% of the respondents consider themselves healthy while 19% indicated that they are unwell. (Figure 4.59).

Plate 4.30: Interviewing the Resident Nurse on duty at the Primary Health Centre at Okunraye Community

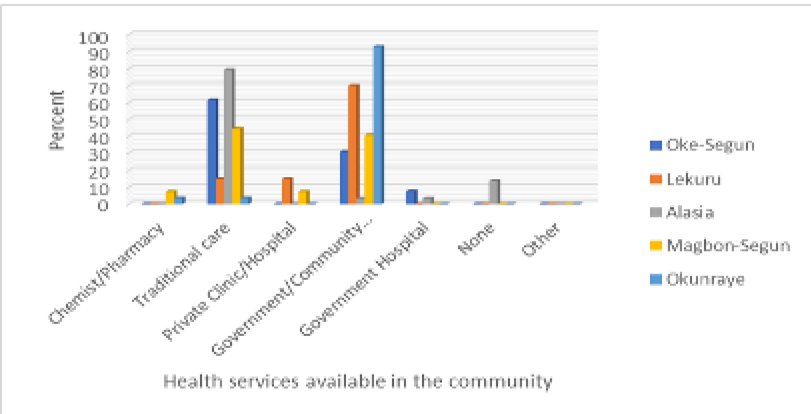


Figure 4.56: Health Services Available in the Communities in the Study Area

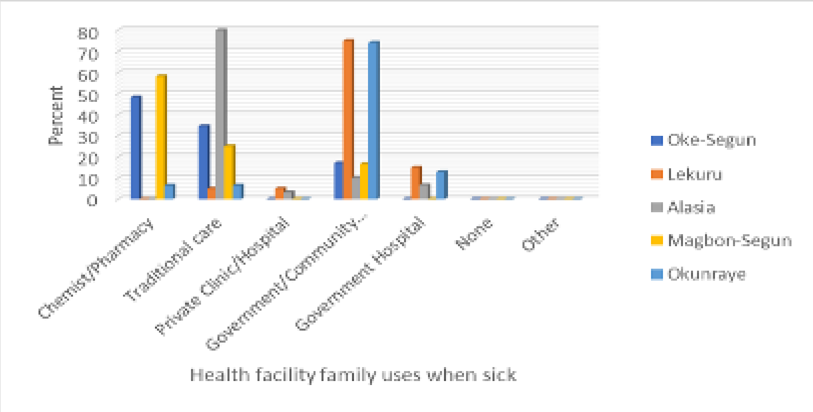


Figure 4.57: Health Services Commonly Patronised by Households

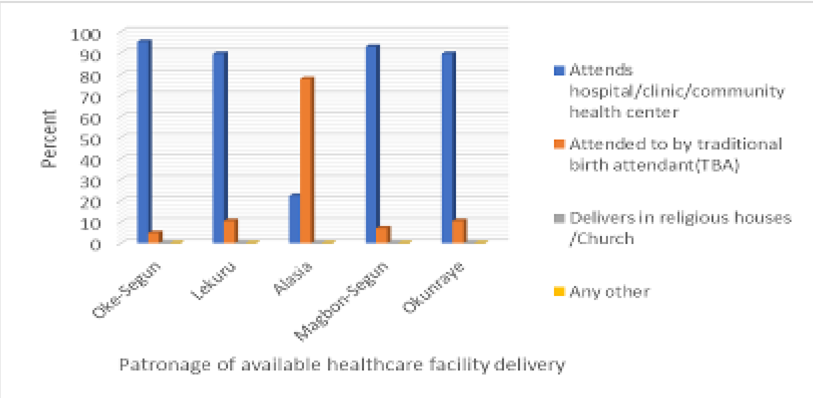


Figure 4.58: Patronage of Health Facilities for Births

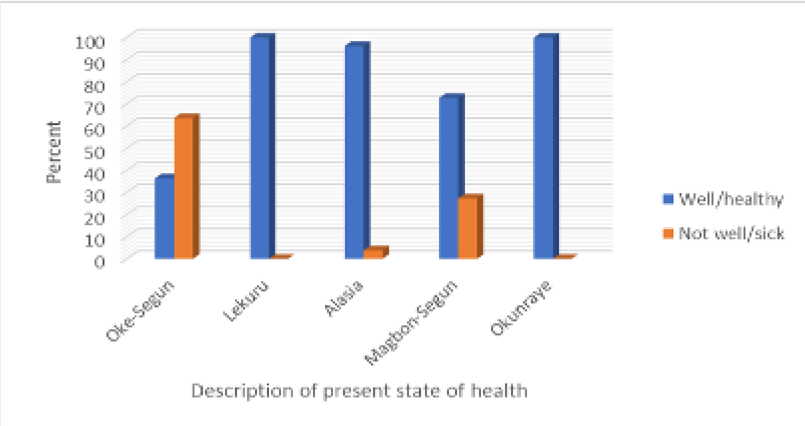


Figure 4.59: Perceievd State of Health by Respondents

The Lagos State Household Survey (2011) examined the health challenges of children under the age of five (5) years who are believed worldwide to be prone to early killer diseases such as diarrhoea, and malaria to determine Infant Mortality Rate (IMR) and Under Five Mortality Rate (U5MR) which are essential indicators for measuring the living standard of people in any geographical area of interest. Results showed that 36% of in the State had children under 5 years while the 64% do not have children under 5 years.

The study disclosed further that 80% of under-five (U5) household members received immunization against BCG in the state while 20% were not immunized against BCG.

In addition, 84% households had no diarrhoea, while 16% of the respondents reported occurrence of the disease in their households. For malaria cases in the State, 42% of under-five (U5) household members had reported having malaria at some point, while 58% of household did not.

In general, 58% of the were satisfied with services rendered at government health facilities while 42% were dissatisfied. Regarding the availability of drugs in health facilities, 7% of the respondents rated the drug provision to be excellent, 39% reported that provision of drugs was good and fair, respectively, while 15% rated the services as being poor.

48% of the respondents adjudged medical equipment in government hospitals in respect of availability and utility in the State as being good, 37% said they were fair, 8% claimed they were poor while 7% affirmed that the equipment was excellent.

The survey also examined mortality rate in the State and the survey result revealed that household mortality rate for all ages stood at 84/1000 population implying that for every 1000 household members, 84 of them had died over the years. Under 5 mortality rates, at household level stood at 48/1000 population.

Perceptions, concerns and social needs/expectations of the population

Perceived Socioeconomic impacts of LFZ Industrial activities

Community consultations and FGDs indicated that the host communities of the LFZ study area are not opposed to the industrialization drive of the State Government and those entrusted in managing the scheme, through the creation of the economic processing zone (EPZ) within their immediate environment. However, the people are concerned about land-take in the communities several projects, ongoing construction activities and operational activities, which they indicated have affected them multiple ways. Some respondents expressed their displeasure with the Lagos State Government and operators in the study area. In particular, indigenes and residents of Idotun and Itoke were unwelcoming and did not permit the study team to undertake any assessments in their communities. The anger is predicated on the following '"inconsideration":

i) The several projects so far executed in the FTZ have already caused shortage of land (farmland) and loss of economic crops/trees;
ii) Compensation for land acquisition and economic crops and trees enumerated by the Lagos State Government has been inadequate;
iii) Promises made before projects' implementation have remained unfilled;
iv) Lack of employment opportunities for residents and indigenes, as the companies employ non-indigenes at the expense of the project affected population, while the few labours employed are '"mere casual labour", whose payment is meagre.
v) Environmental and health hazards associated with projects' construction and operation activities have been a cause for concern; flooding of the nearby Itoke village community is being adduced to the dug canal which has blocked free flow

of water into the Atlantic Ocean, including the fact that that the company premises is raised (elevated) above its surrounding.

vi) The ocean surge and wave actions at the coastline have been traced to the activities of the construction of the other projects in the study area, such as the Deep-Sea Port and Refinery in the study area have caused the accretion and erosion of the shoreline making fishing around the communities difficult. The community leaders in the host communities complained about the non-challant LFZ managers and operators of other FTZ. The people originally had high hopes about the FTZ springing up a multitude of opportunities and reap the benefits associated with being hosts to industrial establishments, their expectations have been unmet.

Table 4.41 shows a summary of community needs and expectations.

Table 4.41: Community Needs and Concerns of Host Communities in the Study Area

Village community	Needs	Concerns
Itoke	• Employment opportunity • Royalty payment on land acquired on a yearly basis • Scholarships for children and wards • Fulfilment of earlier promises to build a town hall, a mosque, surfacing of community road. • Wants the papers backing ownership of land reallocated to six landholding village communities/families.	• Flooding of community in wet season as a result of sand filling and blocking of canal/creek. • Treatment of community labour employed; disparity in payment of wages to indigenes and non-indigenes is causing disaffection.
Idotun	• Fulfilment of earlier promises; secondary school renovation and building of more classrooms, surfacing of community road, employment of indigenes from construction up to operational phases.	• Company's inability to fulfil promises. • Bringing in non-natives as employees who now number above indigenes and working conditions unfavourable; labour hands, working short-time and then laid-off. • Inadequate interaction/communication with company. • Neglect and ignoring of community/landholding families; several letters written which are not responded to.
Lujagba	• Employment opportunity for the youth of the community • Payment of Royalty to the community.	• Company's inability to fulfil promises. • Bringing in non-natives as employees who now number above indigenes and working conditions unfavourable; labour hands, working short-time and then laid-off. • Inadequate interaction/communication with company. • Neglect and ignoring of community/landholding families; several letters written which are not responded to.
Magbon-Segun	• Employment of indigenes • School rehabilitation and provision of infrastructures; electricity, water, road surfacing and health care facility.	• Community members fear that operations may pollute water bodies including swamp areas and Atlantic Ocean and then affect livelihoods (fishing) • Community labour employed is laid off after a week or two but keeps non-indigenes in employment. • Company did promise village communities around some benefits but ever since started construction, nothing of

		such is forthcoming. • When company finally starts operation, shall want some community members appointed as distributors/agents of products and in fact as active members (board members).
Okunraye	• Construction of road into the community • Opening of closed-down market • Employment of indigent children • Building of bumps on road to prevent accidents and care for safety issues	• Traffic management needed during constructional activities; this as at time of study is not well-managed.
Lekuru	• Benefit-sharing as what obtained in other climes: employment opportunities, welfare projects, etc.	• The only benefit from LFZ is electricity from the Lagos State Government • Community not happy that well-qualified indigent members are not employed • Few employed not paid commensurate wages • Those employed not recruited on community slot; they struggle on their own to get what they have • Lekuru was relocated because of the industrial location of some firms and not being given attention like others; community seriously overlooked in the scheme of things.
Alasia	• Community one of those relocated and formerly called 'Ileko' • But companies around have not been too cordial with community, for they say they are no part, they don't have plan for Alasia • Poor employment opportunities rectify to be rectified; LFZ to make room for youth and able-bodied members of community • Better quality of life for community through provision of welfare-enhancing projects	

The LFZ study area has witnessed a lot of development activities over the last decade in accord with the Lagos State Government's industrialisation drive. However, respondents are apprehensive about consequent impact on livelihood activities and general morphological and environmental consequences that may arise if not well implemented.

The fears are expressed are:

- possible pollution of fishing grounds/area caused during the dredging period when turbidity shall be elevated and become harmful to fisheries; and,
- loss of fishing area as the dredging area shall be cordoned off as exclusion zone, thereby reducing the fishing area of fishers

The fears are understandable considering the livelihood system of the people who live by the Ocean and lagoon environment and conduct their business in the water as fishers. Over 60 % of the respondents considered this environmental resource of great value. Their cultural resources (ancestral sites) are also feared may be desecrated or lost during further development activities (34%). Therefore, LFZ must ensure the necessary studies are conducted to identify cultural heritages and resources in any part thereof where development activities are earmarked. (Figure 4.60).

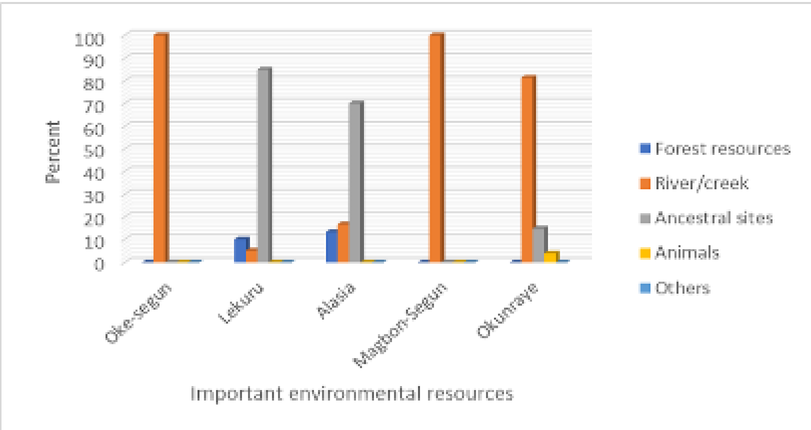


Figure 4.60: Environmental Resources in the Study Area

Community expectations and suggestions to mitigate/enhance social impacts

Most of the respondents havehigh expectations regarding ongoing and future development activities coming on their land. Interactions with community leaders, the various groups as well as responses from questionnaires revealed the interests of all concerned bordered on the associated benefits and/or positive effects that can accrue from further development activities and avoidance/mitigation of socio-environmental effects. Of all social issues, employment opportunities to indigenes at the skilled, semi-skilled and unskilled levels, is ranked highest in priority. Training of youth to enable them work in other existing and upcoming establishments and within the greater Lagos environment was also identified as important. From the palace, the land reclamation project was declared to be accepted by the community. 53.3% of respondents affirmed their acceptance of proposed further development activities within LFZ while the 46.7 % of the respondents are opposed to further activities. The opposition is based on concerns in previous section.

About 38.9% of respondents complained about thelack of employment opportunities for residents of the host communities in the study area (Figure 4.61). Because of the disharmony in the FTZ environment with regards to land acquisition and benefits-sharing, land disputes, inter-family squabbles and inter-village conflicts continue to plague the area as other serious social problems which LFZ management has to contend with and resolve quickly.

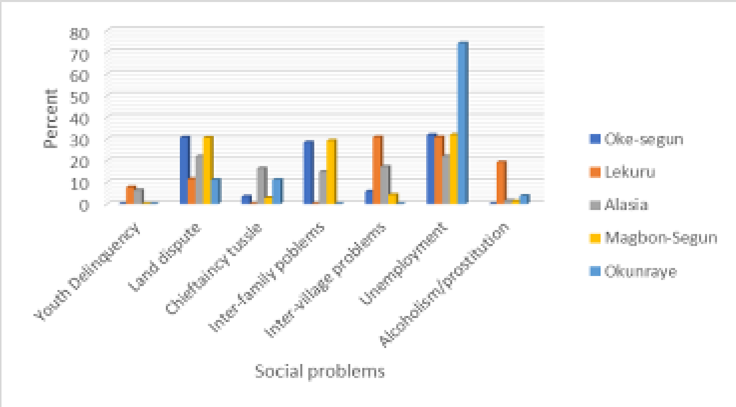


Figure 4.61: Social Problems in the Study Area

The location of the stakeholder communities in between the Atlantic Ocean and the Lagos Lagoon naturally makes them amenable and susceptible to flooding and erosion and problems. About 85 % of the respondents see the combined flooding and shoreline erosion as the most serious environmental problems plaguing the study environment (Figure 4.62). So, the communities are in expectation that the LFZ will do better in helping to curb the sea incursion and the ravages of the Ocean on their land.

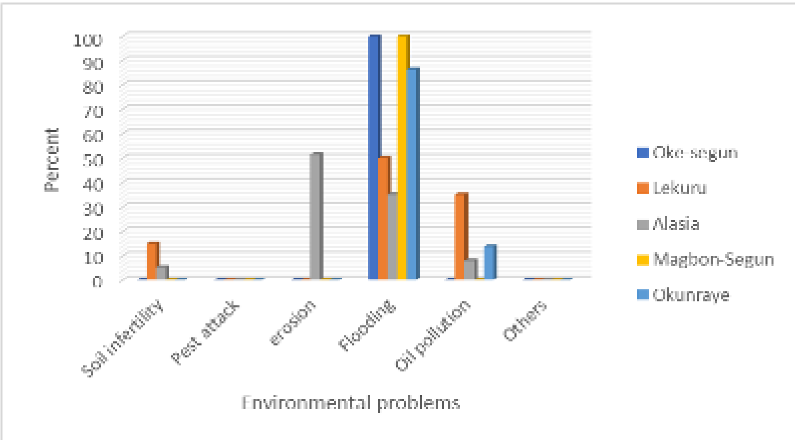


Figure 4.62: Environmental Problems in the Study Area

CHAPTER FIVE

ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACT ASSESSMENT

5.1 Introduction

This chapter presents the methodology for impact assessment of the LFZ development activities. The potential and associated impacts are based on information obtained during the field data gathering and review of project activities to draw inferences on the environmental sensitivities of the project area. Mitigations measures suggested for identified and residual impacts are presented in Chapter 6.

5.2 Assessment Approach

This section of the report assesses the potential impacts of the LFZ development activities on the array of physical, biological and human resources described in details in Chapter 4 of this report. The activities were evaluated for impacts to aquatic, terrestrial and biological resources as well as cultural and socioeconomics resources. Impacts were identified as adverse or beneficial; direct or indirect, or cumulative. These classifications are defined as follows:

- **Direct impacts** are impacts that result directly from the proposed projects. These may include but not limited to local land use changes; impacts to soils; temporary construction impacts (e.g., noise, air quality); and local biodiversity changes.
- **Indirect impacts** are impacts resulting from activities induced by the proposed projects, but not directly attributable to it. These may include changes to the local economy and demographics.
- **Cumulative impacts** result from the sum total of project impacts and/or effect of impacts of other reasonably foreseeable activities in the project area of influence.

Environmental impacts can arise from activities during the construction, development and operational phases of a project. In recognition of the distinct nature of impacts from the activities in the different phases, separate evaluations were carried out. It should also be noted that all upcoming industries within the zone will conduct an EIA and secure approval from FMEnv prior to project implementation.

Potential environmental impacts (both adverse and beneficial) related to the proposed LFZ development activities were analyzed qualitatively and quantitatively. Impact quantification, in both relative and absolute terms, was conducted using an approach derived from the **Battelle Method** based on the preparation of a significance matrix containing a multi-criteria approach. Elements that constitute the matrix are shown in **Table 5.1** and defined in **Table 5.2.** Intensity and extension are given greater weight in calculating the overall impact measurement.

This method was applied only to the identified direct and indirect impacts. Cumulative impacts are addressed qualitatively since it was not possible to characterize other on-going or planned activities that could have a synergistic effect with the LFZ project activities.

Ranking of impacts for significance/ importance was achieved by averaging the results of each identified impact and it varies between 11 and 92. Impacts with values below **20 are**

'negligible'; 'minor' between 20 and 25; 'moderate' between 26 and 40, and 'major' above 40.

Table 5.1: Significance Matrix Elements

NATURE		**INTENSITY (I)**	
Beneficial	+	Low	1
Detrimental	-	Medium	2
		High	4
		Very High	8
		Total	15
EXTENSION (EX)		**MANIFESTATION** (M)	
Punctual	1	Long Term	1
Partial	2	Mid Term	2
Extended	4	Immediate	4
Total	8		
Critical	12	Critical	8
PERSISTENCE (PE)		**REVERSIBILITY** (RV)	
Brief	1	Short Term	1
Partial	2	Middle Term	2
Extended	4	Long Term	4
EFFECTS (EF)		**FREQUENCY** (FR)	
Indirect (secondary)	1	Irregular	1
Direct	4	Periodical	2
		Continuous	4
RECOVERY (RC) Actions			
Immediate	1		
Middle Term	2	**SIGNIFICANCE (S) = Value +/- (3I+2EX+M+PE+RV+EF+FR+RC)**	
Mitigable	4		
Irrecoverable	8		

Table 5.2: Definitions of Significance Matrix Elements

Sign/Nature (+/-)	Impact sign refers to positive or negative character of the different project actions on environmental elements
Intensity (I)	Refers to the degree of disturbances created by an action over the environmental factor evaluated (air quality, number of trees of wooded area). 1= 1 minimal intensity; 12 = total destruction.
Extension (EX)	Refers to the theoretical area of influence of the impact related to the project overall area (% of impacted area). If the action produces a spot effect, the impact is considered localized (l). If on the contrary, it has a generalized influence over the project, the impact shall be considered total (8) or critical (12); intermediate situations correspond to partial impacts (2) and extensive impacts (4).
MANIFESTATION (M)	Is the length of time between initial action and resulted effects. If length of time is null .M= Critical (8); less than 1 year = Short –Term (4); 1-5 years = Mid – Term (2); and more than 5 years M = Long Term (l)
PERSISTENCE (PE)	Duration of the effect Less than 1 year = Brief (I); 1-10years = partial (2); More than 10 years Extended (4).

REVERSIBILITY (RV)	Refers to the possibility of reconstitution of the affected elements, that is, the possibility to return to the initial conditions previous to the action by natural means, once the former stops acting over the affected media. A short term is assigned a value of 1; mid-term is 2; and irreversible effect are assigned a value of 4
EFFECTS (EF)	Indirect Consequence of the action (I). Direct consequence of the action (4)
FREQUENCY(FR)	Manifestation of effects is irregular (I); Periodical (2); Continue (4)
RECOVERY (RC)	Refers to the possibility of reconstitution of the affected element, that is, the possibility to return to the initial conditions previous to the action by introducing corrective measures, once the former stop acting over the affected media. An immediate recovery is assigned a value of 1; a mid-term recovery is 2, a mitigable condition is 4; and an irrecoverable condition is 8.

The importance of each identified impacts is represented by a number derived from the equation:

Value = +/- (3I+2EX+M+PE+RV+EF+PR+RC).

Potential Impacts anticipated from the Construction and Operational Phases of the LFZ Projects are presented in **Table 5.3** below. These impacts were then screened to rank them for significance/ importance using the procedure earlier explained.

Table 5.3: Potential Impacts from Project Phases.

	Project Phase/ Activities	Potential Impacts
A	**Construction Phase**	
1.0	**Mobilization**	
1.1	Mobilization of Mat. & Equipment	Dust generation; noise generation; interference with sources of livelihood; accidents.
1.2	Mobilization of Personnel	Influx of workers from neighboring communities; increased pressure on available resources; introduction of strange diseases; increase in cost of living; increased in rate of STDs; abuse of culture of host communities; increased waste generation.
1.3	Waste Management	Domestic waste generation; solid waste from activities.
2.0	**Land Clearing and Preparation**	
2.1	Land Clearing & Backfilling	Employment of workers from host communities; loss of vegetal cover (flora and fauna); loss of habitat; soil susceptibility to erosion; dust generation; increase in social vices; Threat to health of workers (snake bites, insect bites, injuries, etc.)
2.2	Waste Management	Solid wastes from site clearing activities
3.0	**Infrastructure Development**	
3.1	Internal Roads/ Street Lighting	Employment of workers from host communities; change in landuse; noise pollution; vegetation pollution; soil susceptibility to erosion; dust generation; noxious gas/ particulate emissions

Table 5.3: Potential Impacts from Project Phases.

	Project Phase/ Activities	Potential Impacts
		from reciprocating engines and service generators; Threat to health of workers (snake bites, insect bites, injuries, etc.)
3.2	Drainage Systems	Employment of workers from host communities; change in landuse; noise pollution; surface water pollution; groundwater pollution; soil pollution; soil susceptibility to erosion; noxious gas/ particulate emissions from reciprocating engines and service generators; Threat to health of workers (snake bites, insect bites, injuries, etc.)
3.3	Utilities (Power, Water & Telecommunication)	Employment of workers from host communities; noise pollution; surface noxious gas/ particulate emissions from reciprocating engines and service generators; fire hazards.
3.3	Waste Management	Disposal of construction wastes; packaging materials; domestic wastes
B.	**Operation Phase**	
B1.	Infrastructure/ Utilities Maintenance: Internal Roads Street Lighting Drainage System Power Generation Water Generation Telecommunications	Employment of workers from host communities; noise pollution; surface water pollution; groundwater pollution; soil pollution; noxious gas emissions from reciprocating engines and service generators; fire hazards; Threat to health of workers (snake bites, insect bites, injuries, etc.).
B2.	Waste Management	Solid, liquid and gaseous wastes from production activities; noxious emission reciprocating engines and service generators.
C.	**Decommissioning Phase**	
C1.	Removal of Utilities and Infrastructures: Internal Roads Street Lighting Drainage System Power Generation Water Generation Telecommunications	Loss of vegetal cover (flora and fauna); soil susceptibility to erosion; destruction of soil structure; soil susceptibility to erosion noise pollution; dust generation; disruption of feeding/ breeding sites; Threat to health of workers (snake bites, insect bites, injuries, etc.)
C2.	Landscape Restoration	Land use change
C3.	Waste Management	Solid wastes from decommissioning activities;

Table 5.4 below presents the screening output while Table 5.5 gives a tabular interpretation of the screening exercise.

Table 5.4: Environmental Impact Significance Evaluation Matrix Table

Environmental Impact Significance Evaluation Matrix Modified Version of Conesa-Femandez-Vitora (2003) Significance is assessed by combining 9 factors into the equation: Significance = +/- (3(IN) + 2(EX)+ MA + PE + RV + AC + EF + FR + RC																							
IMPACTS		MEDIA										CHARACTERIZATION											
		Physical				Biological																	
LFZ DEVELOPMENT PROJECT		Climate	Air Quality	Soil Quality	Water Quality	Marine Fauna	Fisheries	Terrestrial Fauna	Terrestrial Flora	Landuse	Socio Economics	Nature (+ or -)	Intensity (IN)	Extension (EX)	Manifestation (MA)	Persistence (PE)	Reversibility (RV)	Accumulation (AC)	Effect (EF)	Frequency (FR)	Recovery (RC)	SIGNIFICANCE	AVERAGE
A.	**CONSTRUCTION PHASE**																						**25**
1.0	**Mobilization**																						**18**
1.1	Mobilization of Equipment/ Materials to Site		x								x	-	1	1	4	1	1	1	4	1	1	18	
1.2	Mobilization of Personnel to Site		x								x	-	1	1	4	1	1	1	4	1	1	18	
1.3	Waste Management		x	x	x				x	x	x	-	1	1	4	1	1	1	4	1	1	18	
2.0	**Land Clearing & Preparation**																						**31**
2.1	Land Clearing & Backfilling		x	x				x	x	x	x	-	4	4	4	2	1	1	4	4	2	38	
2.2	Waste Management		x	x	x			x	x	x	x	-	2	2	4	2	1	1	4	1	1	24	

Environmental Impact Significance Evaluation Matrix

Modified Version of Conesa-Femandez-Vitora (2003)

Significance is assessed by combining 9 factors into the equation:

Significance = +/- (3(IN) + 2(EX)+ MA + PE + RV + AC + EF + FR + RC

IMPACTS		MEDIA										CHARACTERIZATION											
		Physical				Biological																	
LFZ DEVELOPMENT PROJECT		Climate	Air Quality	Soil Quality	Water Quality	Marine Fauna	Fisheries	Terrestrial Fauna	Terrestrial Flora	Landuse	Socio Economics	Nature (+ or -)	Intensity (IN)	Extension (EX)	Manifestation (MA)	Persistence (PE)	Reversibility (RV)	Accumulation (AC)	Effect (EF)	Frequency (FR)	Recovery (RC)	SIGNIFICANCE	AVERAGE
3.0	**Infrastructure Development**		**26**																				
3.1	Internal Roads & Street Lighting		x	x				x	x	x	x	-	2	2	2	2	4	1	4	1	1	25	
3.2	Drainage Systems		x	x	x	x	x	x	x	x	x	-	2	2	2	2	4	1	4	1	1	25	
3.3	Utilities (Power, Water & Telecommunication)		x	x				x	x	x	x	-	2	2	2	2	4	1	4	1	1	25	
3.4	Waste Management		x	x	x		x	x		x	x	-	2	4	4	2	1	1	4	1	1	28	
B.	**OPERATION PHASE**																						**20**
1.1	Maintenance of Infrastructures/ Utilities		x	x	x	x	x	x	x	x	x	-/+	1	1	1	1	2	2	4	2	2	19	
1.2	Waste management		x	x	x	x	x	x	x	x		-	1	1	2	2	1	2	4	2	2	20	
C.	**DECOMMISSIONING PHASE**																						**7**

Environmental Impact Significance Evaluation Matrix

Modified Version of Conesa-Femandez-Vitora (2003)

Significance is assessed by combining 9 factors into the equation:

Significance = +/- (3(IN) + 2(EX)+ MA + PE + RV + AC + EF + FR + RC

IMPACTS		MEDIA										CHARACTERIZATION											
		Physical				Biological																	
LFZ DEVELOPMENT PROJECT		Climate	Air Quality	Soil Quality	Water Quality	Marine Fauna	Fisheries	Terrestrial Fauna	Terrestrial Flora	Landuse	Socio Economics	Nature (+ or -)	Intensity (IN)	Extension (EX)	Manifestation	Persistence (PE)	Reversibility	Accumulation	Effect (EF)	Frequency (FR)	Recovery (RC)	SIGNIFICANCE	AVERAGE
1.1	Removal of Utilities and Infrastructures		x	x	x	x	x	x	x	x		-	2	4	4	2	4	1	4	1	2	32	
1.2	Landscape restoration			x					x	x	x	+	4	4	4	1	1	1	4	1	1	33	
1.3	Waste management		x		x				x	x		-	2	2	4	1	1	1	4	1	1	23	

Positive (+) Impacts		Negative (-) Impacts	
	Negligible		Impacts with values below 20
	Minor		Impacts with values between 20 and 25
	Moderate		Impacts with values between 26 and 40
	Major		Impacts with values above 40

Table 5.5: Ranking of Potential Impacts from Project Phases and Project Activities.

	Project Phase/ Activities	Potential Impacts	Activity Impact Ranking	Project Phase Impact Ranking
A	**Construction Phase**			**Minor (-)**
1.0	**Mobilization**			
1.1	Mobilization of Mat. & Equipment	Traffic congestion; dust generation; noise generation; interference with sources of livelihood; accidents.	**Negligible (-)**	
1.2	Mobilization of Personnel	Influx of workers from neighboring communities; increased pressure on available resources; introduction of strange diseases; increase in cost of living; increased in rate of STDs; abuse of culture of host communities; increased waste generation.	**Negligible (-)**	
1.3	Waste Management	Domestic waste generation; solid waste from base camp.	**Negligible (-)**	
2.0	**Land Clearing and Preparation**			
2.1	Land Clearing & Backfilling	Employment of workers from host communities; loss of vegetal cover (flora and fauna); loss of habitat; soil susceptibility to erosion; dust generation; increase in social vices; Threat to health of workers (snake bites, insect bites, injuries, etc.)	**Moderate (-)**	
2.2	Waste Management	Solid wastes from site clearing activities	**Minor (-)**	
3.0	**Infrastructure Development**			
3.1	Internal Roads/ Street Lighting	Employment of workers from host communities; change in land use; noise pollution; vegetation pollution; soil susceptibility to erosion; dust generation; noxious gas/ particulate emissions from reciprocating engines and service generators; Threat to health of workers (snake bites, insect bites, injuries, etc.)	**Minor (-)**	

Table 5.5: Ranking of Potential Impacts from Project Phases and Project Activities.

	Project Phase/ Activities	Potential Impacts	Activity Impact Ranking	Project Phase Impact Ranking
3.2	Drainage Systems	Employment of workers from host communities; change in land use; noise pollution; surface water pollution; groundwater pollution; soil pollution; soil susceptibility to erosion; vegetation pollution; noxious gas/ particulate emissions from reciprocating engines and service generators; Threat to health of workers (snake bites, insect bites, injuries, etc.)	**Minor (-)**	
3.3	Utilities (Power, Water & Telecommunication)	Employment of workers from host communities; noise pollution; surface noxious gas/ particulate emissions from reciprocating engines and service generators; fire hazards.	**Minor (-)**	
3.3	Waste Management	Disposal of construction wastes; packaging materials; domestic wastes	**Moderate (-)**	
B.	**Operation Phase**			**Minor (-)**
B1.	Infrastructure/ Utilities Maintenance: Internal Roads Street Lighting Drainage System Power Generation Water Generation Telecommunications	Employment of workers from host communities; noise generation; noise pollution; surface water pollution; groundwater pollution; soil pollution; vegetation pollution; noxious gas emission and fire hazard from equipment failure; noxious gas emissions from reciprocating engines and service generators; fire hazards; Threat to health of workers (snake bites, insect bites, injuries, etc.).	**Negligible (-)**	
B2.	Waste Management	Solid, liquid, and gaseous wastes from production activities; noxious emission from reciprocating engines and service generators.	**Negligible (-)**	

Table 5.5: Ranking of Potential Impacts from Project Phases and Project Activities.

	Project Phase/ Activities	Potential Impacts	Activity Impact Ranking	Project Phase Impact Ranking
C.	**Decommissioning Phase**			**Negligible (-)**
C1.	Removal of Utilities and Infrastructures: Internal Roads Street Lighting Drainage System Power Generation Water Generation Telecommunications	Loss of vegetal cover (flora and fauna); soil susceptibility to erosion; destruction of soil structure; soil susceptibility to erosion noise pollution; dust generation; disruption of feeding/ breeding sites; Threat to health of workers (snake bites, insect bites, injuries, etc.)	**Moderate (-)**	
C2.	Landscape Restoration	Landuse change	**Moderate (+)**	
C3.	Waste Management	Solid wastes from decommissioning activities;	**Minor (-)**	

Positive (+) Impacts		Negative (-) Impacts	
	Negligible		Impacts with values below 20
	Minor		Impacts with values between 20 and 25
	Moderate		Impacts with values between 26 and 40
	Major		Impacts with values above 40

5.3 Significant Impacts – Construction Phase

5.3.1 Significant Positive Impact

There are some identified significant positive impacts of the project from this phase such as:

a. employment of work force from within host communities during activities
b. gender empowerment through trade propagation
c. host community's commerce development because of project phase implementation

All the significant positive impacts identified above are negligible in rating and short termed. This is because positive impact because of (a) will be short termed and considering that only laborers will most likely be employed from within the communities, the overall contribution of this impact will be low. Positive impact because of (b) and (c) will also short term because of the relatively short duration of this phase.

5.3.2 Significant Negative Impact

From **Table 5.5**, and based on our ranking profile, project activities during the construction phase of the project that have been identified to have significant negative impacts are:

a. Land Clearing and Preparation Activities

- Land Clearing and Backfilling – Moderate Negative Impact
- Waste Management – Minor Negative Impact

b. Infrastructure Development Activities

- Internal Roads/ Street Lighting – Minor Negative Impact
- Drainage Systems – Minor Negative Impact
- Utilities (Power, Water & Telecommunication) – Minor Negative Impact
- Waste Management – Moderate Negative Impact

The major sources of significant negative impact from (a) above are:

i. Loss of vegetal covers (flora and fauna)
ii. Loss of habitat
iii. Noise and dust pollution
iv. Soil susceptibility to erosion
v. Construction wastes (Solid, Liquid and Gaseous) management issues

The likelihood of (i), (ii), (iii) and (iv) is extremely high considering the magnitude of the project area to be cleared.

Adequate mitigation measures will have to be developed and effective measures shall be put in place to prevent this from happening and to address them if they should occur. Such measures shall be merged with the stringent comprehensive oversight function of FMEnv and Lagos State EPA.

The major sources of significant negative impact from (b) above are:

vi. Noise and dust pollution

vii. Noxious gas/ particulate emissions from reciprocating engines and service generators
viii. Vegetation pollution
ix. Soil susceptibility to erosion
x. Surface & groundwater pollution
xi. Increase in social vices
xii. Threat to health of workers (accidents, snake bites, insect bites)

The contributions of (vi), (vii), (viii), (ix), (x), (xi) and (xii) as a result of proposed project activity will be negligible. Significant contribution of (vi), (vii), (viii), (ix), (x), (xi) and (xii) can only be achieved if Project Proponent fails to adhere to strict implementation of mitigation measures that shall be proffered for these impacts.

5.4 Significant Impacts – Operation Phase

5.4.1 Significant Positive Impact

The following are the significant positive impacts of the project from this phase:

a. employment of work force from host communities during operation phase
b. corporate social responsibility of LFZ towards host communities during operation phase
c. host community's commerce development as a result of project implementation
d. increased revenue to State Government and Federal Government.

However, **only (b) and (d) will eventually have weights as significant positive impacts**. This is because positive impact because of (a) will be very low in view of the fact that LFZ will most likely not require substantial additional personnel to implement these phases of the project.

Contribution of (c) due to establishment of the FTZ will be low (for now). However, it will be high indirectly (eventually) when industries start to populate the FTZ. Such significant positive contributions shall be captured in EIAs that shall be mandatorily prepared for such additional industries prior to commencement of their activities.

5.4.2 Significant Negative Impact

From **Table 5.5**, project activities that have been identified to have significant negative impacts during operation phase are:

a. Infrastructure/ Utilities Maintenance
b. Waste Management

The major sources of significant negative impact from (a) above are:

xiii. Noise and dust pollution
xiv. Noxious gas/ particulate emissions from reciprocating engines and service generators
xv. Surface & groundwater pollution
xvi. Increase in social vices
xvii. Threat to health of workers (accidents)
xviii. Potential for explosion and fire incident

The contributions of (xiii), (xiv), (xv), (xvi), (xvii), and (xviii) because of proposed project activity will be negligible or next to nil. Significant contribution (xiii), (xiv), (xv), (xvi), (xvii), and (xviii) can only be achieved if Project Proponent fails to adhere to strict implementation of mitigation measures that shall be proffered for these impacts.

5.5 Analysis of Cumulative Impacts

In addressing cumulative impacts, existing project activities in the project location were considered and all sources of significant positive/ negative impacts with tendencies for accumulation were identified. Significant negative/ positive impacts from the proposed project activities that have tendencies for accumulation were then super-imposed on the existing impacts to determine their synergistic effects.

The approach above could however not be evaluated quantitatively due to non-availability of all salient data such as:

- present emission contribution (tons/ year) of other existing on-going project activities to ambient air shed loading of the project environment.
- Specific details of other projects adjacent or near LFZ project and their contribution (tons/ year).
- Specific emission contributions (tons/ year) from proposed activity scenarios.

5.5.1 Existing Significant Impacts from Proponent's On-going Activities

The following are the existing significant positive and negative impacts from the on-going Proponent's activities within the project environment:

5.5.1.1 Significant Positive Impacts

a. employment of work force from host communities
b. corporate social responsibility of Proponent towards host communities during operation phase
c. host community's commerce development as a result of previous project implementation
d. revenue to State Government and Federal Government.

5.5.1.2 Significant Negative Impact

e. Noise, Dust, Particulate and Noxious Emission from previous activities and other on-going activities.
f. Pressure on Social Amenities and Infrastructure due to Influx of Workers to Project Area.

5.5.2 Cumulative Impacts of present activities with existing activities

5.5.2.1 Cumulative Positive Impacts

A. Employment of work force from host communities

Contribution of present proposed activities to the above will be low when compared to actual effect of (a) when Proponent was just starting out within the project environment many years ago.

B. Corporate social responsibility of Proponent towards host communities

Proponent had significantly impacted positively on the host communities with many developmental projects with the proposed project activities, Proponent will most likely derive more financial dividends from their presence in the project environment and will conversely be able to further add positive values through additional and or bigger community project implementation. Consequently, (b) above will increase significantly more because of proposed project when compared to its present level right now.

C. Host community's commerce development

Contribution of present proposed activities to the above will be low when compared to actual effect of (c) when Proponent was just starting out within the project environment many years ago. The Group is fully on-ground right now and will not need so many new employees for the additional project implantation. Hence the level of (c) will most likely remain as it is or it may at most just experience a marginal increase during the Construction and Operation Phases.

D. Revenue to State Government and Federal Government

Proposed Project will lead to a direct increase in financial returns (taxes, royalties) contribution to State and Federal Government. Consequently, (d) above will increase significantly more as a result of proposed project when compared to its present level right now.

5.5.2.2 Cumulative Negative Impact

A. Noise, Dust, Particulate and Noxious Emission from previous activities and other on-going activities

On-going activities within the project area have diverse impacts on the different environmental media of the project environment. Negative impact because of (e) above will increase significantly (especially impact on air quality, domestic and production wastes) when this proposed project comes on stream.

B. Pressure on Social Amenities and Infrastructure due to Influx of Workers to Project Area due to on-going projects.

This will be further compounded by the LFZ project with attendant negative impacts on host communities.

5.6 Environmental Attributes Related Impact Identification

In addition to activity related impact identification, there is need to investigate **specific potential and associated impacts** that the project will have on the different environmental components or sensitivities.

5.6.1 Surface Water and Hydrogeology

The under-listed activities may have impacts on both ocean, surface water and the hydrogeological setting of the project area:

- Preparatory phase, involving site clearing as well as mobilization of men and equipment to site.
- Construction phase
- Post-construction phase, encompassing monitoring and maintenance activities as well as safety and security measures etc.

5.6.2 Vegetation

1. Site clearing during construction activities will produce a disturbed ground surface on which weeds can become established.
2. Site clearing would also lead to reduction of biodiversity and abundance.
3. Opening of the forest may lead to uncontrolled exploitation of the vegetation.
4. Accidental oil spillage into the soil (resulting from equipment malfunction or maintenance) has the potential to break down soil aggregates. This usually kills the surrounding vegetation.
5. Equipment mobilized to project site during construction activities may introduce weed seeds (trapped in plant segments and muds).
6. Mechanical damage to plants and stress during land clearing may predispose the vegetation to pathogenic infection.
7. De-vegetation will result in loss of habitat, species diversity, reduced plant vigour and total biomass productivity.

5.6.3 Aquatic and Hydrobiology

A. Planktons

The possible introduction or discharge of waste oil into the water body may cause a significant reduction in the phytoplankton population hence reducing primary productivity of the waterbody. This reduction in productivity could arise as a result of the decrease in light penetration in the water body, which is necessary for the photosynthetic activities of phytoplankton. Zooplankton population would also be reduced drastically because many these might die off because of the toxic component of the spilled oil.

5.6.4 Fisheries and Aquatic Invertebrates

This is one of the important environmental attributes of the project area. Project activities, given the process description presented in an earlier chapter of this report, may not substantially affect the fishery and aquatic invertebrates of the project area. However, certain potential impacts are noteworthy. These include:

1. Increased water traffic/ noise during project development and operations may pose adverse environmental conditions for fish and invertebrates in the study area. Specific effects may include physiological stress on them. This might lead to migration from the area, which might in turn lead to reduction in species diversity and abundance in the area.
2. Site clearance, especially close to the water bodies may destroy the burrows of invertebrates. This might cause physiological stress and possibly disrupt breeding activities.

5.6.5 Soil Quality

Potential impacts of project activities on soil are not likely to be significant, in terms of magnitude, severity and spread. However, without proper construction plans, some of the anticipated impacts may include the following:

1. Cleared soil may become over-exposed to rain. This may lead to erosion and leaching away of nutrients which could in turn lead to a substantial reduction in soil fertility.
2. Trenching for infrastructure development will induce disturbance of the soil environment, also there will be loss of land/soil materials along the portion that will be dug. However, this activity is expected to take place only during the construction phase.
3. Nutrient runoff from the soil into water bodies may cause eutrophication and hasten the process of natural aging of the waters.
4. Movement of heavy machinery and trucks during project activities may damage structure of the soil.
5. Possible contamination of soil from improper handling and disposal of wastes resulting from project activities.

5.6.6 Air Quality

The result of air quality monitoring has been presented in an earlier section of this report. With the proposed developmental activities, there are likely to be some pollution in the air quality due to proposed project activities.

1. Degradation of air quality from construction activities.
2. Increased noise level from the plant equipment can contribute to long-term hearing loss problems and may be very objectionable.

5.6.7 Wildlife

Some impacts on wildlife, likely to result from project activities are:

1. Clearing of vegetation would lead to loss of habitat resulting in the reduction and migration of wildlife resources in the area. Fast moving wildlife would readily migrate to undisturbed areas while slow ones would gradually follow. Such migration leads to upsetting the species balance and evenness.

2. Improper waste management could lead to contamination of water and vegetation which serve as sources of food and shelter for wildlife. This would ultimately result in reduction of wildlife in the area.

5.6.8 Land Use

The severity of the impacts on land use is discussed based on an assessment of the sensitivity of the resources to the proposed project and site. Accordingly, an Environmental Sensitivity Index (ESI) mapping is attempted based on the distance of each feature away from the project site and its activities (Figure 5.1).

Positive Impacts:

- In terms of severity, settlement land use is the most susceptible to the project because it constitutes abodes for all stakeholders. Should the project come on board, the project area shall record appreciable population increase and some corresponding beneficial socio-economic mixes between the workers and the indigenes.
- Provision/ maintenance of common infrastructures especially roads, markets, medicals, drains, and socials are also expected.

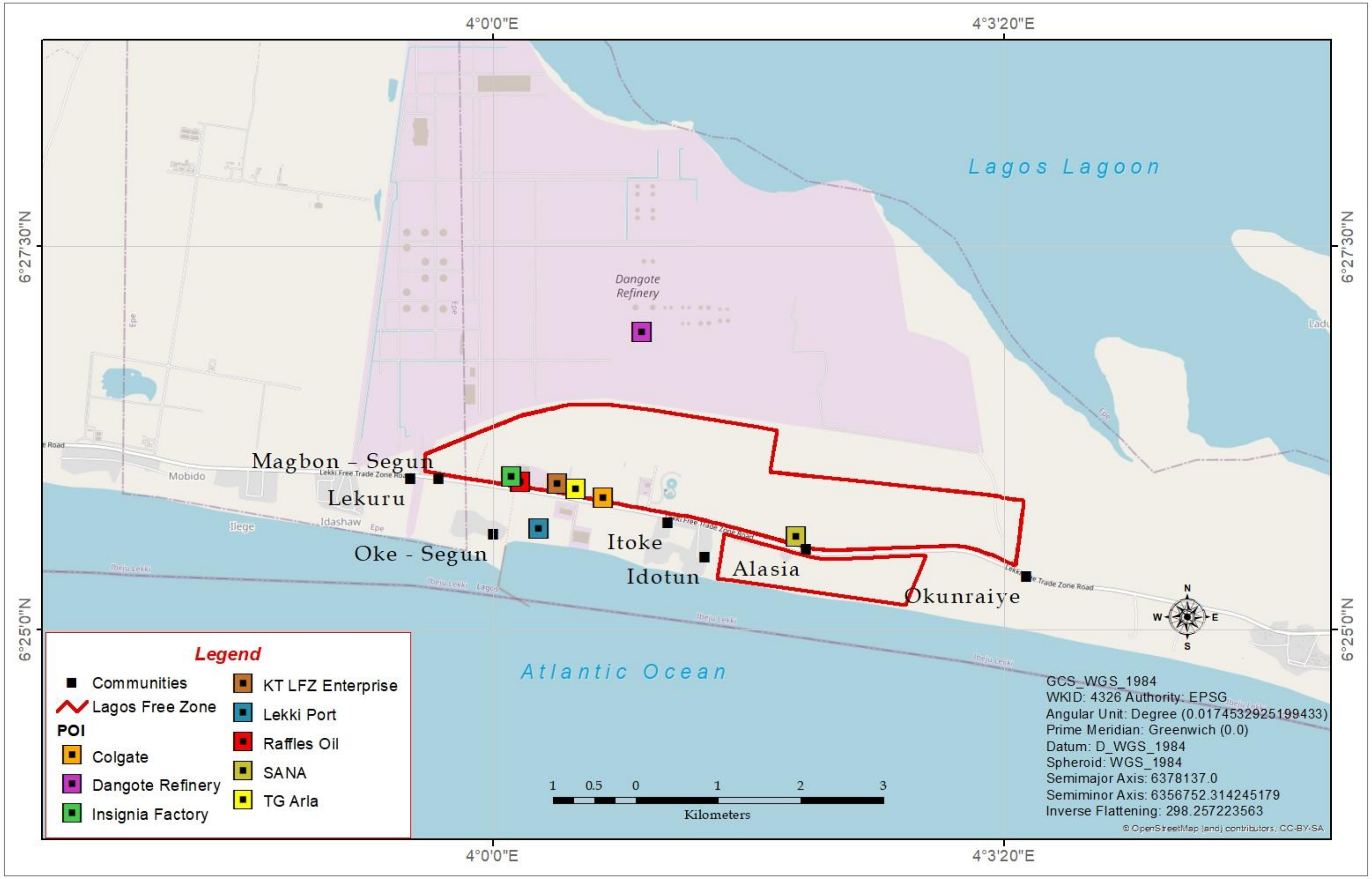


Figure 5.1: Environmental Sensitivity Index

Negative Impacts:

The main negative impacts to the neighboring inhabitants will include the following:

- Acquisition of land within the defined area from the government, owners, and other stakeholders.
- Increased vehicular traffic within the area thereby leading to more competitive use of the road (especially during peak periods). This could lead to traffic congestions, restrictions, and accidents.
- Since more people will be attracted and/or posted to the project area as workers, there is the possibility of further cumulative effects on the entire natural resource use of the area.
- The change in land use might later alter the speed of development in the neighborhood as land speculators might bought over all lands in anticipation of the future growth of the neighborhood. This action may lead to occupational change as residents might have to change from farming to other type of occupation.
- The proposed LFZ development may have impact on the hydrology of the project area, while waterborne emissions may place the quality of both surface water and groundwater at risk.
- Disposal of wastes (during the construction and operational phase of the project), containing toxic or otherwise harmful compounds will have effects on water quality and soil and potential adverse effects on crops and health.
- LFZ development will generally impact on the local economy and may result in social change in the area which mainly depends on fishing, agriculture and other primary sectors for their subsistence.

CHAPTER SIX

MITIGATION MEASURES

6.1 INTRODUCTION

In the previous section of this report, we highlighted some of the impacts that the proposed project is anticipated to have on different environmental media and attributes of the project area based on the findings of the wet and dry season fieldwork. Although most of these impacts (especially the negative ones) are expected to be minimal in terms of magnitude and spread, it is still necessary to provide measures that will further reduce or where possible eliminate such impacts. In this chapter therefore, we present mitigation measures for the identified negative impacts. We are of the professional opinion that these measures, if properly implemented, will eliminate, or at least minimize most of the negative impacts, while some of the positive impacts will be further enhanced.

To mitigate the significant, medium, and high-ranking negative impacts identified as a result of the proposed development, a number of steps have been taken as well as enhance those impacts identified as positive to preserve the environment.

The mitigation measures proposed for the predicted impacts took cognizance of the following:

- Environmental laws in Nigeria and permissible limits for waste streams (FEPA, 1991);
- IFC Guidelines
    - Performance Standards on Social and Environmental Sustainability
    - General EHS Guidelines
- Best Available Technology for sustainable development.
- Feasibility of application of the measures in Nigeria;
- The residual effects that arise despite the mitigation measures have also been discussed for effective mitigation to a low level.

The mitigation measures for both the impacts during the construction and operational phases earlier discussed are summarized below, with respective environmental monitoring and management requirements.

6.2 MITIGATION MEASURES

Specific mitigation measures have been identified during the course of the environmental impact assessment to reduce the negative effects of those impacts identified through detailed analysis. Specification of mitigations focused on impacts identified as high or medium overall impact significance ("HIGH" and "MODERATE" in Chapter 5). Mitigations are however also identified for "LOW" impacts in order to keep them at acceptable levels.

General Mitigation Measures are those that LFZ has already adopted and built into its standards, designs, and plans. In addition, operational best practices will be followed for the implementation phase (post-construction). Since LFZ has committed itself and its contractors to these mitigation measures, they are expected to significantly improve the environmental and social sustainability of the project. When it was known that the general mitigations were part of the project plan, they were typically accounted for when assessing the potential impacts presented in Chapter 5.

In order to meet the EHS performance objectives of the project, a number of mitigation measures are built into the project design and operating philosophy as specifications for environmental, social and health performance.

Mitigation measures developed as part of the ESIA or related processes during the design phase are discussed as Specific Mitigation Measures. Specific mitigation measures are aimed at reducing negative impacts to acceptable levels and where possible, enhancing positive ones. The impacts are therefore re-assessed to determine the effect of each of these specific mitigation measures and the residual impacts are presented.

6.2.1 Implementation of Mitigations

Mitigations are presented in this chapter in relation to specific project activities. In practice however, they are implemented as part of overall operational plans and procedures used by LFZ and its contractors to control their work and ensure compliance with protective measures. In some parts of this chapter, reference is made to a particular plan or set of plans that will address the specific impact and mitigation. The organization of the plans and procedures is the subject of the Environmental and Social Management Plan (ESMP) that is described in Chapter 7.

As part of its Sustainability Commitment, LFZ has committed to requiring that its contractors and sub-contractors comply with its obligations in a manner consistent with LFZ's Environmental, Social and Health Management Plans and/or other sustainability commitment. Mitigation measures will be required of all contractors through contractual obligation. Each contractor will be required to develop a specific Environmental Management Plan (EMP) to support this ESIA, particularly the overall ESMP. They will also be required to provide formal plans, procedures, and other submissions to ensure proper implementation of protective measures and of the specific mitigation requirements identified by the ESIA.

Each Contractor is required to submit the following plans for review by LFZ to determine adherence to requirements of the project's overall HSE management plans. These plans must be approved by LFZ before work can commence:

- Environmental Management Plan;
- Waste Management Plan;
- Emergency Response Plan; and

LFZ will also develop and implement the following plans:

- Labour Plan (including Job Rules);
- Emergency Response Plan
- Community Development Plan

The ESMP presented in Chapter 7 provides specific requirements to monitor the effectiveness of mitigation measures. LFZ will revisit and, to the extent possible, develop alternatives for any mitigation measures that are not resulting in the intended outcome.

6.2.2 Specific Mitigation Measures

Mitigations specific to activities and the activity's impacts have been proffered during the ESIA to address impacts not minimized by the General Mitigation Measures. These specific mitigation measures are presented for each impact category in Table 6-1 following the format used in Chapter 5.

LFZ has developed mitigations working within the framework of Best Available Technology Not Entailing Excessive Cost (BATNEEC) with the goal of reducing impacts or the risk of impacts to "As Low As Reasonably Practicable" (ALARP). In determining whether to implement a mitigation measure, especially for those recommended by the ESIA, the following factors have been taken into consideration:

- Feasibility;
- Ease of implementation;
- Local suitability;
- Institutional requirements;
- Training requirements;
- Monitoring requirements;
- Cost (capital and operating); and
- Cost-effectiveness.

The residual impact ratings presented were reached by re-assessing the impacts and the effect of the mitigation on the impact severity criteria and likelihood. Similarly, projects support for self-help initiatives and awareness campaigns on solid waste management practices, such as waste collection and proper storage, will reduce, but not eliminate, the magnitude of in-migration related increase in solid wastes.

It is noted however that some impacts by their very nature may not be readily mitigated to low significance levels. For some of these, in-kind or compensatory measures will be taken as mitigation. One example is land take and economic displacement which will be addressed through the compensation procedures developed for the project. Some social impacts may require wider-reaching government action for effective mitigation (e.g., provision of basic infrastructure). In this regard, LFZ will through advocacy and continuous engagement, work with the LFTZ, communities in the area and the Government of Lagos State to bring about the desired outcomes.

Table 6.1: Summary of Identified Impacts from Project Phases and Project Activities with Corresponding Mitigation Measures

	Project Phase/ Activities	Potential Impacts	Impact Ranking Before Mitigation	Mitigation Measures	Residual Impact Ranking After Mitigation
A	**Construction Phase**				**Negligible (-)**
1.0	**Mobilization**				
1.1	Mobilization of Material & Equipment	Traffic congestion; dust generation; noise generation; interference with sources of livelihood; accidents.	**Negligible (-)**	- During mobilization of equipment and materials, as much as possible, large and slow-moving vehicles shall be scheduled during off peak periods. - LFZ shall raise community awareness of unusual activities. - LFZ shall carry out pre-mobilization of all vehicles. - LFZ shall enforce her journey management policy. - LFZ shall enforce defensive driving course for LFZ and contractors' drivers. - LFZ shall ensure that anti-venom/ anti-histamine is provided on site to mitigate snake bites and insect stings. - In order to reduce the potential for accidental road deaths of wildlife species, project workers shall be well briefed of areas of wildlife concentration.	
1.2	Mobilization of Personnel	Influx of workers from neighboring communities; increased pressure on available resources; introduction of strange diseases; increase in cost of living; increased in rate of STDs; abuse of culture of host communities; increased waste generation.			
1.3	Waste Management	Domestic waste generation; solid waste from base camp.			
2.0	**Land Clearing and Preparation**				**Minor (-)**
2.1	Land Clearing & Backfilling	Employment of workers from host communities; loss of vegetal cover (flora and fauna); loss of habitat; soil susceptibility to erosion; dust generation; increase in social vices; Threat to health of workers (snake bites, insect bites, injuries, etc.)	**Moderate (-)**	- Cleared areas shall be promptly re-vegetated to eliminate the risks of susceptibility of the exposed soils to erosion. Proper erosion control measures shall be implemented in places where cutting of access will expose the area to erosion and other similar environmental hazards. - As much as possible, site clearing shall be done sparingly, clearing only the really necessary sites to avoid climatic	
2.2	Waste Management	Solid wastes from site clearing activities	**Minor (-)**		

Table 6.1: Summary of Identified Impacts from Project Phases and Project Activities with Corresponding Mitigation Measures

	Project Phase/ Activities	Potential Impacts	Impact Ranking Before Mitigation	Mitigation Measures	Residual Impact Ranking After Mitigation
3.0	**Infrastructure Development**			modifications that may result from opening the area to light and wind penetration. - Great care shall be taken to avoid the introduction of foreign vegetation species into cleared areas by washing of all tracked equipment and wheeled vehicles of mud and vegetative debris prior to movement onto the project site in order to reduce the potential for weed transfer. - Any previously unidentified significant habitat features/specialized habitat for wildlife or nesting sites discovered during construction shall be avoided or relocated. - The construction schedule for the project shall, as much as possible, be implemented to avoid nest establishment, incubation and fledgling periods for the avian species as well as the reproductive and early rearing activities of the mammalian species. - LFZ shall carry out pre-mobilization of all vehicles and equipment to be used for construction. - LFZ shall enforce her journey management policy during this phase and enforce defensive driving course for LFZ and contractors' drivers. - The villagers (representatives) shall be consulted before any major activity is started in order to forestall occurrence of any form of communal disturbances.	**Minor (-)**
3.1	Internal Roads/ Street Lighting	Employment of workers from host communities; change in land use; noise pollution; vegetation pollution; soil susceptibility to erosion; dust generation; noxious gas/ particulate emissions from reciprocating engines and service generators; Threat to health of workers (snake bites, insect bites, injuries, etc.)	**Minor (-)**		
3.2	Drainage Systems	Employment of workers from host communities; change in landuse; noise pollution; surface water pollution; groundwater pollution; soil pollution; soil susceptibility to erosion; vegetation pollution; noxious gas/ particulate emissions from reciprocating engines and service generators; Threat to health of workers (snake bites, insect bites, injuries, etc.)			
3.3	Utilities (Power, Water & Telecommunication)	Employment of workers from host communities; noise pollution; surface noxious gas/ particulate emissions from reciprocating engines and service generators; fire hazards.	**Minor (-)**		

Table 6.1: Summary of Identified Impacts from Project Phases and Project Activities with Corresponding Mitigation Measures

	Project Phase/ Activities	Potential Impacts	Impact Ranking Before Mitigation	Mitigation Measures	Residual Impact Ranking After Mitigation
3.3	Waste Management	Generation of large volumes of construction wastes; packaging materials; domestic wastes.	**Moderate (-)**	- LFZ shall ensure that project workers are integrated into the social ways of local communities to avoid conflicts in social norms and values. - Regular fora on safety and health with the locals around LFZ's facilities shall be designed. This shall also encompass environmental, cultural and economic awareness systems that can improve their standard of living.	
B.	**Operation Phase**				
B1.	Infrastructure/ Utilities Maintenance: Internal Roads Street Lighting Drainage System Power Generation Water Generation Telecommunications	Employment of workers from host communities; noise generation; noise pollution; surface water pollution; groundwater pollution; soil pollution; vegetation pollution; fire hazard; noxious gas emissions from reciprocating engines and service generators; fire hazards; Threat to health of workers (snake bites, insect bites, injuries, etc.).	**Negligible (-)**	- Good rapport during the various phases of project implementation shall be maintained with neighboring villages by LFZ so that the villagers will co-operate with LFZ's plans. This will ensure that adequate understanding of the realities of the project exist among the impacted communities. - LFZ shall ensure regular maintenance of vehicles, reciprocating engines and operation equipment. - LFZ shall ensure that anti-venom/ anti-histamine is provided on site to mitigate snake bites and insect stings. - Accidental spills shall be promptly and effectively contained and managed. - The threat of pollution of soil, vegetation and water bodies through wastes generated from this phase (operations wastes, camp solid wastes and sewage handling) shall be minimized by ensuring that waste treatment facilities capable of handling the envisaged waste types and volumes are installed on site.	**Negligible (-)**
B2.	Waste Management	Solid, liquid and gaseous wastes from operations activities; noxious emission from; reciprocating engines and service generators.	**Negligible (-)**		**Negligible (-)**

Table 6.1: Summary of Identified Impacts from Project Phases and Project Activities with Corresponding Mitigation Measures

	Project Phase/ Activities	Potential Impacts	Impact Ranking Before Mitigation	Mitigation Measures	Residual Impact Ranking After Mitigation
C.	**Decommissioning Phase**				
C1.	Removal of Utilities and Infrastructures: Internal Roads, Street Lighting, Drainage System, Power Generation, Water Generation Telecommunications	Loss of vegetal cover (flora and fauna); soil susceptibility to erosion; destruction of soil structure; noise pollution; dust generation; disruption of feeding/ breeding sites; Threat to health of workers (snake bites, insect bites, injuries, etc.)	**Moderate (-)**	- Cleared areas shall be promptly re-vegetated using indigenous species to the project area. - The threat of pollution of soil, vegetation and water bodies through wastes generated from this phase shall be minimized by ensuring that all wastes are appropriately disposed. For example: demobilized equipment and structures that are still functional can be sold as scraps, demobilized concrete structures can be given to villagers to be used as foundation base or sold to construction companies, demobilized metal scraps can be sold as scraps.	**Negligible (-)**
C2.	Landscape Restoration	Land use change	**Moderate (+)**		
C3.	Waste Management	Solid wastes from decommissioning activities;	**Minor (-)**		

CHAPTER SEVEN

ENVIRONMENTAL MANAGEMENT PLAN

7.1. Introduction

An Environmental Management Plan (EMP) is the essential and stand-alone component of an EIA that provides the assurance that the mitigation measures developed for reducing the effects of adverse associated and potential impacts to As Low As Reasonably Practicable (ALARP) as well as those proposed for enhancing beneficial impacts are implemented and maintained throughout the project lifecycle. The EMP for the proposed LFZ Project, outlining the strategies for managing hazards, associated and potential impacts and their effects on the environment, is presented in this chapter.

Hence, this EMP shall not be based on specific impacts and associated mitigation measures of all the possible development project activities anticipated in the industrial and non-industrial zones of the project area. The EMP shall focus on the anticipated impacts associated with the operations of the possible project activities identified for the development of the land resources in the LFZ. It is believed that individual Environmental Impact Assessment shall be carried out specifically for each potential industrial and non-industrial development interventions that would eventually occupy the LFZ plots, during which the impacts at all phases of such project life cycle shall be identified and mitigated by the developers. Hence, this EMP shall delimit its compilation to the prevailing baseline environmental and social conditions of the project area presented in this EIA report and the potential impacts of the implementation of the possible project activities presented herein, during the operation phase, on various environmental monitoring parameters and indicators presented in the chapter on baseline environmental and social conditions of the LFZ. Precisely, this EMP is designed to enhance the continual monitoring of the specific environmental parameters and indicators of the imprint of the effects of the anticipated industrial and non-industrial projects on the social and environmental conditions of the zone.

Furthermore, this EMP outline in great details the additional guidelines and control measures for mitigating anticipated project impacts on ambient air quality; surface (freshwater, pond water, potable water and marine water) and groundwater quality; noise and vibrations; terrestrial environment (soil quality and topography); socio-economic environment; and the management and handling of wastewater, storm water, sewage, solid and hazardous wastes generated within the FTZ. Also highlighted are the Environment, Health and Safety policy requirements of LFZ, the Emergency Preparedness and Response Plan in place as well as the EHS training requirements.

7.2. The Objectives of the EMP

The Environmental Management Plan (EMP) hereby proposed has the following objectives:

- To demonstrate that a systematic procedure for ensuring that all project activities are executed in compliance with applicable legislations and LFZ policies on Health, Safety, Environment, Security and Community Relations have been established for the project;

- To document and provide assurance that the environmental impact mitigation measures recommended for specific project impacts identified for the LFZ development project are effective in the amelioration of such project impacts;
- To ensure that regulatory standards for pollutants are not exceeded;
- To provide early warning of environmental damage, so that actions may be taken to reduce the harmful imprints on the environment;
- To demonstrate that emergency response and recovery plan and measures are in place. This assures prompt responses to emergencies during project implementation; and
- To set out the structure that will ensure compliance by LFZ and its contractors, with the provisions in the EMP.

The environmental monitoring plan sequel to the Environmental Management Plan herein presented is designed to put in place a strategy to prevent, avoid and minimize the negative environmental impacts that were identified and could occur during the operation phases of the anticipated industrial and non-industrial development project initiatives. Hence, the environmental monitoring plan presents the guidelines for evaluating the effectiveness of the impact mitigation measures in minimizing and mitigating the potential impacts from the possible project activities.

7.3. Responsibilities for Environmental Management

For effective implementation of the proposed EMP, it is imperative that all participation stakeholders must understand clearly their responsibilities regarding the protection of the environment and be committed to the implementation of the control measures and guidelines required to fulfil these responsibilities. With respect to the Lagos Free Zone project, the stakeholders that have environmental and social management responsibilities are:

- Lagos Free Zone Sustainability Department and Project Team;
- Project Developers and Investors
- Construction Contractors;
- Environmental Management Specialist/Consultant;
- Federal Ministry of Environment (FMEnv);
- Lagos State Ministry of Environment
- Lagos State Environmental Protection Agency (LASEPA)
- Lagos State Waste Management Authority (LAWMA)

The roles and responsibilities of these key stakeholders in the implementation of the requirements of this EMP are presented hereafter.

Lagos Free Zone Sustainability Department (LFZ Project Team)

The top management of LFZ shall retain the overall responsibility of ensuring that environmental commitments are met throughout the FZ life cycle. In this regard, the company shall identify specific responsibilities and schedule for training on matters relating to the environment. Essentially, top management shall ensure that all environmental considerations are integrated into project execution.

However, specific day to day responsibility on environmental issues shall rest on the LFZ senior project manager or advisor who shall head the project implementation team (PIT). The PIT shall comprise of LFZ Project Director, LFZ EHS Manager, LFZ Project Manager and LFZ Independent Environmental Consultant. The specific responsibilities of the LFZ Project Team (the LFZ Sustainability Department) are as follows:

- Monitor the environmental and social conditions of the LFZ to ensure that regulatory requirements for pollutants are not exceeded and provide early warning of environmental damage, so that actions may be taken to reduce the harmful imprints on the environment;
- Monitor the Investors / Developers of LFZ land resources, and Construction Contractor activities with respect to environmental and social matters and document their observations regarding compliance with the Contractor EHS plans, site specific EHS plans and this EMP;
- Document and report non-compliance situations through the LFZ Independent Environmental consultant to the LFZ Project Director, EHS Manager and the Project Manager;
- Provide advice to the Construction Contractors and staff regarding environmental matters;
- Assist the Construction Contractors in resolving non-compliance situations;
- Follow-up to ensure that non-compliance situations are successfully addressed.

The roles and responsibilities of all the key players/stakeholders in the implementation of the monitoring program are as shown in Table 7.1 while the EHS organogram is presented in Figure 7.1 below.

Table 7.1: Roles and responsibilities of key stakeholders

S/No.	Key Stakeholder	Responsibilities
1	LFZ Project Director	• Establish and ensure high level management commitment to the fulfilment and compliance with the requirements of the EMP and other relevant guidelines and regulatory/permit requirements; • Ensure that the development of LFZ land resources and all possible project development options and activities are conducted in

S/No.	Key Stakeholder	Responsibilities
		accordance with all the requirements of the LFZ sustainability policies and the EMP commitments; • Provide leadership and overall direction to EHS Manager and the entire LFZ Project Team and Staffs
2	LFZ EHS Manager	• Provide EHS management and guidance for protection of the environment during the development of LFZ land resources to ensure that the guidelines and requirements of the Development Framework are complied with, and the construction and operation phases of the project are implemented in a sustainable manner; • Coordinate the overall implementation of the environmental impact monitoring proposed in the EMP; • Ensure that Construction Contractors comply with: – The proposed EMP and the Contractor's EHS plan and the other site-specific plans such as Waste Management Plan, Storm Water Management Plan, Waste Water Treatment Plan, Solid Waste Management Plan; – Applicable environmental, social and health-related regulations; • Ensure EHS monitoring and audit of project development and operations and the management the EHS system and procedures;
3	LFZ Project Manager	• Responsible to ensure that work at all phases of the project are conducted in accordance with all the requirements and commitments in the EMP; • Ensure that the contractors adhere to EMP requirements during the construction phase of the project;
4	Construction Contractor's EHS Manager	• Responsible for the implementation and operation of the Contractor's EHS plan and site-specific plans and ensuring that measures for environmental and social protection are carried out;

S/No.	Key Stakeholder	Responsibilities
		• Implement EMP requirements and Contractor's HES plan and other site-specific plans;
5	LFZ Environmental Management Specialist / Consultant	• Coordinate the implementation of the requirements of the EMP during the phases of the project; • Communicate environmental and social matters and concerns with project stakeholders; • Compile a comprehensive report on the implementation of this EMP for submission to the regulatory agencies and other relevant stakeholders.
6	Federal Ministry of Environment	• Ensure that the development of LFZ land resources and possible development projects are implemented in compliance with all the environmental requirements of FMEnv and the proposed EMP; • Review the EMP report submitted by LFZ and the Developers of its land resources and give approval on the environmental performance of the project.
7	Lagos State Ministry of Environment	• Ensure that the development of LFZ land resources and possible development projects are implemented in compliance with all the environmental requirements of FMEnv, Lagos State legislations and regulatory requirements, and the commitments stated in this EMP document;
8	LASEPA	Ensure that the project is carried out in compliance with the environmental regulations of LASEPA
9	LAWMA	Collaboration with LFZ regarding Solid Waste Management and the provision of waste management infrastructure within the LFZ
	Lekki Free Zone Development Authority	Ensure that the project complies with the requirements of LFZ Development Authority

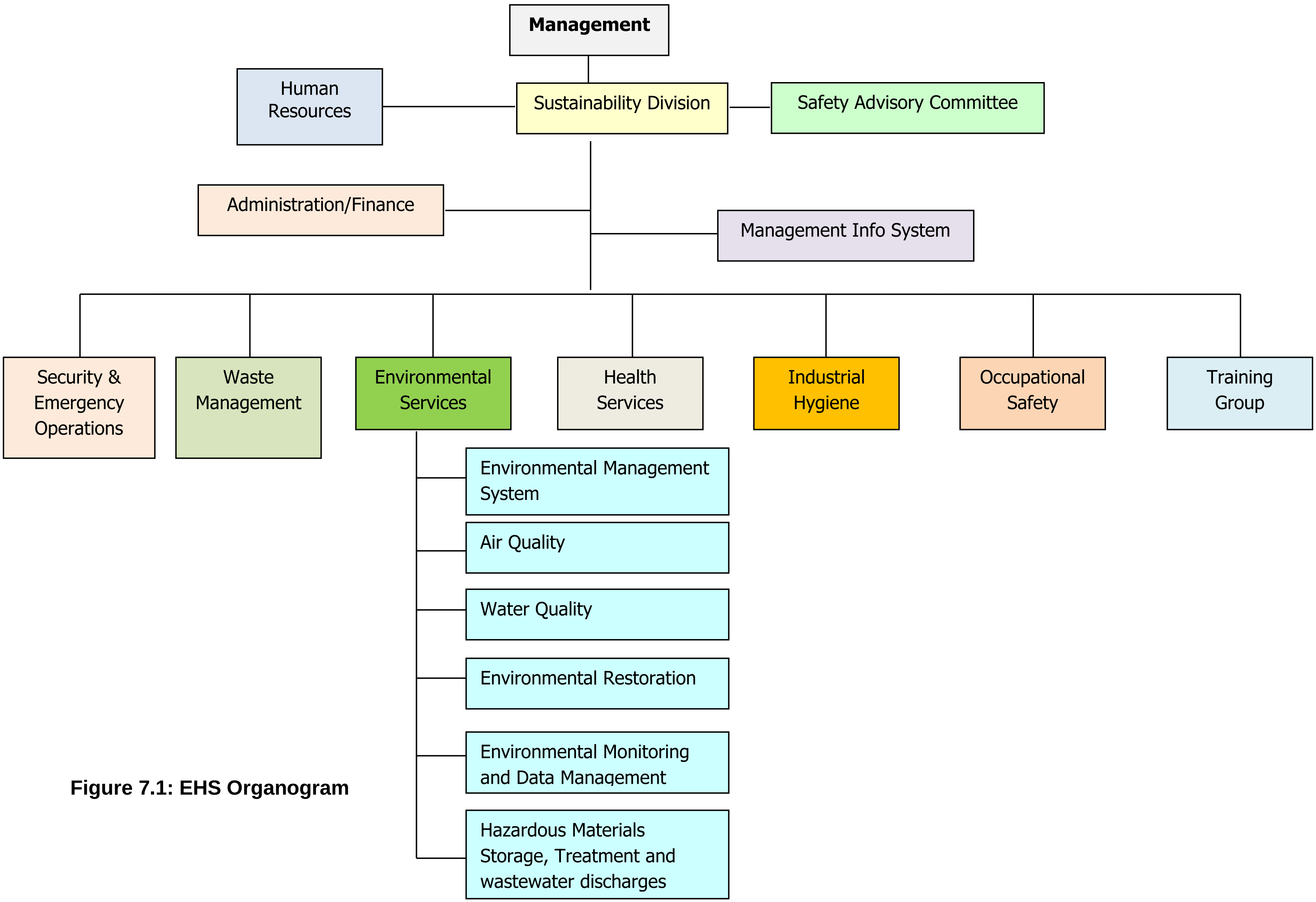


Figure 7.1: EHS Organogram

7.3.1 Communication

For successful implementation of the proposed EMP and the management of environmental concerns during the construction phase and development of the LFZ land resources, effective communications among all the stakeholders and project team is highly essential. Consequently, a definite line of flow of environmental and social performance information has to be established and followed especially during the construction phase of the project. The flow of environmental and social information, including reporting and resolution of non-compliance situations during the construction phase is as shown in Figure 7.2 below.

7.3.1.1 LFZ EHS Department

The LFZ EHS Department is the central hub for environmental performance information on the project. All information and reports on the implementation of the EMP and compliance performance will be received by the EHS Department from the third-party Environmental Management Consultant by the Contractor's EHS Manager. LFZ EHS Manager shall be responsible for the dissemination of pertinent information and reports to the Project Director, the Local Communities, FMEnv, NESREA, LASEPA, Lagos State Ministry of Environment and LFZ Authority. The individual monitoring and auditing carried out on the EMP implementation by the third-party Environmental Management Consultant shall also be communicated through the LFZ EHS Manager and the EHS Department to relevant regulatory agencies as necessary.

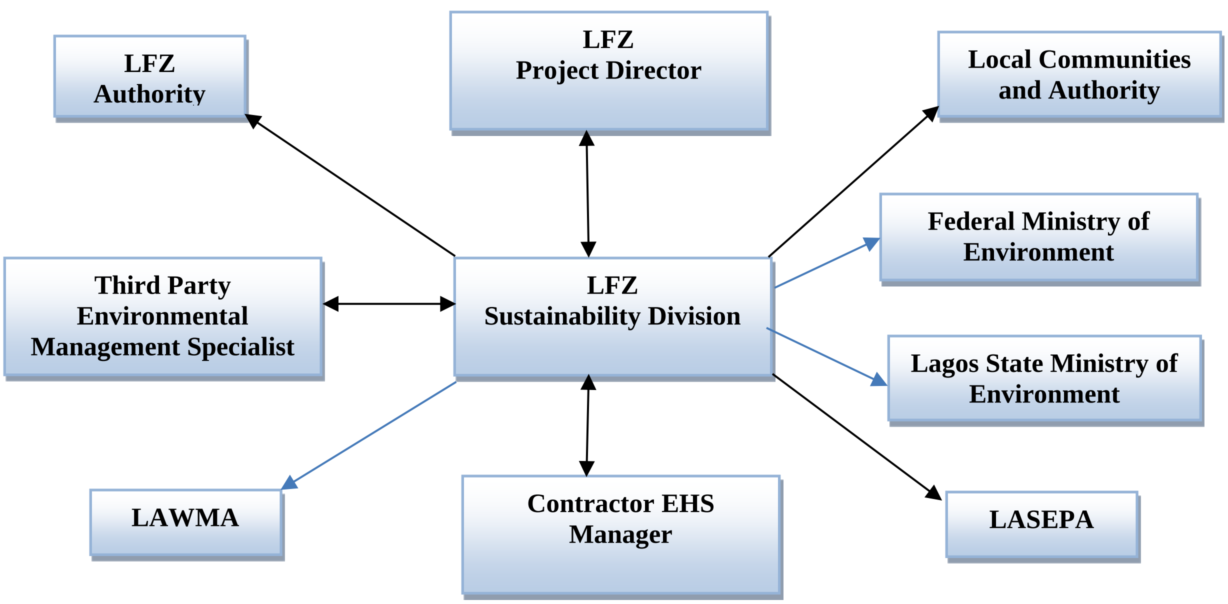


Figure 7.2: Line of flow information during the implementation of the EMP

7.3.1.2 Reports

The reports associated with the implementation of this EMP are as follows:

1. Yearly mitigation measures compliance monitoring reports must be complied by third party Environmental Consultant for submission to the LFZ Project Director through the EHS Manager;
2. Daily site inspections must be conducted by the LFZ EHS Manager as well as the Contractor EHS Manager. The daily site inspections shall check the site conditions with respect to environmental and social commitments and the implementation of the recommended mitigation measures. Both reports shall be reviewed by the EHS Manager of LFZ for consistency and forwarded to the LFZ Director;
3. Monthly site inspections report shall be compiled from the weekly site inspection reports on the site conditions regarding the environmental commitments and the implementation of the mitigation measures by the Contractor EHS Manager and submitted to the LFZ EHS Manager for review based on the individual monitoring and inspections done by the LFZ EHS Manager for the specific month;
4. Incident reports describing incidents and non-compliance events or situations shall be prepared immediately such situation occurs and submitted to the LFZ EHS Manager;
5. Environmental impact monitoring report shall be compiled by the third-party Environmental Management Consultant working on the implementation of the proposed EMP. The report will include the details of the environmental control measures and environmental monitoring carried out within the period of the construction works performed. This report shall constitute the EMP implementation report that shall be compiled during the site clearing/preparation and construction phases of the project. This report shall be submitted to LFZ EHS Manager who shall forward the same to the Project Director and finally to the appropriate regulatory agencies and LFZ Authority. Please note that impact monitoring will continue post construction for about 1-3 months.

7.3.2 EMP Documentation

LFZ EHS Department will control EMP and EHS documentation and all associated procedures, forms and reports. The EMP shall be communicated to all pertinent stakeholders as required.

7.3.1.1 Environmental Impacts Monitoring and Control Measures Recommended for Compliance

It is the responsibility of the LFZ EHS Department and Project Team to identify specific operations associated with the identified potential adverse environmental and social impacts that require operational control measures consistent with the LFZ EHS policy, objectives and targets. These operational controls are to ensure and facilitate the implementation of the impact mitigation measures and other beneficial site-management practices in situations where absence of documented procedures could lead to deviations from the environmental policy, goals and objectives of LFZ. These operational controls specify the appropriate procedures, work instructions, best-management practices, roles, responsibilities, authorities, environmental monitoring, measurements and record keeping that are all designed to mitigate, avoid or minimize environmental impacts of the project throughout the life of the project.

7.4 LFZ Environmental Health and Safety (EHS) Procedures

LFZ is committed to environmental conservation, the health and safety of its employees, business associates and the public in general, and intends to conduct all business activities in a manner that is environmentally and socially responsible. Beyond achieving regulatory compliance, LFZ understands that creating a business culture where EHS is properly managed, makes good business sense and is the right thing to do. LFZ is therefore committed to this policy as an integral part of its business success.

LFZ EHS procedures is hinged on the following cardinal principles and actions:

- **Environmental Conservation, Workplace Health and Safety:** Responsibilities for EHS are shared by all. Every employee and contractors to LFZ must actively support those behaviors and the attitudes necessary to prevent work-related injuries, illnesses, property damage, and adverse impact to the environment. Employees and contractors must comply with the company and site EHS requirements as a condition of engagement. Employees must immediately report any unsafe conditions, work-related injuries or illnesses, property damage, or environmental events to their direct supervisor or manager. LFZ encourage employees to bring forth and help the company to enact their EHS concerns and suggestions.

  LFZ shall establish focused efforts to preserve natural resources through its tenants both in operating facilities and in product offerings to customers.

- **Community Service:** Actively participate in developmental stride in the communities where we have operations and support efforts to positively impact the quality of life locally and beyond. LFZ will actively and systematically identify and control significant environmental impacts or health and safety risks that could adversely affect the communities where we carry out our business.
- **Excellence:** Establish EHS performance metrics to assess and improve our policies, procedures, and practices, and remain open and transparent in our EHS communications with our employees, stakeholders and community. EHS will be part of our decision-making processes and planning. We will provide employee training on EHS and internal requirements, including established EHS policies, procedures, and practices.

  LFZ is committed to achieving its EHS objectives by:

  - Maintaining a copy of and adhering to the policies regarding environmental, health and safety issues at each workplace, operational site and location of our business.

- Maintaining a copy of the EHS Management Plan at each work site and base of business operation and ensure the communication of and adherence to the plan.
- Engaging a responsible, qualified person (professional or manager) at each workplace and business location and equip that person with the authority, tools and support necessary to coordinate and implement the environmental, health and safety program.
- Measuring performance against the Environmental, Health and Safety Management Plan.
- Providing necessary training programs to employees, staff, consultants, associates and participants to equip them with the skills and knowledge required to support the Environmental, Health and Safety Management Plan.
- Updating the Environmental, Health and Safety Management Plan on an annual basis.

7.4.1 EHS Training Programs for LFZ Employees

All employees of LFZ shall undergo general environmental, health and safety awareness training and specific EHS training as might be required in order to fulfill their responsibilities under this EMP. The objective of the training is to ensure that all employees understand their obligation to exercise due diligence for EHS matters.

LFZ through its contractor will ensure that security personnel are trained adequately in the appropriate conduct towards the local communities and require to act under the applicable law. Local communities will be made aware of the presence of the Security personnel on site and of their roles and responsibilities.

all LFZ employees will undergo EHS Induction to acquaint employees with LFZ policies on EHS regarding their line of duty. The EHS department has responsibility for promoting LFZ EHS policies shall conduct or organize training programs as presented in Table 7.2.

Table 7.2: Training and Awareness Program for LFZ Employees and Contractors

EHS Training and Awareness Program	LFZ Employees				Contractors	
	Senior Managers	Managers	Team Leads	Team Members	Contractors	Sub-contractors
Site Specific EHS Induction			*	*	*	*
Tool Box Meetings			*	*	*	*
Office Safety Awareness	*	*	*	*	*	*
PPE			*	*	*	*
Power Tools Safety						
Confined Space			*	*	*	*
Basic Fire Fighting	*	*	*	*		
Basic First Aid Awareness	*	*	*	*	*	*
Slips, Trips & Falls	*	*	*	*	*	*
Environmental and Waste Management		*	*			
Security Operations		*	*			
Risk Assessment		*	*			
Hazardous Material Communication		*	*	*		
Journey Management						
Driving Safety				*		
Survival Swimming	*	*	*	*		
Scaffolds Safety				*		
Excavations			*	*		
Concrete Working				*		
Permit to Work (PTW) Systems	*	*	*			
Job Hazard Analysis		*	*	*		
Incident Reporting & Investigation.	*	*	*	*		

Training Frequency						
Daily	Weekly	Monthly	Quarterly	Yearly	TBD by EHS Department	Must be Conducted
						*

7.5 Emergency Preparedness

7.5.1 Environmental Response Plan (ERP) Framework

7.5.1.1 Introduction and Purpose

LFZ is committed to the safety and well-being of its employees, contractors and public and has incorporated into its project design all the necessary safety measures to minimize if not completely eliminate accidents and emergencies. However, accidents do occur due to human error, equipment failure, sabotage or natural occurrence. In order to uphold its commitment, great deal of planning and practice is required. This framework exists to satisfy those needs and to outline the steps to be taken to prepare for and respond to an emergency affecting LFZ operations.

7.5.1.2 Goals:

The goals of LFZ in emergency preparedness and response plan include:

- The preservation of environment from adverse impact,
- The physical and emotional well-being of LFZ employees, contractors, and public.
- The timely stabilization of an emergency situation.
- The protection of LFZ facility, property, and the belongings of employees, and public.

7.5.1.3 Applicability and Scope:

This plan applies to all employees of LFZ and any person occupying LFZ property and its immediate environment.

The scope of this plan is intended to encompass all hazards. This plan may be consulted when responding to any and all emergencies. When encountering a situation which has not been expressly addressed in this plan, use good judgment and the guiding principles outlined below.

7.5.1.4 Process for Maintenance and Update of ERP

This plan is the direct responsibility of LFZ's top management. The top management will review and update this plan at least once annually. As a basis for maintenance and updating of the ERP, periodical drills that simulates fire, medical, evacuation, utilities failure and flood emergencies shall be conducted. Drill performance in terms of response and timing shall form inputs for review and possible update of the ERP. Revisions will be made as needed throughout the year. Any suggestions, comments, or questions should be directed to the project manager.

7.5.1.5 Hierarchal Order during Emergency

The hierarchy order to be observed for effective management of an emergency shall flow downward as follows:

1. Chief Executive Officer
2. Project Manager
3. EHS Manager
4. Site Supervisors

7.5.1.6 Emergency Communications

During an emergency, LFZ will use the following means and methods of communication.

- Landline Telephones,
- Cell Phones (possible outages during emergency)
- Texting (more reliable during an emergency)
- Two-way Radios
- Email

Communications during emergency shall be coordinated by the EHS manager who will constantly be in touch with site supervisors and thereafter give periodic update to the project manager. The EHS manager is to ascertain the type, exact location and onset time of emergency from the site supervisors. Depending on the type of emergency, employees are expected to follow the procedures contained in this emergency response plan. In the case of a major emergency, the EHS manager with the approval of the top management is to activate appropriate contingency plan contained herein.

7.5.1.7 Media Inquiries

Inquiries from the media during or after an emergency will be addressed by the managing director or whoever he may appoint. The project manager will be consulted in releasing any information to the media. At any time, the media can simply be referred to the project manager.

7.5.1.8 Fire Contingency

Given the fact that the most serious concern in terms of accidents is fire outbreak and explosions, LFZ EHS department shall implement, review and update where necessary the following fire contingency plan in preparedness in the event of emergency:

- adequate fire protection/fighting facilities including ABC fire extinguishers, sand bags/ buckets in strategic position in LFZ facility and property;
- efficient fire (heat/smoke/flame) detection systems
- fire drills and mock firefighting exercises to keep employees prepared in case of emergency.
- employees training of staff on safety and loss prevention activities.

In addition to the above, LFZ EHS department shall ensure routine check-ups of fire-fighting facilities at least once every week and conduct fire drills at least once every quarter.

In preparedness against fire incident, the EHS department must ensure that:

- All exits in LFZ facility and property are clear.
- Fire Extinguishers (class ABC) are placed in all exits adequate for flammable liquids/gases and electric fires.
- Alternative exits are available in case any regular exit is blocked by fire.
- An acoustic alarm system is installed and maintained periodically.
- Exits and corridors to access the alarm system are properly illuminated.
- At least one (1) of the EHS personnel working on-site is permanently in charge of the alarm system.

- The alarm system is installed to produce at least two different signals:
  - First signal indicating a controllable fire should indicate location.
  - Second signal indicating immediate evacuation of LFZ facility and property
- Each section of LFZ facility has a manual alarm button, easily visible and reachable.

7.6 EHS Monitoring and Review For LFZ

This section presents the key strategies and processes for the implementation of the EMP. LFZ EHS department and project team will supervise the construction phase project activities for each potential development initiative within the FTZ upon the completion and approval of their respective Environmental Impact Assessment Final Report. Hence, the LFZ EHS department will be responsible for supervision of the implementation of all project activities and the management of environmental and social components of the FTZ to ensure compliance with project impact mitigation measures during the construction phase of each specific development project. Thus, the management approach for environmental and social protection within the LFZ include the following key strategies:

- Development of an EMP based on the identified environmental and social impacts, mitigation measures and the existing baseline environmental conditions of the FZ presented in the EIA in line with regulatory requirements and permits;
- Establishment of an implementable and cost effective environmental and social management and monitoring plan with high level commitment, well defined with assigned responsibilities to appropriate staffs;
- Contractual binding of LFZ Project Contractors to comply with the EMP environmental and social requirements, specifications, guidelines, and procedures applicable to their specific work and equal requirement of their sub-contractors to comply with the same;
- Requiring LFZ Contractors to develop site-specific EHS Plans including environmental and social impact mitigation measures, storm water management plan, wastewater management plan, solid waste management plan, emergency response plan, among others;
- Review and approval of the environmental and social impact mitigation control measures of the LFZ Contractors EHS plans by the LFZ EHS Department prior to commencement of construction project activities to ensure consistency with and the adequacy in satisfying the requirements of the EIA, EMP, Federal Ministry of Environment and contractual obligations;
- Disclosure of the EIA EMP and EHS documents to appropriate stakeholders.

The monitoring review process is presented in Figure 7.3.

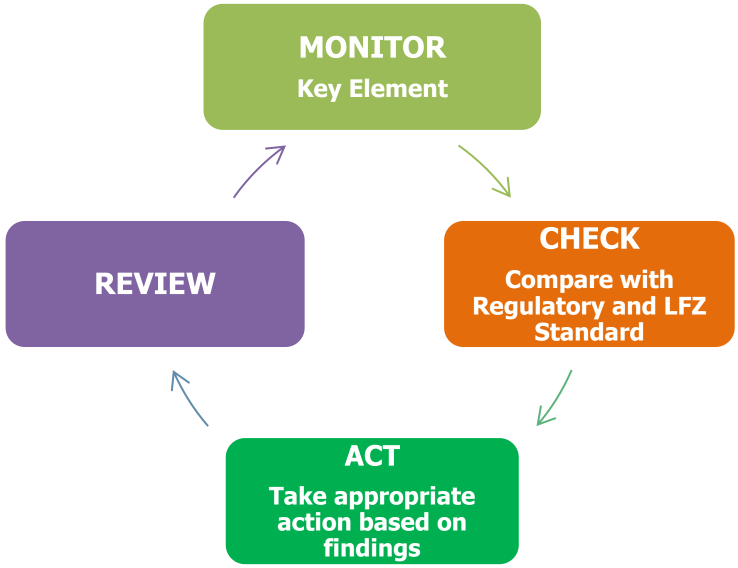


Figure 7.3: EHS Monitoring Review Process

7.6.1 Environmental Monitoring Program Implementation Approach

The overall objective of (performance) monitoring shall be to identify any unanticipated changes to the biophysical, health and social environment brought about by Proposed Project. Baseline information against which development and post development impacts and mitigation measures can be measured and compared has been established. LFZ shall ensure that deviations from the baseline beyond reasonable limits shall trigger corrective actions so that monitoring becomes a dynamic activity as opposed to passive collection of data. Figure 7.3 presents the monitoring review process.

7.6.2 Environmental Monitoring Plan for LFZ Development

Tables 7.3 to **7.6** present the impact management and mitigation plan at the various stages of the LFZ development. In formulating this plan, care has been taken to ensure that LFZ complies fully with FMEnv regulatory control measures; international best practices and self-imposed standards (LFZ EHS Policy). The national regulatory agencies in conjunction with the relevant states and local government authorities shall conduct routine impact mitigation monitoring visits as and at when due.

Table 7.3: Impact Management and Monitoring Plan – Mobilization

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
Mobilization of goods, equipment and personnel	Potential increase in road traffic volume	As much as possible, large and slow-moving vehicles should be scheduled during off peak periods	None	Journey management record; night driving permit and statistics	Weekly	Monthly	Contractor HSE adviser
		Raise community awareness of unusual activity	None	Record of awareness sessions	Monthly	Six monthly	LFZ CLOs
	Potential increase in road traffic incidents	Pre-mobilization of all vehicles	LFZ contract agreement	Pre-mob certificate and statistics	Weekly	Monthly	LFZ Contract Holder
		Visible warning signs on roads and vehicles	Federal traffic regulation	Number and adequacy of signs and speed breakers	Weekly	Monthly	LFZ
		Speed breakers at sections traversing communities	LFZ HSE Policy	Number of speed breakers	Weekly	Monthly	LFZ
		Defensive driving course for LFZ and contractor drivers	LFZ HSE Policy	Driving permit and statistics	Weekly	Monthly	LFZ Contract holder
		Vehicle monitoring device /LFZ journey management policy/ night driving and alcohol policy shall be enforced	LFZ HSE Policy	Journey management record; IVMS record, night driving permit and statistics	Weekly	Monthly	LFZ
		First aid training of workforce and provision of first aid boxes in operational vehicles	LFZ HSE Policy	Number of first aid certificates issued and records of vehicle first aid boxes audit	Weekly	Monthly	LFZ
	Increase in noise Levels	Enforce night driving policy (no night driving except when unavoidable)	LFZ Policy	Night Driving permit and statistics	Weekly	Monthly	LFZ

Table 7.3: Impact Management and Monitoring Plan – Mobilization

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
		LFZ shall ensure that all vehicles and equipment conform to World Bank limits for noise	World Bank guidelines	Vehicle maintenance records	Monthly	Monthly	LFZ
	Reduction in air quality (dust, exhaust fumes)	LFZ shall ensure that only vehicles with pre-mobilization certificates are used to reduce emissions from vehicle exhaust	FMEnv Standards	Pre-mob certificates and statistics	Weekly	Monthly	LFZ, EMC FMEnv

Table 7.4: Impact Management and Monitoring Plan – Construction

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
Site preparatio n (Land clearing, excavation and backfilling)	Loss of flora and fauna	Site clearing shall commence from developed (e.g. roads) to undeveloped areas to provide escape routes for wildlife	None	Site clearing inspection records	Daily	Weekly	LFZ, EMC
		Hunting by the workforce shall be prohibited	LFZ Policy	Compliance records	Weekly	Monthly	LFZ
		LFZ shall educate construction workers and host communities on the sensitive nature of the biodiversity of the area and the need for conservation	None	Records of HSE meetings and community enlightenment sessions	Weekly	Monthly	LFZ

Table 7.4: Impact Management and Monitoring Plan – Construction

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
	Loss of habitat	LFZ shall limit cleared area to what is required	LFZ Policy	Site clearing Inspection records	Daily	Weekly	LFZ, EMC
		LFZ shall encourage the re-vegetation of land cleared for temporary use where feasible	LFZ/ FMENV Policy	Implementation records	One month after site clearance	Three monthly	LFZ, EMC
	Increase in dust and noise	LFZ shall ensure that nose masks and earmuffs are worn by site workers during excavation	LFZ Policy	SPM, records of respiratory diseases and noise levels	Monthly	Monthly	LFZ, EMC
		Water shall be sprayed on construction sites to reduce dust levels especially during dry season	World Bank Standards	Records on compliance, SPM at selected sites within 500m band	Weekly	Monthly	LFZ, EMC
	Potential increase in erosion	LFZ shall re-vegetate areas not needed for construction as soon as possible following.	None	Records of re-vegetation exercise	Monthly	Quarterly	LFZ, EMC
Influx of Labour and followers (dependen ts)	Increase in morbidity (Including STDs) and mortality	Health awareness on the mode of transmission of STDs (including HIV/AIDS)	None	Statistics of health awareness lectures	Intensive phase 1 to 2 months prior to mobilization and quarterly there after	Quarterly	LFZ and Occupation al Health teams
		As much as possible,	Government Policy	Records of HIV support programs	Quarterly	6-monthly	LFZ and Occupation al

Table 7.4: Impact Management and Monitoring Plan – Construction

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
		psychological support shall be provided to persons living with the HIV virus					Health teams
		Immunization of workforce as appropriate	None	Records and statistics of immunization	During mobilization	Quarterly	LFZ
		Vector control to reduce incidence of malaria (such as regular spraying of camp and provision of insecticide treated nets) (ITN)	LFZ	Records and statistics of ITN distribution	Monthly	Quarterly	LFZ
		Awareness campaign shall be carried out to enlighten the communities/field workers on the common communicable diseases and the health implications of drug and alcohol abuse, unprotected sex, prostitution and the need to sustain cultural values	None	Statistics of health awareness lectures	Monthly	Quarterly	LFZ
		Alcohol and drug policy shall be implemented to encourage healthy lifestyle for workers	LFZ Policy	Records of violations	Monthly	6-monthly	LFZ

Table 7.4: Impact Management and Monitoring Plan – Construction

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
		LFZ shall support the activities of the state action committee on STDs/HIV/AIDS within the local communities	None	Records of Engagement of an NGO	Monthly	Quarterly	LFZ Occupation al Health team, NGO
		LFZ shall provide site clinic to take care of minor illnesses for all workers	LFZ Policy	Statistics of attendance, morbidity and mortality	Weekly	Monthly	LFZ
		LFZ shall ensure that contractor enforces the alcohol and drug policy for staff	LFZ Policy	Records of violation	6-monthly	Annually	LFZ
		LFZ shall ensure that contractor implements HSE awareness programs for all workers at induction and on a continuous basis throughout the life of the project	LFZ Policy	Statistics of social and health awareness programmes	At induction and quarterly thereafter	Annually	LFZ
		LFZ shall provide basic recreational facilities for workers within their camps	None	Number and types of facilities	Quarterly	6-monthly	LFZ
	Changes in culture, lifestyle and habits	LFZ shall carry out enlightenment campaigns to	None	Records of enlightenment sessions	6-monthly	Annually	LFZ

Table 7.4: Impact Management and Monitoring Plan – Construction

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
		encourage positive influences on cultural values and healthy lifestyles (e.g. breast feeding habits, alcohol and drug use, exercise, monogamy, high moral values with regard to sexuality etc) and discourage adverse influences (e.g. prostitution, drug abuse, alcoholism etc)					
Infrastructure Development Internal Roads/ Street Lighting Drainage Systems Utilities (Power, Water & Telecoms)	Increase in dust, noise and vibration	LFZ shall ensure that all construction equipment shall be in proper operating condition	None	Number of equipment fitted with such facilities; maintenance records, SPM	Monthly	Quarterly	LFZ, EMC
		LFZ shall provide and enforce the use of PPE (e.g. nose masks and earmuffs)	LFZ Policy	Compliance	Weekly	Monthly	LFZ
		Water shall be sprayed on construction sites to reduce dust levels especially during dry season	None	Records of compliance	Daily	Weekly	LFZ
	Increase in potential for	LFZ shall re-vegetate areas	FMEnv	Records of re-vegetation	Monthly	Quarterly	LFZ

Table 7.4: Impact Management and Monitoring Plan – Construction

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
	erosion	not needed for construction as soon as possible		exercise			
	Soil degradation	LFZ shall provide containment for chemicals and liquid discharges	LFZ Policy	Compliance	Weekly	Monthly	LFZ
		LFZ waste management policy shall be enforced	DPR, FMENV and LFZ Policy	Waste collection records	Weekly	Monthly	LFZ
		LFZ shall ensure that a controlled fueling, maintenance and servicing protocol for construction machinery at worksite is established and followed to minimize leaks and spills	LFZ Policy	Fuelling, maintenance and servicing record	Weekly	Monthly	LFZ
	Injury to workers	LFZ shall carry out first aid training of workers	LFZ Policy	Training records	Monthly	Annually	LFZ
		LFZ shall provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles)	LFZ Policy	Compliance	Weekly	Monthly	LFZ, EMC
		LFZ shall ensure toolbox talks are held, prior to work activities	LFZ Policy	Compliance	Weekly	Monthly	LFZ
	Reduction in air quality	LFZ shall ensure that all mobile and stationary internal combustion engines are properly maintained	FMENV Standards	Maintenance Records Air Quality Monitoring	Monthly	Annually	LFZ, EMC

Table 7.4: Impact Management and Monitoring Plan – Construction

Project Activity	Impact (Positive or Negative)	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
Waste generation and disposal	Increase in breeding ground for disease vectors and other agents of diseases	LFZ waste management policy shall be enforced	LFZ Policy	Compliance	Weekly	Monthly	LFZ
	Increase in Nuisance effect	LFZ shall enforce adequate waste management on site	Public Health Law (CAP 103), LFZ Policy	Compliance	Monthly	Quarterly	LFZ
	Blockage of natural drainages	LFZ shall ensure that wastes are disposed of at appropriate locations provided for waste disposal and collected as quickly as possible	Public Health Law (CAP 103), LFZ Policy	Compliance	Monthly	Quarterly	LFZ
	Pressure on existing waste management system	LFZ shall explore ways to assist the communities in managing wastes	Public Health Law (CAP 103); LFZ Standard	Records of supportive action	Quarterly	Annually	LFZ

Table 7.5: Impact Management and Monitoring Plan – Operation and Maintenance

Project Activity	Impact (positive or negative	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
Operation and Maintenance of: Internal Roads/ Street Lighting Drainage Systems Utilities (Power, Water & Telecoms)	Increase in noise levels	LFZ shall maintain sound barriers around noisy equipment	None	Visual monitoring of compliance	3-monthly	6-monthly	LFZ EMC
		LFZ shall protect Hearing of Workers through the Enforcement of the Recommendations of Job Hazard Analysis (JHA)	LFZ Policy	Compliance Air Quality Monitoring	3-monthly	6-mothly	LFZ EMC
	Potential for erosion around facilities	LFZ shall utilize onsite drainage system to collect runoff from all impervious onsite locations	None	Compliance	6-monthly	Annually	LFZ
	Reduction in air quality	LFZ shall ensure that appropriate maintenance programs are in place for all equipment	LFZ Policy	Maintenance Records, Air Quality Monitoring	6-monthly	Annually	LFZ EMC
	Degradation of soil and surface water from spills and leaks	LFZ shall provide containment for chemicals and liquid discharges	LFZ Policy	Compliance	Quarterly	6-monthly	LFZ
		LFZ shall ensure that chemicals are stored in lined bunded areas in sealed containers with rain protection	LFZ Policy	Compliance Soil Monitoring Water Monitoring	Quarterly	6-monthly	LFZ EMC

Table 7.6: Impact Management and Monitoring Plan – Decommissioning Restoration and Abandonment

Project Activity	Impact (Positive or negative	Mitigation/ Enhancement	Compliance Requirement (if any)	Parameters for Monitoring (if any)	Frequency of Inspectional/ Monitoring	Frequency of Formal reporting	Action Party
Dismantling of: Internal Roads/ Street Lighting Drainage Systems Utilities (Power, Water & Telecoms)	Increase in dust generation	LFZ shall ensure proper use of appropriate PPE	LFZ Policy	Compliance SPM Monitoring	Weekly	Monthly	LFZ EMC
		LFZ shall ensure that water is sprayed to reduce dust levels	None	Records of Compliance	Daily	Weekly	LFZ EMC
	Increase in noise levels	LFZ shall inform communities in advance of likely increase in noise level during decommissioning	None	Noise Monitoring	Daily	Weekly	LFZ EMC
		LFZ shall ensure proper use of PPE (ear muffs)	LFZ Policy	Compliance	Weekly	Monthly	LFZ EMC
	Increase in Waste generation	LFZ shall ensure that wastes are disposed of in accordance with her waste management plan for this project	LFZ Policy	Compliance	Weekly	Monthly	LFZ EMC
	Potential for community unrest (from employment, pollution and resistance to dismantling of equipment)	LFZ shall ensure fair community representation in the employment of local labour	None	Employment Records	Quarterly	Six – monthly	LFZ
		LFZ shall abide by the MOUs signed with the communities for this project	Contractual	Compliance with MOU items	Yearly	Once during decommissioning	LFZ

Once the proposed EMP has been reviewed, it shall be prepared as a stand-alone document and signed by LFZ Managing Director or Project Manager. This is to ensure ownership and implementation of the EMP, and shall be updated as results of monitoring determine the effectiveness or otherwise of the proposed mitigation/enhancements.

The EMP will also be reviewed as environmental regulations, guidelines and policies (including those of LFZ are updated and/or changed.

7.6.3 Environmental Monitoring Plan for LFZ Zones

The environmental elements susceptible to impacts vis-à-vis suggested monitoring parameters for the diverse industry types anticipated for all zones of the LFZ are presented in Table 7.7 while specific applicable environmental elements and suggested monitoring parameters for the different zones are presented in Table 7.7.

The monitoring for LFZ Zones is targeted at key environmental components which are the primary receptors of LFZ development project adverse impacts. These key environmental elements are:

- Air quality and Noise Level
- Water Quality
  - Freshwater/Pond water
  - Groundwater
  - Potable water
- Terrestrial Environment

The main sources of impacts, monitoring performance objectives, management strategies and performance indicator for the key environmental components are presented in Table 7.8.

Table 7.7: EHS Monitoring Schedule

Element	Monitoring Parameter	Monitoring Frequency	Frequency of Formal Reporting	Responsible Party
Ambient Air Quality Monitoring	TSP, CO, NO_2, SO_2, VOCs, Particulate Matter.	Monthly	Monthly	LFZ EHS Department, Environmental Consultants
Noise Monitoring	Noise Level (dBA)	Monthly	Monthly	LFZ EHS Department, Environmental Consultants
Surface water Monitoring	THC, Grease, TDS, COD, TSS, BOD, Turbidity, pH, Temperature, Heavy metals	Quarterly	Quarterly	LFZ EHS Department, Environmental Consultants
Groundwater Monitoring	THC, Grease, TDS, COD, TSS, BOD, Turbidity, pH, Temp, Heavy metals	Quarterly	Quarterly	LFZ EHS Department, Environmental Consultants
Potable Water Monitoring	THC, Grease, TDS, COD, TSS, BOD, Turbidity, pH, Temp, Heavy metals, colour, E-coli	Quarterly	Quarterly	LFZ EHS Department, Environmental Consultants
Terrestrial Environment Monitoring	pH, TOC, Heavy metals, texture, fauna, flora, Invertebrate	Bi-annual	Bi-annual	LFZ EHS Department, Environmental Consultants

Table 7.8: Monitoring of Key Environmental Elements

Element	Sources of Impact	Performance Objective	Management Strategies	Performance Indicator
Air Quality Monitoring	*Construction Phase:* • Exhaust emissions, dust from earth and vehicle movements and fugitive dust from stored material. *Operation Phase:* • Exhaust emissions and particulate matter from utility vehicles and generator. • Emissions from process equipment *Decommissioning Phase:* • Dust and exhaust emission from decommissioning activities.	• To minimize the impact to air quality from the LFZ development projects. • To ensure compliance with FMEnv, NESREA, LASEPA, DPR guidelines and LFZ policy on EHS.	• Environmental awareness training. • Implementation of Construction Management Plan during construction phase. • Use of Best Available Technology (BAT). • Implementation of equipment maintenance program during construction and operations phases. • Continuous monitoring and evaluation of the effect of air emissions where appropriate. • LFZ shall utilize all practical methods and devices available to control, prevent and otherwise minimize atmospheric emissions or the discharge of air contaminants during all phases of the development project. • Indiscriminate burning of materials shall not be permitted.	• Nil complaints relating to air quality management. • Compliance with regulatory standards.
Noise Monitoring	*Construction Phase:* • Noise nuisance from earth and vehicle movements and fugitive dust from stored material.	• To minimize the impact of noise nuisance from the LFZ development projects.	• Environmental awareness training. • Implementation of Construction Management Plan during construction phase. • Use of Best Available Technology (BAT).	• Nil complaints relating to noise nuisance. • Compliance with regulatory standards.

Element	Sources of Impact	Performance Objective	Management Strategies	Performance Indicator
	Operation Phase: • Noise produced from vehicles and generator. *Decommissioning Phase:* • Noise nuisance from decommissioning activities.	• To ensure compliance with FMEnv, NESREA, LASEPA, DPR guidelines and LFZ policy on EHS. • To avoid nuisance noise to nearby residents.	• Implementation of equipment maintenance program during construction and operations phases. • Continuous monitoring and evaluation of the effect of noise nuisance where appropriate. • LFZ shall utilize all practical methods and devices available to control, prevent and otherwise minimize noise emissions. • Activities that produce excessive noise will be restricted as much as possible. • Use of noise reduction equipment; enclosure of excessively noisy equipment likely to generate community complaints where economically feasible.	
Groundwater, Freshwater Pond Water Portable Water	The main sources of impact on water quality, during the project phases are: • accidental chemical spills, sewage and grey water disposal from onsite facilities; • contaminated stormwater runoff	• To minimize the impact to water quality from the LFZ development projects. • To ensure compliance with FMEnv, NESREA, LASEPA, DPR	• Environmental awareness training. • Implementation of Construction Management Plan during construction phase. • Use of Best Available Technology (BAT). • Implementation of equipment maintenance program during construction and operations phases. • Implementation of waste management plan throughout project life span.	• Compliance with regulatory standards.

Element	Sources of Impact	Performance Objective	Management Strategies	Performance Indicator
	during construction and operations phases.	guidelines and LFZ policy on EHS.	• Monitoring effluent and discharges from LFZ development zones during operations phase. • Monitor water resources within LFZ development zones throughout project life span.	
Terrestrial Environment	The main sources of impact on terrestrial environment are: • impacts from clearing and construction activities; • impacts due to accidental spill from maintenance works during operations; • impact from equipment dismantling and excavation works during decommissioning.	• To minimize the impact to soil and vegetation due to LFZ development project; • To ensure compliance with the relevant provisions on environmental protection as contained in FMEnv, NESREA, LASEPA and DPR guidelines	• Environmental awareness training. • Implementation of Construction Management Plan during construction phase. • Use of Best Available Technology (BAT). • Implementation of equipment maintenance program during construction and operations phases. • Implementation of waste management plan throughout project life span. • Monitoring effluent and discharges from LFZ development zones during operations phase. • Periodic statutory environmental auditing.	• Compliance with regulatory standards.

7.7 Stakeholder Engagement

7.7.1 Introduction

Stakeholder engagement refers to a process of sharing information and knowledge, seeking to understand the concerns of others and building relationships based on collaboration, thereby allowing stakeholders to understand the risks, impacts and opportunities of a project in other to achieve positive outcomes.

It is an inclusive and culturally appropriate process that provides stakeholders with opportunities to express their views about the project. These views are then considered, responded to and incorporated into the decision making. It is a two-way process of communication between the project proponent (LFZ) and its stakeholders.

7.7.2 Establishment of Stakeholder Engagement Plan (SEP)

In establishing the Stakeholder Engagement Plan (SEP) the following were considered:

- Identification of stakeholders and mechanisms for their engagement (meetings, letters, press releases);
- Development of project information for dissemination including a Background Information Document (BID) appropriate for the target audience;
- Identification of where in the EIA process and during the project implementation phases, certain stakeholders should be engaged and how;
- The planned programme for disclosure of Project information and consultation with stakeholders; and
- Methods for handling stakeholders' complaints (or 'grievances') in case they arise.

The SEP is designed to ensure that the project undertakes meaningful engagement with stakeholders in line with the requirements of national regulations and international lender standards.

The SEP is a 'live' document, which will be updated and adjusted as the EIA progress and project planning evolves. It will thus provide a framework to facilitate and manage effective and meaningful engagement with key stakeholders.

7.7.3 Principles for Communicating with Stakeholders

Requirements for stakeholder engagement in the EIA process are contained in *Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.* PS1 establishes the importance of effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them.

7.7.3.1 Stakeholder Analysis and Engagement Planning.

In line with PS1 requirements that project proponent carry out a planning and analysis process to identify the range of stakeholders that may be interested in their actions and consider how external communications might facilitate a dialog, LFZ had identified the following stakeholders:

- Lekuru, Magbon-segun, Oke-segun, Itoke, Lujagba, Okunraiye, Alasia and Idotun**;**
- NGOs, FMEnv, NESREA, DPR, LASEPA, NPA, other regulatory authorities pertinent to all stages of the project lifecycle;
- representatives of local community members including farmers, health workers and teachers. It will also include vulnerable sub-groups such as women, young people and the elderly;

7.7.3.2 Disclosure of Information

In line with PS1 requirements, LFZ disclosed relevant project information so that stakeholders can understand the risks, impacts and opportunities of the project. Specifically, LFZ provided affected communities with information on:

- the purpose, nature, and scale of the project;
- any risks to and potential impacts on such communities and relevant mitigation measures;
- the envisaged stakeholder engagement process; and
- the grievance mechanism.

7.7.3.3 Consultation

Consultation was conducted in a manner that provided the affected communities with opportunities to express their views thereby providing a mechanism for considering and responding to them. Also as defined in the PS1, consultation was:

- began early in the process of identification of environmental and social risks and impacts and as continued on an on-going basis as risks and impacts arise;
- based on the prior disclosure and dissemination of relevant, transparent, objective, meaningful and easily accessible information in English and local language (Yoruba).
- enabled meaningful participation, where applicable; and
- Documented (photographs, meeting minutes, and attendance records).

7.7.3.4 External Communications and Grievance Mechanisms

In line with requirements that a project proponent have a documented procedure for external communications that includes means to:

- receive and register external communications from the public;
- screen and assess the issues raised and determine how to address them;
- provide, track, and document responses, if any; and
- adjust the management programme, as appropriate.

LFZ had put together a grievance mechanism to receive and facilitate resolution of concerns and grievances regarding environmental and social performance. Sample of the grievance log developed for LFZ project is presented in Figure 7.4.

7.7.3.5 Provision of Periodic Reports

In line with requirements, LFZ shall provide regular reports to the affected communities that describe progress on issues involving risk or impacts and on issues that the consultation process or grievance mechanism have identified as a concern. The frequency of these reports will be proportionate to the concerns of affected communities but not less than annually.

7.7.3.6 Establishment of a Grievance Mechanism

LFZ is in the process of developing a stakeholder engagement database, which will be used to store, analyze and report on stakeholder engagement activities.

SECTION 1: COMPLAINANT DETAILS			
Complaint Reference Number	**Date Received**	**Recipient of Complaint**	**Manner in which Complaint was Identified Submitted by Complainant**

Name of Complainant / Organisation Registering Complaint (if not anonymous)

Contact Details	**Telephone Number**	**Physical and/or Postal Address**

SECTION 2: DETAILS OF COMPLAINT	
Company Manager Responsible for Addressing the Complaint	
Time and Date Complaint Refers to	

Description of Complaint and / or Evidence of the Issue

SECTION 3: ACTION TAKEN / REQUIRED		
Acknowledgement of Complaint Sent to Complainant? (Y / N)	**Date When Acknowledgment Provided**	**Date Set for Resolution of Complaint**

Description of Subsequent Action Taken (divide into Immediate Action and Subsequent Investigation, if applicable)

Action Carried Out By Whom	**Date of Completion**	**Method of feedback to Complainant**

Stakeholder Response to Action.
SECTION 4: EFFECTIVENESS REVIEW
How was the Actions Verified to be Effective at Resolving the Complaint?

Approved By	**Date**

Figure 7.4: Grievance Log developed for LFZ Project

It will be populated with information based on the meetings held to date and the information collected to date by LFZ through the EIA as well as the experience and knowledge of the social consulting team in the field.

The list of stakeholder groups to be consulted on an on-going basis will be continually revised and updated as additional stakeholders are identified.

Minutes of all engagement activities will be uploaded onto the stakeholder database so that they can be referred to by the project team for consideration if needed. The database will be interrogated on a regular basis by the project to identify any trends in grievances and corrective actions that are required.

7.8 Security Management Plan Framework

Security management plan framework for the LFZ project is presented in Table 7,10.

7.9 Transport Operations

The project shall manage all transportation operations in line with the following guidelines in order to forestall accidents/incidents.

7.9.1 Pre-mobilization of Vehicles

All vehicles to be used for transportation of equipment, materials and personnel shall be premobilized. The pre-mobilization shall be conducted to confirm that the vehicles are fit for purpose and that the driver of the vehicles as well as their assistants has the necessary competencies needed for the job. It shall also be confirmed during the pre-mobilization exercise that a job hazard analysis (JHA) has been conducted for the project and that all recommended precautions (mitigation measures) have been adopted.

7.9.2 Journey Management Plan

In liaison with the EHS and Security Team Leads, the contractors for this project shall manage their day-to-day transportation needs within a framework of controls that ensures compliance with LFZ's standards.

Journey management shall include the following:

- Planning takes place before travelling;
- Distances travelled are minimized;
- Unnecessary journeys are avoided;
- Transport tasks are combined, e.g. unused cargo space and empty seats;
- Right vehicle and driver for the job are selected
- The safest times and routes are selected; and
- No night driving unless absolutely necessary and waiver obtained

Table 7.9: Security Management Plan Framework

Management Issues	Security of live and property and confidential information within LFZ Zones.
Objectives	• Secure LFZ employees, Customers, and immediate public • Secure LFZ assets and environmental integrity using appropriate measures. • Control information traffic of LFZ zones
Performance Indicators	Performance indicators will be developed consistent with relevant regulatory standards

Management Strategies	• Use security signage
	    o No Smoking
	    o Restricted Area – Authorized Personnel Only
	    o Appropriate warning
	    o No Trespassing etc.
	• Perimeter Fence/Security Barrier
	• Use restricted area identification card (RAIC) for restricted areas in the zones.
	• Installation of CCTV Camera and other security wares at strategy locations
	• Illumination of all facilities in the zones
	• Maintain synergistic relationships with government security agencies
	• Emergency access is kept clear
	• Controlled access of persons and vehicles into the zones
	• Use Company Employment Card/Identity Card
	• Maintain information control using appropriate technology/software

Monitoring	• 24 hour surveillance of LFZ zones using CCTV Camera security personnel working 8-hours per shift. • LFZ zones perimeter fence. • company employment card/identity card checks within the LFZ zones
Reporting	Daily security reports for LFZ Zones.

7.10 Prevention of Accidents/ Incidents

Prevention of workplace accidents and incidents during the proposed project shall be achieved

using the JHA tool and written work instructions (WWIs). Consequently, the ESH and Security Team Leaders shall arrange for JHA to be conducted for all ESH critical activities. Written and explicit work instructions from such activities shall be developed.

Compliance to regulatory standards, operations/maintenance codes and specifications as well as ESH guidelines shall form the basis for the execution of the proposed project. However, emergency situations could still occur as a result of equipment failure, weather, negligence and/or sabotage. Consequently, a contingency plan shall be developed as back up to other containment systems put in place to handle such occurrences. As a minimum, the contingency plans that shall apply to both LFZ and contractors, shall address the following emergency situations.

- Fires and Explosions;
- Serious injury or illness;
- Uncontrolled leaks and chemical spills
- Weather related disasters; and
- Land vehicle mishaps.

The ESH and Security Team Leaders shall ensure that adequate security arrangements are put in place. Such plan shall have inputs from host communities' representatives.

The team shall also identify, evaluate and manage the risks to personnel and property arising from malicious practices, crime, civil disorder or armed conflict. The security activities shall be co-coordinated from a common viewpoint by all stakeholders and be in line with LFZ security guidelines.

In addition, each contractor shall be required to submit a project security plan to LFZ for review and approval. As part of the Environmental Management Plan and with the approval of the LFZ Project Manager, the Security Team Leader shall organize security workshops to identify, evaluate and recommend contingency plans for all security risks associated with the LFZ Development Project.

7.11 Maintenance Programme

The maintenance officer to be employed by the contractors for the project shall develop a comprehensive maintenance programme for all equipment. The maintenance schedule contained in the programme shall be designed in line with manufacturer's specifications for each of the equipment. A maintenance log book shall also be operated and it shall be regularly audited/ checked by the ESH and Security Team Leader. In addition, the maintenance status (last and next service dates) shall be displayed at appropriate and clearly visible points on each equipment and machine.

7.12 Construction Guidelines

7.12.1 Site Preparation/Clearance

Site preparation/ clearance works shall be carried out within defined perimeters and only when necessary.

The maximum permissible time lapse between site clearing and initiation of construction operations shall be reduced to the barest minimum necessary to permit safe operations. Areas cleared in excess of operational requirements shall be reinstated with indigenous topsoil and vegetation.

During construction, acquired land not used for project activities shall be fenced off and left undisturbed. As an additional measure to mitigate reduction in biodiversity, approved clearing of land for construction activities shall commence from the road into the bushes. This is to give any animals present in the area to be cleared the opportunity to move away.

7.12.2 Use of Public Rights of Way

All transportation and construction works shall be executed in such a manner that will minimize traffic disruption. However, if operational safety demands that public roads be blocked, then LFZ Project Manager may approve such action only when temporary traffic control and diversion arrangements have been provided. Dumping or storage of litter/ debris, tools and equipment in public or private roads shall be prohibited. Contractors shall develop road clearing strategies to ensure that public roads are kept clear, safe and passable.

7.13 Waste Management Guidelines

The handling, storage and disposal of all wastes that will be generated during the life of the project shall be in accordance with LFZ approved waste management guidelines.

These guidelines shall be binding on all staff and contractors involved in the proposed project with respect to the:

- Emission or release of pollutants, exhaust and/or fugitive gases;
- Discharge or spill of effluent into ocean, surface water, swamp or land;
- Discharge of solid wastes (including domestic waste) into ocean, surface water, swamp or land and
- Generation of noise and vibration.

A detailed waste management plan shall be developed for the wastes generated during the decommissioning and abandonment of facilities. This waste management plan for these wastes shall be subject to approval by the regulatory authorities prior to abandonment. In the design of this plan the focus shall be on optimal recycling and reuse of materials.

7.13.1 Waste Handling

For proper handling and disposal, wastes shall be well defined at source and the definition transmitted along with the waste to the final disposal points. Contractors and LFZ personnel shall define and document all wastes generated in the course of work. Basic information that must be provided, as a minimum, for adequate definition of wastes include:

- Waste type identification

- Proper waste categorization
- Waste segregation information
- Recommended Management practices.

7.13.2 Waste Minimization

Waste minimization implies reduction to the greatest extent possible of the volume of waste materials. The four principles of waste minimization process: recycle, reduce, reuse and recover shall be adopted as applicable. Opportunities to achieve significant waste volume reductions during the proposed project are functions of activity level, age, depreciation and maintenance level of facilities and operating equipment. As much as possible, excavated materials shall be used for landscaping or other remedial works on site.

7.13.3 Waste Segregation

For effective implementation of appropriate wastes disposal methods, it is important that wastes be segregated, preferably at source into clearly designated bins at strategic locations. It is the responsibility of the contractors, during their operations to provide enough clearly marked bins at strategic locations to ensure proper segregation.

7.13.4 Waste Disposal

All waste, shall be cleared regularly from the site and disposed-off at LFZ or Government designated areas and facilities. Wastes in transit must be accompanied and tracked by consignment notes. The waste consignment notes shall contain the following information as a minimum:

- Date of dispatch;
- Description of waste;
- Waste quantity/container type;
- Consignee/driver name and means of transportation; and
- Confirmation of actual disposal (time and date).

7.13.5 Operational Wastes and Disposal Methods

7.13.5.1 Solid wastes

LFZ shall provide for proper storage and subsequent disposal of all sludge/solid wastes generated at the facilities in accordance with LFZ and FMEnv waste management guidelines. In addition, LFZ shall engage a government registered industrial waste management company to evacuate any organic wastes generated from site. No dumping of wastes in swamps or water bodies shall be permitted. All operational solid wastes shall be segregated prior to disposal.

7.13.5.2 Liquid wastes

- **Industrial Wastewaters**: Industrial wastewaters generated from the project activities and facilities shall be channeled to the central wastewater treatment plant and subjected to requisite treatment to ensure compliance to regulatory levels prior to disposal into public drains. These wastes shall include chemically contaminated water from the chemical unloading area, effluents which are likely to be contaminated by oils and potentially contaminated storm water collected from zones within the LFZ.
- **Chemical Spills:** Appropriate measures shall be employed in managing chemical spills. Where applicable, direct flushing with water shall be carried out. Covered containers shall be provided for the chemicals used on a routine basis in order to minimize spills.
- **Hydrocarbon Spills:** Minor hydrocarbon spills shall be cleaned immediately using appropriate absorbent granules and powders. Direct flushing into water body shall not be permitted until such measures are taken and the majority of the spill absorbed.

7.13.5.3 Gaseous Wastes

Provisions shall be made in the facilities design to permit upgrade of equipment in order to reduce emissions and discharges as new technologies emerge. Facilities for in-situ measurement of emissions and discharge levels shall also be provided where practicable or included into the scope of work of the EMC.

7.14 Prevention of Erosion

During construction, the contractors shall where necessary ensure that surface water flow on land or swamp areas are controlled and if necessary channeled into temporary discharge pits. Such pits shall be located, designed and constructed in a manner that will minimize the potential threat of erosion. Muddy water and surface runoff from work sites shall be drained into suitable silt traps before discharge into the environment. Excessive site clearing shall be avoided and exposed surfaces shall be re-vegetated as soon as practicable to minimize erosion.

7.15 Noise Minimization Guidelines

Noise and vibration generated by facilities and equipment shall meet the ergonomic requirements of LFZ and other National and International Standards, Codes of Practice and Statutory Regulations. Where noise level exceeds the stipulated limits, it shall be treated as nuisance and the contractor concerned shall put in place adequate mitigation measures to ensure that the situation is properly addressed. All personnel working for a long period in high noise area shall be required to use earmuffs at all times. Permanent warning signs shall be posted at the boundaries of these restricted areas.

DE-COMMISSIONING AND ABANDONMENT

8.1 Introduction

During the planning of any development project, it is imperative for the project proponent to put in place plans to recover and/or restore the project site to its original state after the project is closed or decommissioned. This requires a good understanding of all the environmental implications the project will have on the ecosystem during its service life. In line with this thought, it is therefore, environmentally sustainable to take into consideration, this component during the planning stage of the project.

This will also, in no small measure enable the project proponent to factor into the construction and operational costs of executing the project, the costs of carrying out these remediation measures.

The remediation measures that need to be undertaken will be such that will check the resultant negative impacts of this phase of the proposed project on the environment. The likely resources of impact will include:

- Physical disturbance arising from equipment removal techniques.
- Residual contamination from accidental oil and chemical spills.
- Waste management problems.

To achieve these objectives, the waste management contingency plans will be strictly adhered to.

8.2 Remediation Plans After Closure/Decommissioning

The site remediation measures described in this section of the study depend on the environmental sensitivities identified during the characterization of the study area, and the predicted potential and associated impacts, especially the negative impacts. These measures include:

- Soils contaminated from accidental oil and/or chemical spills during the operational phase shall be removed for ex-situ or offsite treatment. However, the soil can also be treated using various available in-situ treatment technologies i.e. landfarming.
- All equipment and debris shall be removed from the project environment and disposed of in an environmentally friendly manner.
- Indigenous plant species that were cut down during site clearing activities for access road/ site clearing shall all be replanted.
- The site shall be graded to near its original landscape to prevent incidences of erosion.

- A good waste management plan shall be practiced. All used chemical containers and any other material shall be properly disposed of. For example, reusable or recyclable materials shall be taken back to the manufacturers of the products or sold to local vendors.

- Created access routes shall be blocked wherever possible, especially where subsequent use by local communities is not appropriate.

- After the restoration measures have been implemented, the site shall be photographed and monitored by the proponent's representatives. The aim is to enable the proponent through proper documentation, to effectively monitor the site recovery.

9.1 Conclusions

The field samplings and detailed laboratory analyses based on the fieldwork of the EIA study of the proposed LFZ development were conducted in accordance with the required Local, National (FMEnv) and international standards.

The baseline data gathered were used to characterize the project environment. Based on the results obtained from the fieldwork, key environmental sensitivities were identified within the project area in terms of the natural environment and the socio-cultural characteristics that may be impacted by the project.

Overall, the results, analyses, and interpretations was used to identify all potential environmental impacts that may result from the proposed activity. With the impact prediction therefore, appropriate mitigation measures and environmental management/monitoring plans have been proffered.

From the results and the predicted associated impacts of the project, the proposed LFZ development could be carried out successfully with minimal environmental effects if all the identified mitigation measures proposed in the report are applied and the suggested monitoring requirements are complied with.

9.2 Recommendations

The management of LFZ shall follow the principles/ precepts/ guidelines of the Lagos State Ministry of Environment and FMEnv as listed in this EIA report. All mitigation measures shall also be carried out promptly to avoid accumulation/backlog of restoration activities. The Management of LFZ shall ensure that the members of the host communities are carried along if and where required to avoid any unrest.

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APPENDIX 4.1: METHODOLOGY

INTRODUCTION

For the purpose of executing this project, we have grouped all the activities to be carried out into the following overlapping phases, which will be executed concurrently:

- Extensive Literature Survey
- Field Data Gathering
- Socio-economic, Health and Cultural Assessment
- Analysis of results and identification of pertinent environmental issues and areas;
- Recommendations on Findings
- Reporting.

A brief description of the approach to be employed for each of the six phases are listed and presented in this section of the report.

This section outlines the systematic approach adopted during the fieldwork for the EIA Data Revalidation / EIA Upgrade Exercise, sampling event undertaken from the 27th to 30th of July, 2020 and 14th – 16th February, 2021 for the wet and dry seasons data gathering exercise, in line with the Terms of Reference/Work Execution Plan (ToR/WEP) submitted to Project Proponent, approved by FMEnv and supervised by both the Proponent and FMEnv representatives.

LITERATURE SURVEY

All available information about the study area, including all previous works/ studies on the area and other areas with similar environmental features were reviewed and collated to aid sampling approach and location/number of sampling points.

FIELD DATA GATHERING

Laboratory Analyses of Samples

Samples were analysed in Searchgate laboratory Limited (38, Diya Street, Ifako, Gbagada, Lagos Nigeria) in line with FMEnv and international applicable standards. The Laboratory is certified by the Federal Ministry of Environment. Analytical methodologies used for samples analyses were based on the American Society for Testing and Materials (ASTM) and American Public Health Association (APHA), WHO, NESREA, FME and DPR Standards.

Sampling Design

Sampling design was done to comprehensively cover and characterise the entire Lagos Free Zone (LFZ) land take area. The area was geographically gridded taking cognisance of the different vegetation cover, river systems and human settlements in the area.

Sampling Equipment / Materials

Table A1: List of Equipment

S/N	Equipment / Material	Use
1.	HORIBA U-50 Series Multi Parameter	In-Situ Water Parameters
2.	WolfPack^{TM} Modular Area Monitor equipment	Air Quality Gaseous Parameters
3.	GrayWolf handheld particle counter (model GW-3016)	Total Suspended Particulates

4.	Digital hand held ELE model 460-050 Wind Speed Indicator	Wind Speed and Direction
5.	EXTECH Instruments, US Model 407735	In-Situ noise Measurement
6.	Bucket-type Soil Auger, Cutlass	Soil Sampling
7.	Inland Water Grab	Bottom Sediment Sampling
8.	0.5 – 1 mm Sieves	Benthos Sampling
9.	Plankton net (mesh aperture = 30 – 70 μm)	Phytoplankton Sampling
10.	Conical tow-net (mesh aperture = 30 – 50 μm)	Zooplankton Sampling
11.	Wide mouth plastic basin, 250 ml plastic containers, Hand gloves-polyethylene and cloth type and Polyethylene bags.	Sampling Materials
12.	Formalin, Rose Bengal solution	Preservatives

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 were 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 were 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 on the sample record. Basic information was recorded together with results of analysis, in a sample register. With proper, sustained calibration of the instrument and the use of standardised observational procedures, equipment errors were brought to acceptable minimum.

METHODOLOGIES FOR THE FIELD EXERCISE

Land use

Objective

The observation will be conducted within and around the project area with a view to identifying, existing land cover/land use and changes; if any over time. Identify factors that may be associated with the changes and geo-reference features.

Methodology

Indirect and direct methods of observations were used in this study. Prior to visiting the field, satellite imageries and existing topographic maps were reviewed. To guide the various aspects of biophysical sampling on the field, a proposed sampling map was produced.

A walk and drive through the field, offered on-site observations that presented clarity. Several pictures were taken as well for onward review during data and map analysis. A Garmin Handheld Global Positioning Satellite (GPS) was used in geo-referencing biophysical sampling points in addition to aiding navigation. For easy of work and time management, an MGRS & UTM mapping software was used for real-time mapping on the field.

Scope of Work (SOW)

1. Carry out surveys and provide detailed descriptions and mapping of the existing land use patterns for the proposed project area;
2. Assess the cumulative impacts of the addition of the project to the local area of influence (e.g. in the context of other projects and project development area, what is this project's additional and cumulative impacts?

AIR QUALITY / NOISE MEASUREMENT STUDY

This is the report of atmospheric conditions assessment carried out in Lekki Free Zone (LFZ), Lagos, Nigeria, in support of its Environmental Impact Assessment (EIA) upgrade. Sampling took place on 28 – 30 July, 2020 and 14 – 16 February, 2021 for the wet and dry seasons respectively at different stations strategically located in and around the project site (Table A2).

Table A2: Sampling Locations for Meteorology, Air Quality and Noise

Station Code	Coordinates		Designation
	Latitude	Longitude	
AQ1	6.42386° N	4.05659° E	Downwind
AQ2	6.42513° N	4.05658° E	Downwind
AQ3	6.42659° N	4.05621° E	Downwind
AQ4	6.42926° N	4.05472° E	Downwind
AQ5	6.42610° N	4.05494° E	Downwind
AQ6	6.42925° N	4.02305° E	Upwind
AQ7	6.42979° N	4.02313° E	Upwind
AQ8	6.43101° N	4.02294° E	Upwind
AQ9	6.42850° N	4.02007° E	Upwind
AQ10	6.43424° N	4.01854° E	Project Site
AQ11	6.43660° N	4.02788° E	Project Site
AQ12	6.43664° N	4.01850° E	Project Site
AQ13	6.43245° N	3.99769° E	Magbon-Segun
AQ14	6.43920° N	3.51640° E	Control, Lekki

Scope of Work and Field Methodology

The fieldwork involved monitoring of gaseous pollutants, particulate matter and ambient noise. Also monitored were microclimatic parameters. The monitored gaseous air pollutants were ammonia (NH_3), carbon monoxide (CO), hydrogen sulphide (H_2S), nitric oxide (NO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), methane (CH_4) and volatile organic compounds (VOCs). Also monitored were particulates fractions with diameter less than 2.5 microns ($PM_{2.5}$), 10 microns (PM_{10}) and Total Suspended Particulates (TSP).

Meteorological Parameters

Some meteorological parameters were monitored with the EXTECH 45170 Environmental Meter. This is a multi-function environmental monitoring instrument used to measure major environmental conditions including air temperature, relative humidity, wind speed, and light intensity.

Air Sampling for Particulate Matter

Particulate matter (PM) was measured with the AEROCET 531S Particle Mass/Particle Count Monitor, an equipment from Met One Instruments. It is handheld, battery operated and completely portable unit measuring five mass ranges of TSP: PM_1, $PM_{2.5}$, PM_4, PM_7, PM_{10}, and TSP with a concentration range of 0 – 1000 µg/m^3 and 0 – 3000000 particle cubic foot (and resolution of 0.1 µg/m^3). The PM Monitor samples at a flow rate of 2.83 l/min. To measure, the monitor is placed at 1 m above the ground level, switched on in the environment of interest and the measured concentration read directly on the screen after particle capturing. The respirable fractions of the total particulates were the focus of this measurement.

Air Sampling for Gaseous Pollutants

Oxides of nitrogen (NO and NO_2), sulphur dioxide (SO_2) carbon monoxide (CO), Volatile organic compounds (VOCs), hydrogen sulphide (H_2S), ozone (O_3), methane (CH_4) and ammonia (NH_3) were measured with the *insitu* Aeroqual Series 200 gas monitor. It has facility from which concentration for the last 5 minutes can be determined. For measurement, the monitor is placed at 1 m above the ground level, switched on and measure the concentration displayed on the screen. Ammonia (NH_3) was measured with sensor ENG-1808140-005 having detection range of 0 – 100 ppm and 0.1 ppm resolution while NO and NO_2 were measured with sensor ENW-2402150-009 having a detection range 0 – 1 ppm and 0.001 ppm resolution. Aeroqual Head sensor ESO-2502155-007 was used to monitor SO_2 but EHS/EHS2 was used for H_2S during the fieldwork with both having detection limit of 0 – 10 ppm with 0.01 ppm resolution. Both VOCs and CO were monitored with sensors VM-2305142-025 and ECN-2811140-015 respectively.

While the VOCs sensor has a detection limit of 0 – 25 ppm, CO sensor's limit is 0 – 100 ppm with both having resolution of 0.1 ppm. These were supported with the WolfPackTM Modular Area Monitor, an Indoor Air Quality and other environmental air monitoring applications equipment. It is embedded with WinCE® computer that runs GrayWolf's WolfSense® 2009 application software for displaying, documenting, and logging key parameters. It monitors up to 20 sensors, simultaneously generates 30 readings, and runs on rechargeable battery that can lasts 15 hours of continuous measurements. It has facility for but not limited to Short Term Exposure Limit (STEL) from which the gaseous concentrations for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas since monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. Its resolution for the pollutants is 0.01 ppm.

Noise Measurements

Noise measurements were taken with a digital, battery-powered, sound pressure level meter (EXTEC Instruments, US Model 407730). It has both A and C weighting and 0.1 dB resolution with fast/slow responses. The meter is also equipped with a build-in calibration check (94 dB), tripod mount, and analogue DC/AC conditioned outputs of 10mV/dB and utilized a 0.49" (12.3 mm) condenser microphone. To measure the noise levels at any of the sampling locations, the sound level meter was placed at a distance of at least 3 m from any barrier or other sound reflecting sources and at about 1.2 – 1.5 m above ground level. Measurements were taken by setting the sound level meter to the "A" weighting network.

All these methods are as recommended by the Federal Ministry of Environment (FEPA, 1991). Typical sampling set-ups during the study are reported in Plate 1.

Plate 1: Typical Samling Activities during the Wet Season Fieldwork


Plate 2: Typical Samling Activities during the Dry Season Fieldwork

Ambient Air Quality Assessment Study Approach
The present air quality status and airshed classification according the World Bank Guidelines were determined using the national and World Bank standards (Table A1).

Table A3: Ambient Air Quality Standards Considered in the Study

Air Pollutant	Time Average	Limit (µg/m3)	
		FMEnv (FEPA, 1991)	World Bank (2007)
NH_3	24-hr	0.28 ppm	-
CO	24-hr	11,400 (10 ppm)	-
SO_2	1-hr	260 (0.1 ppm)	-
	24-hr	26 (0.01 ppm)	20
NO_X	1-hr	-	200
	24-hr	75 – 113 (0.04 – 0.06 ppm)	-
VOCs	24-hr	1.6 ppm	-
$PM_{2.5}$	24-hr	-	25
PM_{10}	24-hr	-	80
TSP	24-hr	250	-

SOIL STUDY
Sampling Design
A brief summary of the sampling methods is presented here while the detailed sampling design, approach and methods will be presented in the Environmental Data Re-validation report. All the field sampling methods employed are in line with the recommended methods by the Federal Ministry of Environment (FEPA, 1991) and ASTM E1903-97 Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process (ASTM 2005).

Soil samples were collected at Fifty (50) uniformly locations, with a near uniform spatial spread. Conditions for choice of sampling location were based on factors, such as;

i. Accessibility,
ii. Distance from previous sampling location,
iii. Representativeness, and
iv. Suitability of sample.

Sampling locations were designed and adequately well distributed to cover both the project area and some control locations. The locations of sampling points and codes for each of these samples are presented in Table 1.

Sample Collection

At each soil sampling location, representative soil samples were collected at two depths (0–15 cm and 15–30 cm), representing the topsoil and subsoil, respectively. To ensure the collection of representative soil samples, 2 core soil samples were taken within a 5–10 m radius of the sampling location which were composited/bulked in a plastic bucket, and thoroughly homogenized before sub-sampling for laboratory analysis. Samples for organic parameters were collected in aluminium foil paper while samples for microbiological parameters and physico-chemical properties were collected in specimen bottles and polythene bags respectively.

Plate 2(A-I) shows the tools deployed for the sample collection.

A: Soil Auger for soil burrowing

B: Hand trowel

C: Aluminium foil for Organic Samples

D: Polythene bags for sample collection

E: GPS for coordinate/geospatial data collection

F: Digital Camera

G: Bucket for soil homogenizing

H: Latex gloves

I: Paper Tape for sample tagging

j: Marker for sample tagging

Plate 2: Soil sampling process

Sample Handling, Transport and Custody

This was carried out as far as practicably possible in accordance with FMEnv (1995) (Sampling & Handling of Samples). Other proven scientifically acceptable methods of sample collection and handling were also used where necessary.

MARINE, FRESH AND GROUND WATER SAMPLING

Sampling And Monitoring Site

Two water bodies (Marine and Freshwater) were identified to be within the Lagos Free Zone. Seven (7) sampling points were determined along each of the two water bodies. Seven communities were identified which are Okunraye, Alasia, Idotun, Itoke, Oke-Segun, Magbon-Segun and Lekuru. Two (2) groundwater samples were collected from each of the communities making a total of fourteen (14) samples.

Table A3 - A5 below shows the geospatial coordinates of the determined sampling locations for both the ground and surface water.

Table A3: Sampling Coordinates for groundwater samples

SAMPLE CODE	LATITUDE (N)	LONGITUDE (E)
OKU 1	06.42000	004.05428
OKU 2	06.41936	004.05326
ALA 1	06.42528	004.03214
ALA 2	06.42517	004.03274
IDO 1	06.42330	004.02130
IDO 2	06.42356	004.02212
ITO 1	06.42423	004.01796
ITO 2	06.42461	004.01878
OKE 1	06.42702	003.99964
OKE 2	06.42666	004.00081
MAG 1	06.42731	003.99826
MAG 2	06.42748	003.99644
LEK 1	06.43308	003.99086
LEK 2	06.43280	003.99116

Table A4: Surface Water (Marine)

SAMPLE CODE	LATITUDE (N)	LONGITUDE (E)
SW 1	06.25163	004.01293
SW 2	06.25338	004.00800
SW 3	06.25426	004.00314
SW 4	06.25327	004.00001
SW 5	06.42253	004.01679
SW 6	06.42156	004.01830
SW 7	06.25578	003.59320

Table A5: Fresh Water (Lekki lagoon)

SAMPLE CODE	LATITUDE (N)	LONGITUDE (E)
LW 1	06.43246	004.09629
LW 2	06.44339	004.08025
LW 3	06.45003	004.07464
LW 4	06.45424	004.07047
LW 5	06.46151	004.06324
LW 6	06.44960	004.06879
LW 7	06.43416	004.09266

SAMPLING METHODOLOGY

Procedures

A consistent methodology was applied to all water sampling carried out. Procedures used are for the safe and efficient undertaking of the task and to ensure consistency of quality control procedures. Procedures used are routinely reviewed and updated to reflect current industry best practice. The results obtained will be compared with NSWQ (Nigerian Standards for Water Quality), WHO (World Health Organization) and the FMEnv (Federal Ministry of Environment) standards for drinking and recreational water.

Equipment and Instruments

Equipment's used for the water sampling at the Sites includes:

- ❖ Polyethylene containers for surface water and groundwater sample collection for physio-chemical parameter testing.
- ❖ Vile for microbial samples.
- ❖ Water Quality Monitor (HORIBA equipment) An **Horiba U-50 Series Multi-Parameter Water Quality In-situ Meter** was used to capture surface water in-situ data at all the sampling stations. This meter has capabilities to measure and display 11 parameters simultaneously with newly designed control unit and sensor technology. This meter has data logging capabilities. Up to 10,000 data sets can be stored in the control unit and transferred to a computer later. Parameters measurable include: pH, ORP (Oxygen Reduction Potential), Dissolved Oxygen (DO), Conductivity, Salinity, TDS (Total Dissolved Solids), Specific Gravity, Temperature, Turbidity and Water Depth.

- ❖ Sample gloves
- ❖ Rubber boots
- ❖ Life jacket
- ❖ Preserving Acids e.g Nitric Acid.
- ❖ Laboratory supplied de-ionised water for rinsing of equipment;

The Scientific monitoring equipment were checked, maintained and calibrated according to manufacturer's instructions and selected to meet the standards required for the task.

When sampling, equipment was rinsed at each sample point with the deionised water and the sample water; All samples were clearly labelled and placed in a storage bag and handled in line with applicable industry's best practice for water sample handling, storage, and transportation.

Analytical specification and completion of Chain of Custody documentation was done and sent with the samples to the laboratory. Samples were placed in sealed coolers and bags and dispatched. The plates below shows In-situ field sampling activities and sample collection for laboratory analysis.

Plate 3: Surface water in-situ sampling and sample collection

Plate 4: Groundwater in-situ sampling and sample collection

VEGETATION AND WILDLIFE

Summary of Methodology

The technique applied for the sampling of vegetation and wildlife include the use of spot sampling, target sampling for specific species (based on Known location) and use of quadrats within line transects. Sweep nets were also used to search for flying and climbing insects across the landscape, within delineated transect areas. Creeping and crawling animals were searched for in burrows across the landscape which subterranean species such as earthworms and arthropods were searched for by commissioning deliberate shallow digging campaigns. A total of 25 points were assessed across the landscape, covering the stretch of the project site and control areas (Table A6).

Table A6: sampling locations for wildlife and Vegetation

S/N	Longitude	Latitude	Description	Assessment Conducted
1	6.43434	4.01925	Upland areas	Vegetation and wildlife
2	6.43411	4.01973	Upland areas	Vegetation and wildlife
3	6.43421	4.02042	Upland areas	Vegetation and wildlife
4	6.43436	4.02042	Upland areas	Vegetation and wildlife
5	6.43436	4.01855	Upland areas	Vegetation and wildlife
6	6.43452	4.01803	Upland areas	Vegetation and wildlife
7	6.4348	4.01787	Upland areas	Vegetation and wildlife
8	6.43412	4.01989	Upland areas	Vegetation and wildlife
9	6.4345	4.01932	Upland areas	Vegetation and wildlife
10	6.43419	4.01879	Upland areas	Vegetation and wildlife
11	6.53426	4.01824	Upland areas	Vegetation and wildlife
12	6.43531	4.01738	Upland areas	Vegetation and wildlife
13	6.43606	4.018	Upland areas	Vegetation and wildlife
14	6.43592	4.01766	Upland areas	Vegetation and wildlife
15	6.43614	4.01738	Upland areas	Vegetation and wildlife
16	6.43644	4.01709	Upland areas	Vegetation and wildlife
17	6.43664	4.01676	Lowland wetlands	Vegetation and wildlife
18	6.43669	4.01655	Lowland wetlands	Vegetation and wildlife
19	6.43727	4.01681	Lowland wetlands	Vegetation and wildlife
20	6.4374	4.01726	Temporary pond	Vegetation and wildlife
21	6.43252	4.0225	Temporary pond	Vegetation and wildlife
22	6.43088	4.02264	Marshy grasslands	Vegetation and wildlife
23	6.43236	4.0234	Marshy grasslands	Vegetation and wildlife
24	6.43246	4.02497	Marshy grasslands	Vegetation and wildlife
25	6.4327	4.0248	Marshy grasslands	Vegetation and wildlife

HYDROBIOLOGY ASSESSMENT

Summary of sampling methods

With respect to the hydrobiology assessment, two water bodies bordering the project site were sampled (Lekki Lagoon and Atlantic Ocean). Both water bodies were assessed for benthic animals, phytoplankton, zooplanktons and fisheries resources. In each water body seven (7) samples were collected including 6 along near the project site and one distant control (Table A7).

The sediment samples in the water bodies were grabbed using a Van veen grab and sieved in order to obtain the macrobenthic fauna present in the water bodies (Plate 5- 7). This was followed in each occasion by deploying the plankton net into water to fetch the plankton species in the water column (Plate 8 and 9). All samples collected were preserved in plastic container using 4% formalin before transporting to the laboratory (Zoology Lab, UNILAG) for analysis.

The fisheries resources were assessed via land (for inland creeks/ponds) as well as via fishermen at the water side using motorized wooden boats (Plate 10)

Table A7: Sediment and Plankton sampling coordinates and environmental details

Station	GPS	Nature Of Sediment	Activities In the Area	Benthic/Dept	Fishing Activity
Atlantic Ocean					
SW/SD-1	N (6.25163) E (4.01293)	Coarse Shape Sand	Coastal Vegetations / Uninhabited	Rich/7m	Not Observed
SW/SD-2	N (6.25338) E (4.00800)	Not Coarse Nor Fine Sand	Settlement	Poor/8m	Not Observed
SW/SD-3	N (6.25426) E (4.00314)	Not Coarse Nor Fine Sand	Settlement	Poor/8m	Not Observed
SW/SD-4	N (6.25327) E (4.00001)	Not Coarse Nor Fine Sand	Lekki Port	Rich/10m	Not Observed
SW/SD-5	N (6.42253) E (4.01679)	Too Fine	Dangote Refinery	Rich/10m	Not Observed
SW/SD-6	N (6.42156) E (4.01830)	Too Fine	Settlement	Rich/10m	Not Observed
SW/SD-7 (Control site)	N (6.25578) E (3.59320)	Too Fine	Settlement	Rich/9m	Not Observed
Lekki Lagoon					
LW/SD-1	6.43246 N 4.09629 E	Muddy	Swamp Forest	Rich/5m	Observed
LW/SD-2	6.44339 N 4.08025 E	Muddy	Local Fishing Sites	Rich/3m	Observed
LW/SD-3	6.45003 N 4.07464 E	Muddy	Local Fishing Sites	Rich/3m	Observed
W/SD-4	6.45424 N 4.07047 E	Muddy	Local Fishing Sites	Rich/2.4m	Observed
LW/SD-5	6.46151 N 4.06324 E	Muddy	Local Fishing Sites	Rich/5m	Observed
LW/SD-6	6.44960 N 4.06879 E	Muddy	Dangote Fertilizer	Rich/3m	Not Observed
LW/SD-7 (Control)	6.43416 N 4.09266 E	Muddy	Mangrove Swamps	Rich/4m	Observed

Plate 5: Grab sampling from the bottom of the Lekki Lagoon

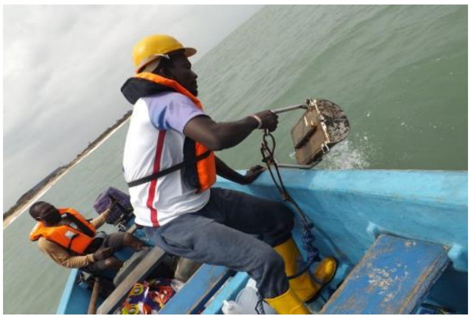

Plate 6: Grabbing at the Atlantic Ocean

Plate 7: Sieving of benthic animals in the Atlantic Ocean

Plate 8: Sampling of plankton in the Lekki Lagoon

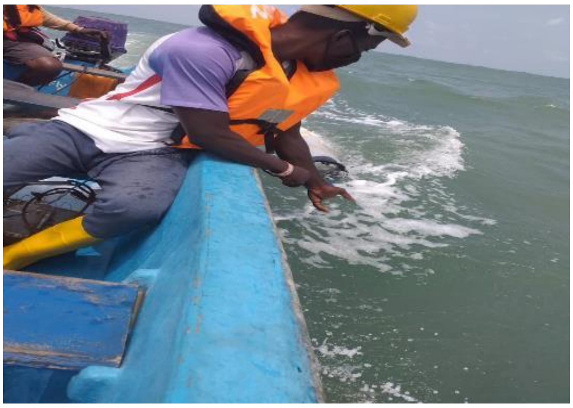

Plate 9: Plankton sampling in the Atlantic Ocean

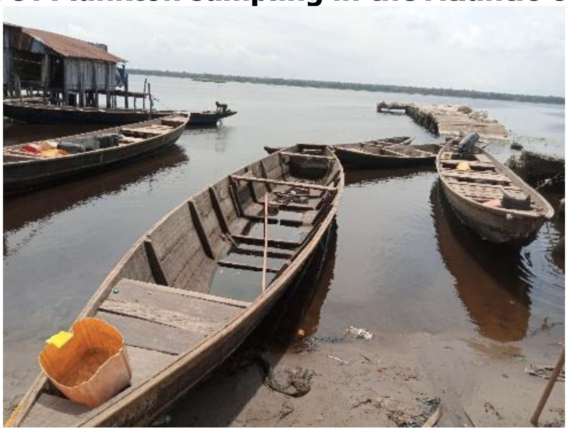

Plate 10: Typical wooded boats used in fishing in the Lekki Lagoon

SOCIO ECONOMIC/ HEALTH ASSESSMENT STUDIES

This section of the Environmental Impact Assessment report presents the baseline socio-economic of the proximate human environment of the project environment, following both the Nigerian Government and internationally laid down EIA Guidelines and methodologies. The report also undertakes a social impact assessment (SIA), proffers measures to mitigate identified project's adverse effects as well as those to enhance the human environment.

Scope of work for Socio-economic and Health Studies

The specific tasks of the Socio-economic and community health environmental studies within the overall environmental data revalidation/EIA upgrade, according to the terms of reference/scope of work are generically same as for a fresh development (the terms are mixed-up though; community health survey and health impact assessment!).

For the social environment (Socio – Economic), the Consultant is expected to:

- Carry out reconnaissance visit and consultation with the communities;
- Generate data using questionnaires, statistics from institutions and/or government agencies on economic infrastructure, education, health, cultural resources and general quality of life in the project area.

And for the Community Health Survey, Consultant is also expected to:

- Determine existing health symptoms;
- Carry out physical and/or clinical observation for evaluation of eyes, respiratory, ears skin and oral hygiene.
- Acquire local community health statistics to determine diseases trend, existing health care provisions and/ or services.
- As a follow-up, Consultant shall assess health vulnerability linkage (matrix), health sensitivities (disease vectors, water portability, waste disposal etc.) as part of the Health Impact Assessment process.

The above tasks are to be based on extensive literature materials and interviews using structured questionnaires, in-depth interviews and focus group discussions (FGDs) within the communities.

Socio-economic and community health data acquisition methodology

As earlier pointed out above, the task of carrying out the data revalidation/EIA upgrade is expected to follow a series of overarching and overlapping activities including but not limited to the following concurrently:

• Extensive Literature Survey

• Field Data Gathering – one-off for socio-economic and Health Assessment

• Analysis of results and identification of pertinent socio-environmental and health issues

• Recommendations on Findings

• Reporting.

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

The methods and techniques for collecting the relevant socio-economic and health data were a priority set out in the TOR/SOW to include the use of extensive literature materials and interviews using structured copies of the questionnaire, in-depth interviews and focus group discussions (FGDs) within the communities.

The socio-economic study and SIA will be conducted to update information available on the host communities in close proximity to the LFZ project area.

Consultant shall employ a combination of methods in order to achieve optimum results. The methods will include the following:

- **Administration of Structured Questionnaires**

Designed questionnaires will be administered on the field to selected sample sizes, which will be determined by a number of factors including population size, heterogeneity of population, etc. In order to facilitate and ease communications with respondents, field labour will be hired within the communities to assist in questionnaire administration and enumeration activities.

- **Focus Group Discussions**

Discussions will be held with specific focus groups. This will include Fishermen's Associations, Traders Associations, youths, women organizations, etc. The purpose of this is to obtain and document the views of each of these stakeholders.

- **Social Impact Assessment**
- ✓ Consultant shall also determine the impact of the project from the regional to local scale. Critical in this will be the current local area land and resource use and the impacts the project have had on such uses.
- ✓ Consultant shall also update dependence on natural resources such as fishing, farming and hunting for sustenance and income generation. Consultant shall update records of chieftaincy matters and traditional power structures, land ownership system, festivals etc.
- **Health Impact Assessment**
- ✓ For this phase of socio-economic activities, certified public health personnel will carry out on-site investigation and examination in the communities, to re-establish the existing status of health in the area. Secondary data will be collected from health institutions around the study area, most recent population and housing census data, economic census. In addition, supplementary information will be collected from statistics and data from the National Public Health Institute (INSP) and the Federal Ministry of Health, etc.
- ✓ All of the information listed above will be effectively combined toward updating the initial baseline information available on the social and health environment of the study area.

Pre-field Activities: Standardization of Survey Instrument

One of the preliminary activities embarked upon prior to mobilisation to the field for the data revalidation exercise was the preparation of the socioeconomic and community study instrument. The Socioeconomic study approach/methodology, including the survey instruments (questionnaire) was reviewed and confirmed satisfactory and thus approved for use in the field for socio-economic data collection.

Delineation of Study Area- Spatial Coverage

One area where the proposed environmental data revalidation/EIA Upgrade appears to be poorly conceptualized is the area coverage. The Lagos Free Zone (LFZ), previously registered and known as Lagos Free Trade Zone (LFTZ), is the first private owned free trade zone in Nigeria. It is spread over 805 hectares of land, and the zone is expected to have several industrial zones and offer access to an enormous consumer market across West Africa. On ground in the same area is the Lekki Free Trade Zone (LFZ). In the TOR/SOW, attention is paid more to designing a biophysical ''sampling map" at the neglect of the human environment! A long and expansive fence is discernable in the study area at one but not before coming across the LFZ's area of operations as well.

The above observed shortcoming notwithstanding, the Consultants are aware that the operational area of the Lagos Free Zone is a cluster-type project, representing a single point on the earth surface. The acquired land surface for the masterplan is located next to and within the living environment of seven (8 nos.) stakeholder village communities in the Ibeju-Lekki area. All 8 communities were visited but only 5 obliged the Consultants with consultations and interactions. The stakeholder communities of the LFZ include (not mentioned in any specific importance):

1. Lekuru;
2. Okunraye;
3. Alasia;
4. Itoke
5. Idotun
6. Oke-Segun; and
7. Magbon-Segun.
8. Lujagba

Itoke and Idotun, pencilled for interactions like other stakeholder village communities could not have the required social interactions because they were angry with LFZ and the Lekki Sea Port management for a long-standing misunderstanding. They therefore, withdrew their consent because of those subsisting grouses. The study team (SIA) were however, allowed into the communities and to see some of the reasons why they were angry: the ravaging coastal surges that have wrought havoc on property.

Community Interaction/Focus Group Discussions (FGDs) and Questionnaire Administration

Effective socio-economic baseline data collection involves the deployment of several techniques and methods, including using interview schedules, questionnaire administration, Focus Group Discussions (FGDs) and key informant interviews (KIIs). These techniques are within the basket of participatory rural appraisal and participatory learning appraisal techniques (PRA/PLA) which overtime have been found to yield better results when appropriately utilised (Ojile, et. Al., 2016; Akpofure and Ojile 1999).

Fieldwork for the socioeconomic and health impact assessment studies and data collection took place from Wednesday 19th August to Sunday, 23rd August, 2020. Five (5) out of the 8 stakeholder communities mentioned earlier were visited for data collection.

The socioeconomic study was based on a participative approach, involving the affected stakeholders as much and effectively as possible in the course of data collection. Both the qualitative and quantitative methods were employed for effective socioeconomic and community health data collection. Qualitative methods have to do with people's perceptions, how they view themselves and the world around them. For the Lagos Free Zone environmental data revalidation/EIA Upgrade study, community-wide interactions and discussions, Focus group meetings/discussions (FGDs) and key informant interviews (KIIs) were utilized to solicit necessary information, including opinion and perceptions about the activities of the industrial establishments and others yet to be on the ground (Plates 11-15).

Quantitative methods were also used to generate data, mostly at household level, using the structured copies of the questionnaire and the survey method. The administration of a set of structured questionnaires is a conventional method of data collection in the social sciences. As a survey instrument and primary data collection method, the questionnaire is structured to incorporate socioeconomic and environmental issues and included binary, optional and open-ended questions that solicited relevant information from the householder. Over One hundred and Eighty copies of the questionnaire (185 copies actual) were administered to the population in stakeholder communities. The sample size was proportional, ranging from 2 - 3%, with a minimum of 30 and a maximum of 42 copies administered to the affected communities according to the physical and population sizes of each community.

Questionnaires were administered face to face to community respondents after community-wide and focus group discussions. Respondents found literate were also allowed to self-administer the questionnaire, after clarifications on how to fill same. But time and logistics necessitated leaving behind some of the questionnaire to enable a larger reach and retrieval. Arrangements were put in place to retrieve same for analysis and use in the socioeconomic reporting.

To complement the fieldwork, the secondary source of data collection shall also be utilized, to fill the gaps that may arise from the field data collection. These shall involve statistical (census data/community profile), models (population projections), (Dale & Davis, 1995, SIEP, 1996, 2001), and reports of other socioeconomic/environmental assessment studies carried out in the area in the recent past as well as the consultant's knowledge of the area and literature searches.

Table A8: Pattern of questionnaire administration in the LFZ stakeholder communities

S/no	Name of Community	No. of Questionnaires administered	No. retrieved
1	Lekuru	30	20
2	Okunraye	42	26
3	Alasia	35	29
4	Oke-Segun	40	31
5	Magbon-Segun	38	26
6	Itoke**	Nil	N.A.
7	Idotun**	Nil	N.A.
8	Lujagba	Nil	N.A
	Total	**185**	**132**

**Both communities were in crises mode as at time of study; consults entered Itoke but could not conduct the study even though allowed some informal interactions and survey of the coastal area under serious coastal flooding and erosion impact, a principal grouse of the communities.

Ground-truthing was also undertaken to identify, and verify existing social infrastructures, their functionality, and capacity/adequacy and authenticate claims of community representatives/participants. These were subsequently photographed where necessary to aid report preparation (See attached plates). The secondary source of data collection was also extensively utilized, and these involved statistical (census data/community profile), models (population projections), (Dale & Davis, 1995, SIEP, 1996, 2001) and literature searches. Data gathering and analysis were also based on advocated philosophy of "triangulation" (use of a variety of data sources, multiple perspectives and multiple methods (Denzin, 1970, Grady, et al., 1987, as reported by Glasson, 1995).

Plate 11: Interactive session at Lekuru community

Plate 12: The Consultants also took time out with the women group in the interactive session @ Lekuru communty

Plate 13: Interactive session at Alasia community

Plate 14: Interactive session at Okunraye community with all fully COVID-19 compliant with PPE

Plate 15: Interactive session at Oke-Segun community

Plate 16: Consultants at Magbon-Segun community

APPENDIX 4.2: RESULTS

Mean Measured Gaseous Pollutants during the Study

Season	Station	Concentrations (ppm)								
		VOC	CO	SO_2	NO	NO_2	NH_3	H_2S	CH_4	O_3
Wet Season	AQ1	0.0	0	0	0.004	0.0	0.13	0.0	0.0	0.0
	AQ2	0.0	0.0	0.0	0.003	0.0	0.10	0.04	0.0	0.0
	AQ3	0.0	0.0	0.0	0.003	0.0	0.12	0.04	0.0	0.0
	AQ4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AQ5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AQ6	0.15	2.1	0.0	0.0	0.0	0.12	0.01	0.0	0.0
	AQ7	0.12	5.2	0.0	0.0	0.003	0.0	0.0	0.0	0.0
	AQ8	0.0	0.0	0.02	0.0	0.002	0.0	0.0	0.0	0.0
	AQ9	0.0	0.0	0.01	0.0	0.004	0.0	0.0	0.0	0.0
	AQ10	0.15	6.7	0.01	0.004	0.0	0.0	0.04	0.0	0.0
	AQ11	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.0
	AQ12	0.0	0.0	0.07	0.0	0.0	0.0	0.0	0.0	0.01
	AQ13	0.15	7.1	0.0	0.0	0.004	0.0	0.0	0.0	0.01
	Mean	0.14	5.3	0.03	0.0	0.0	0.12	0.03	-	0.01
	Stdev	0.02	2.3	0.03	0.0	0.0	0.01	0.02	-	0.0
	AQ14 (Ctrl)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.01
Dry Season	AQ1	0.0	0.0	0.0	0.0	0.06	0.0	0.0	0.0	0.06
	AQ2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AQ3	0.0	0.3	0.0	0.0	0.03	0.0	0.0	0.0	0.08
	AQ4	0.0	3.3	0.0	0.0	0.0	0.0	0.02	0.0	0.0
	AQ5	0.0	1.0	0.02	0.0	0.0	0.0	0.0	0.0	0.07
	AQ6	0.0	1.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0
	AQ7	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.05
	AQ8	0.0	3.7	0.02	0.0	0.0	0.0	0.0	0.0	0.0
	AQ9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AQ10	0.0	6.6	0.02	0.0	0.0	0.0	0.0	0.0	0.0
	AQ11	0.0	1.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	AQ12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AQ13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	1.7	0.01	0.0	0.01	0.0	0.002	0.0	0.02
	Stdev	0.0	2.3	0.01	0.01	0.02	0.0	0.01	0.0	0.03
	AQ14 (Ctrl)	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FMEnv Limit		5.0	20.0	0.10	-	-	0.3	0.10	-	0.20

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

Measured Suspended Particulates during the Study

Season	Station	Particulates (µg/m^3)		
		$PM_{2.5}$	PM_{10}	TSP
Wet Season	AQ1	29.4	83.4	90.8
	AQ2	21.6	75.0	99.1
	AQ3	20.0	57.1	68.1
	AQ4	19.0	60.4	62.9
	AQ5	18.7	55.4	56.0
	AQ6	18.2	77.9	111.8
	AQ7	17.1	45.6	51.8
	AQ8	18.0	42.0	48.1

	AQ9	28.0	89.0	122.3
	AQ10	15.7	62.5	89.0
	AQ11	18.8	54.0	71.2
	AQ12	14.0	87.3	119.4
	AQ13	42.8	223.5	291.3
	Mean	21.6	77.9	98.6
	Stdev	7.7	46.4	63.2
	AQ14 (Ctrl)	24.0	62.0	71.0
Dry Season	AQ1	12.6	53.7	59.2
	AQ2	18.5	96.4	145.2
	AQ3	17.3	81.9	105.7
	AQ4	19.5	91.1	118.0
	AQ5	15.8	66.0	82.2
	AQ6	19.3	72.0	89.3
	AQ7	17.1	79.2	131.3
	AQ8	18.3	71.5	74.6
	AQ9	21.6	79.0	85.8
	AQ10	22.1	80.2	101.8
	AQ11	17.7	114.2	148.7
	AQ12	22.7	147.1	170.0
	AQ13	21.9	112.7	125.0
	Mean	18.8	88.1	110.5
	Stdev	2.9	24.7	32.6
	AQ14 (Ctrl)	44.5	214.8	250.8
FMEnv Limit		-	-	600.0

Source: GET Fieldwork – LFZ Project Area, July 2020 (Wet)/February 2021 (Dry)

Phytoplankton abundance and community structure in the Atlantic Ocean (September, 2020)

		Sampling stations						Control	Total
S/N	Phytoplankton Taxa	SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	Division – Bacillariophyta								
	Class-Bacillariophyceae								
	Order I – Centrales								
1	*Aulacoseira granulata var. angstissima Muller*	15	9	8	12	16	0	7	
2	*Ditylum brightwelli (T. West) Grunow*	11	13	8	5	5	9	6	
3	*Melosira moniliformis Agardh*	4	0	10	16	13	7	7	
	Order Fragillariales								
4	*Fragillaria sp.*	0	5	0	0	6	3	4	
	Order Naviculales								
5	*Navicula sp.*	4	9	0	0	0	0	0	
6	*Navicula peregrina (Ehrenberg) Kutzing*	0	16	0	0	0	11	13	
7	*Navicula mutica Kutzing*	11	10	8	8	6	4	3	
	Order II – Pennales								
8	*Bacillaria sp.*	7	4	11	0	0	5	2	
9	*Nitzschia obtusa Wm Smith*	0	5	4	9	0	5	0	
10	*Pinnularia sp.*	0	11	16	0	6	21	11	
11	*Pinnularia major (Kutzing) Rabenh*	23	15	0	0	9	0	9	
12	*Synedra ulna (Nitzsch) Ehrenberg*	4	6	0	5	14	0	4	
	Order Tabellariales								
13	*Diatoma vulgaris Bory 1824*	3	14	0	6	0	0	0	
	Class Coscinodiscophyceae								
	Order Coscinodicales								
14	*Coscinodiscus sp.*	0	10	0	3	0	0	13	
15	*Coscinodiscus concinnus W. Smith*	9	14	0	7	0	0	0	
16	*Coscinodiscus jonesianus (Greville) Ostenfield*	2	6	6	19	5	0	0	
17	*Coscinodiscus radiatus f. asteromphalus Ehrenberg*	0	0	8	4	15	7	8	
	Order Surirelales								
18	*Surirella caproni (Breb.)*	0	0	9	11	4	0	9	

	ORDER THALASSIONEMATALES								
19	*Thalassiothrix sp.*	0	0	0	0	18	4	0	
	Class mediophyceae								
	Order Eupodiscales								
20	*Odontella aurita (Lyngbye) C. Agardh*	0	8	6	4	0	0	0	
21	*Odontella chinensis(greville) Grunow*	9	17	11	9	12	0	13	
	ORDER BIDDULPHIALES								
22	*Biddulphia sp*	5	11	8	3	0	5	6	
23	*Biddulphia aurita (Lyngye) Brebisson*	0	0	0	0	0	11	0	
	Order Melosirales								
24	*Podosira stelligera (Bailey) A.Mann 1907*	4	0	9	0	9	0	4	886
	Division Cyanophyta								
	Class – Cyanophyceae								
	Order Chroccocales								
25	*Microcystis aureginosa Kutzing*	4	8	9	11	10	8	8	
	Order Hormogonales								
26	*Lynbgya limnetica Lemm*	0	5	0	0	7	2	9	
27	*Oscillatoria curviceps C. Agardh ex Gomot*	6	21	11	0	10	9	15	
28	*Oscillatoria principes Vaucher ex Gomot*	9	0	9	0	0	3	11	
29	*Oscillatoria limosa C. Agardh ex Gomot*	14	0	4	8	13	7	4	
30	*Oscillatoria sancta f.tenuis (woronichin) Elenkin*	6	3	4	12	6	0	9	
	Order Nostocales								
31	*Trichormus variabilis (Kützing ex Bornet & Flahault)*	2	0	16	4	8	0	0	305
	Division Chlorophyta								
	Class – Chlorophyceae								
	Order Chlorococcales								
32	*Akistrodesmus sp.*	0	1	5	4	8	10	0	
	Order Sphaeropleales								
33	*Tetraedron tumidulum (Riensch)*	0	3	8	5	0	0	0	

34	*Ankistrodesmus falcatus (Corda) Ralfs 1848*	10	14	2	8	0	6	4	
	Order Oedogoniales								
35	*Oedogonium capillare var. fuscum Kützing*	0	0	4	5	11	8	3	
36	*Chlamydomonas reinhardtii P.A.Dangeard*	3	5	2	0	0	0	0	129
	Division Dinophyta								
	Order Gonyaulacales								
37	*Ceratium sp.*	0	3	0	0	13	14	0	
38	*Ceratium hirundinella* (O.F. Muller) Dujardin	0	7	0	0	0	7	6	50
	Total species diversity (S)	22	28	25	23	23	22	25	
	Total abundance (N)	165	253	196	178	224	166	188	
	Shannon-Wiener Index (Hs)	2.884	3.179	3.113	3.005	3.058	2.956	3.104	
	Equitability Index	0.8208	0.858	0.8999	0.8776	0.925	0.8735	0.8911	
	Margalef Index (d)	4.113	4.879	4.547	4.246	4.065	4.108	4.583	

Phytoplankton abundance and community structure in the Atlantic Ocean during the dry season (Feb, 2021)

		Sampling stations						Con	Total
S/N	Phytoplankton Taxa	SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	Division – Bacillariophyta								
	Class-Bacillariophyceae								
	Order I – Centrales								
	Aulacoseira sp.	4	0	0	8	0	1	0	
1	*Aulacoseira granulata var. angstissima Muller*	11	5	9	5	16	0	0	
2	*Ditylum brightwelli (T. West) Grunow*	6	10	4	0	5	9	4	
3	*Melosira moniliformis Agardh*	6	0	7	9	13	5	11	
	Order Naviculales								
4	*Navicula sp.*	2	0	0	0	0	0	0	
5	*Navicula amphora Ehrenberg*	5	6	6	11	8	2	6	

6	*Navicula peregrina (Ehrenberg) Kutzing*	0	0	0	0	5	7	18	
7	*Navicula mutica Kutzing*	11	10	8	0	5	2	0	
	Order II – Pennales								
8	*Bacillaria sp.*	6	0	11	0	0	0	7	
9	*Nitzschia obtusa Wm Smith*	0	0	0	6	0	3	3	
10	*Pinnularia major (Kutzing) Rabenh*	10	1	10	0	0	5	2	
11	*Synedra ulna (Nitzsch) Ehrenberg*	0	7	0	6	10	3	6	
	Order Tabellariales								
12	*Diatoma vulgaris Bory 1824*	9	0	0	6	0	0	0	
	Order Thalassiophysales								
13	*Amphora ovalis (Kützing) Kützing*	6	2	1	1	5	3	0	
	Class Coscinodiscophyceae								
	Order Coscinodicales								
14	Actinoptychus senarius (Ehrenberg) Ehrenberg	0	0	0	8	0	0	4	
15	*Coscinodiscus sp.*	0	10	0	3	0	0	13	
16	*Coscinodiscus concinnus W. Smith*	9	14	0	7	0	0	0	
17	*Coscinodiscus jonesianus (Greville) Ostenfield*	2	6	6	19	5	0	0	
18	*Coscinodiscus radiatus f. asteromphalus Ehrenberg*	0	0	8	4	15	7	8	
	Order Surirelales								
19	*Surirella caproni (Breb.)*	0	0	9	11	4	0	5	
20	*Surirella striatula Turpin*	3	6	4	0	0	0	3	
	Class mediophyceae								
	Order Eupodiscales								
20	*Odontella aurita (Lyngbye) C. Agardh*	3	9	7	4	0	0	0	
21	*Odontella chinensis(greville) Grunow*	6	9	4	0	10	13	8	
	Order Bidduphiales								
22	*Biddulphia sp*	8	6	8	3	0	5	1	
23	*Biddulphia aurita (Lyngye) Brebisson*	0	0	0	0	0	2	0	688

	Division Cyanophyta								
	Class – Cyanophyceae								
	Order Chroccocales								
24	*Microcystis aureginosa Kutzing*	0	9	0	0	3	11	7	
25	*Microcystis flosaquae (Wittrock) Kirchner*	10	2	2	0	0	0	0	
	Order Hormogonales								
26	*Lynbgya limnetica Lemm*	14	2	8	0	6	4	2	
27	*Oscillatoria curviceps C. Agardh ex Gomot*	3	5	2	0	0	0	0	
28	*Oscillatoria principes Vaucher ex Gomot*	0	2	8	0	6	4	7	
29	*Oscillatoria limosa C. Agardh ex Gomot*	9	2	14	8	0	8	5	
	Order Nostocales								
30	*Trichormus variabilis (Kützing ex Bornet & Flahault)*	6	2	9	0	0	5	0	185
	Division Chlorophyta								
	Class – Chlorophyceae								
	Order Sphaeropleales								
31	*Tetraedron tumidulum (Riensch)*	0	3	8	7	0	0	7	
32	*Ankistrodesmus falcatus (Corda) Ralfs 1848*	8	11	2	8	0	6	5	
	Order Oedogoniales								
33	*Oedogonium capillare var. fuscum Kützing*	7	0	0	0	7	6	0	
34	*Chlamydomonas reinhardtii P.A.Dangeard*	5	5	2	0	0	5	0	102
	Division Dinophyta								
	Order Gonyaulacales								
35	*Ceratium sp.*	2	3	0	0	4	7	9	
36	*Ceratium hirundinella* (O.F. Muller) Dujardin	0	0	0	3	0	3	5	36
	Number of Species (S)	26	25	24	20	17	24	23	
	Number of Individuals (N)	171	147	157	137	127	126	146	
	Shannon-Wiener Index (Hs)	3.141	3.035	3.041	2.85	2.712	3.033	2.974	

	Equitability Index	0.964	0.943	0.957	0.865	0.886	0.865	0.851	
	Margalef Index (d)	4.862	4.809	4.549	3.862	3.303	4.756	4.414	

SW: Surface water

Zooplankton abundance and community structure in the Atlantic Ocean (September, 2020)

S/N	Zooplankton Taxa	Stations						Contr	Total
		SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	Phylum- Crustacea								
	Class- Copepoda								
	Order- Calanoida								
1	*Acartia tonsa*	10	24	14	0	9	5	5	
2	*Calanus sp.*	26	19	0	4	12	19	0	
3	*Paracalanus sp.*	3	4	0	2	0	0	0	
4	*Paracalanus parvus*	3	7	12	6	11	1	16	
	Order - Cyclopoida								
5	*Cyclops strenus Fisher*	5	3	9	0	0	9	2	
6	*Mesocyclops sp.*	11	8	6	12	18	5	3	
7	*Oithona nana*	2	0	5	3	6	1	0	
8	*Pontella sp.*								
	Class ostracoda								
9	*Eurycerus sp.*	0	0	0	0	24	0	9	
	Class Eumalacostraca								
10	*Lucifer sp.*	11	2	0	3	7	15	9	
11	*Lucifer Hansen*	4	9	16	3	8	4	11	
	Order- Cladocera								
12	*Bosminia longirostris*	4	7	14	11	3	30	4	
13	*Daphnia sp.*	0	5	3	7	14	21	5	583
	Phylum Chaetognatha								

	Class Sagittoidea								
	Order Aphragomophora								
14	*Krohnitta subtilis (Grassi, 1881)*	13	4	9	0	13	9	9	
15	*Flaccisagitta enflata (Grassi, 1881)*	6	11	1	16	8	11	20	130
	PHYLUM CHORDATA								
	CLASS APPENDICULARIA								
	ORDER COPELATA								
16	*Oikopleura sp.*	0	1	3	0	3	0	0	7
	PHYLUM FORAMINIFERA								
	CLASS GLOBOTHALAMEA								
	ORDER ROTALIIDA								
17	*Globigerina sp.*	14	11	3	30	4	9	11	
18	*Globigerina bulloides*	3	7	14	21	5	0	16	148
	Phylum: Rotifera								
	Class: Monogonota								
	Order: Ploima								
19	*Brachionus sp.*	0	0	0	5	3	3	3	
20	*Brachionu splicatilis muller*	0	7	4	13	9	16	12	
21	*Keratella cochlearis (Gosse, 1851)*	0	8	0	0	0	4	3	
	CLASS EUROTATORIA								
	ORDER FLOSCULARIACEAE								
22	*Testudinella sp*	3	0	0	0	0	15	0	108
	Phylum Mollusca								
	Class Gastropoda								
	Order Nudibranchia								
23	*Fiona sp.*	0	3	0	2	0	0	0	5

	Juvenile stages								
24	Fish eggs	13	5	16	4	23	10	14	
25	Brachyllura larva	0	1	6	9	11	10	2	
26	Cirripede nauplius	12	8	5	1	0	4	3	
27	Zoe larvae	9	2	8	2	0	3	7	188
	Total species diversity (S)	18	22	18	19	19	21	20	
	Total abundance (N)	152	156	148	154	191	204	164	
	Shannon-Wiener Index (Hs)	2.667	2.834	2.709	2.588	2.771	2.776	2.791	
	Evenness Index	0.8002	0.773	0.835	0.6999	0.841	0.7645	0.8146	
	Margalef Index (d)	3.384	4.159	3.402	3.574	3.427	3.761	3.726	

Zooplankton abundance and community structure in the Atlantic Ocean during the dry season (Feb, 2021)

S/N	Zooplankton Taxa	Stations						Cont	Total
		SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	PHYLUM CRUSTECEA								
	Class- Copepoda								
	Order- Calanoida								
1	*Acartia tonsa*	9	16	3	8	4	11	8	
2	*Paracalanus parvus*	0	1	3	5	3	0	0	
	Order - Cyclopoida								
3	*Cyclops strenus Fisher*	2	6	6	1	1	5	3	
4	*Oithona nana*	2	0	5	3	6	1	0	
5	*Pontella sp.*								
	Class ostracoda								
6	*Eurycerus sp.*	0	0	0	0	13	0	9	
	Class Eumalacostraca								
7	*Lucifer sp.*	2	5	7	0	3	0	0	
8	*Lucifer Hansen*	11	0	7	5	3	9	14	

	Order- Cladocera								
9	*Bosminia longirostris*	9	0	5	0	0	11	7	232
	PHYLUM CHAETOGNATHA								
	Class Sagittoidea								
	Order Aphragomophora								
10	*Flaccisagitta enflata (Grassi, 1881)*	9	15	0	9	13	4	11	61
	PHYLUM CHORDATA								
	CLASS APPENDICULARIA								
	ORDER COPELATA								
11	*Oikopleura sp.*	2	0	2	0	0	0	0	
12	*Oikopleura dioica*	3	0	0	0	0	9	3	19
	PHYLUM FORAMINIFERA								
	CLASS GLOBOTHALAMEA								
	ORDER ROTALIIDA								
13	*Globigerina sp.*	4	0	0	2	0	0	0	
14	*Globigerina bulloides*	17	9	4	17	3	8	15	79
	PHYLUM ROTIFERA								
	Class: Monogonota								
	Order: Ploima								
15	*Brachionus sp.*	0	0	0	5	3	3	3	
16	*Brachionu splicatilis muller*	0	7	4	13	9	16	12	
17	*Keratella cochlearis (Gosse, 1851)*	0	8	0	0	0	4	3	
	CLASS EUROTATORIA								
	ORDER FLOSCULARIACEAE								
18	*Testudinella sp*	5	0	0	3	0	11	0	109

	PHYLUM MOLLUSCA								
	Class Gastropoda								
	Order Nudibranchia								
19	*Fiona sp.*	0	0	0	6	0	0	0	6
	JUVENILE STAGES/EGGS								
20	Fish eggs	9	7	11	9	9	8	11	
21	Brachyllura larva	2	0	3	4	8	5	0	
22	Cirripede nauplius	16	0	8	0	0	5	4	
23	Copepod larvae	3	5	0	3	0	0	3	
24	Zoe larvae	3	0	0	6	0	0	0	142
	Number of Species (S)	17	10	13	16	13	15	14	
	Number of Individuals (N)	108	79	68	99	78	110	106	
	Shannon-Wiener Index (Hs)	2.567	2.148	2.463	2.573	2.361	2.566	2.473	
	Evenness Index	0.766	0.857	0.903	0.819	0.816	0.867	0.847	
	Margalef Index (d)	3.417	2.06	2.844	3.264	2.754	2.978	2.788	

SW: Surface water

Macrobenthic fauna abundance and community structure in the Atlantic Ocean (September, 2020)

S/N	TAXA	Sampling locations						Cont	Total
		SD1	SD2	SD3	SD4	SD5	SD6	SDC	
	PHYLUM ANNELIDA								
	CLASS POLYCHAETA								
1	Eunice siciliensis (Grube,1840)	0	2	2	9	0	4	0	
2	Nephtys capensis	9	0	0	4	1	1	1	
3	Onuphis elegans	0	0	0	0	0	3	0	
4	Alitta sp (Kinberg,1805)	2	5	3	5	0	1	0	
5	Leiochone leiopygos	11	4	0	0	9	0	8	84

	PHYLUM ARTHROPODA								
	CLASS CRUSTECEA								
6	Balanus pallidus (Darwin, 1854)	6	1	0	0	6	6	3	
7	Cirolana sp.	0	0	0	4	0	0	1	21
	PHYLUM BRACHIOPODA								
	CLASS LINGULATA								
8	*Lingula anatina*	0	0	0	2	0	2	0	4
	PHYLUM MOLLUSCA								
	CLASS GASTROPODA								
9	*Natica fusca*	4	5	0	0	0	0	4	
10	*Clavatula delphinae*	0	0	0	0	0	0	0	
11	Cymbium cymbium	1	0	0	0	4	4	0	
12	Nassarius vibex	9	1	2	9	2	3	3	
13	*Schilderia sp.*	0	1	0	1	0	0	0	
14	Pleurocera acuta (Rafinesque,1818)	7	0	6	2	0	0	4	
	CLASS BIVALVIA-								
15	*Aloidis sp.*	0	0	11	5	0	0	0	
16	*Corbula sulcata*	3	0	5	6	6	0	0	
17	*Donax rugosus*	0	13	0	0	0	0	11	
18	*Polymesoda sp. (Rafinesque , 1820)*	0	0	2	2	2	0	0	
19	*Iphigenia rostrata (Römer , 1869)*	0	0	3	0	1	9	5	
20	*Tellina radiata*	0	0	1	5	0	0	4	
	CLASS SCAPHOPODA								
21	*Dentalium vulgare*	0	0	2	0	0	0	0	168
	Number of Species	9	8	10	12	8	9	10	
	Number of Individuals	52	32	37	54	31	33	44	
	Shannon Weiner’s Index	2.02	1.704	2.062	2.328	1.834	1.994	2.096	

	Evenness Index	0.84	0.6871	0.7861	0.855	0.783	0.816	0.813	
	Margalef's Index	2.03	2.02	2.492	2.758	2.038	2.288	2.378	

Macrobenthic fauna abundance and community structure in the Atlantic Ocean during the dry season (Feb, 2021)

S/N	TAXA	Sampling locations						Control	Total
		SD1	SD2	SD3	SD4	SD5	SD6	SDC	
	PHYLUM ANNELIDA								
	CLASS POLYCHAETA								
1	*Nephtys capensis*	1	0	0	0	4	4	0	
2	*Onuphis elegans*	3	0	5	6	6	0	0	
3	*Alitta sp (*Kinberg,1805)	2	5	3	5	0	1	3	
4	*Leiochone leiopygos*	0	0	3	0	1	3	5	60
5	*Mercierella engimatica*								
	PHYLUM ARTHROPODA								
	CLASS CRUSTECEA								
6	*Balanus pallidus* (Darwin, 1854)	11	0	8	0	13	2	0	34
	PHYLUM BRACHIOPODA								
	CLASS LINGULATA								
7	*Lingula sp.*	0	0	0	4	0	0	2	
8	*Lingula anatina*	3	0	0	6	0	2	2	19
	PHYLUM MOLLUSCA								
	CLASS GASTROPODA								
9	*Clavatula delphinae*	0	0	0	0	0	4	0	
10	*Cymbium cymbium*	4	0	0	3	0	3	6	
11	*Nassarius vibex*	11	1	2	7	2	3	0	

12	*Pleurocera acuta (Rafinesque,1818)*	5	0	8	2	2	3	2	
	CLASS BIVALVIA-								
13	*Aloidis trigona*	4	0	4	0	0	3	0	
14	*Corbula sulcata*	0	3	4	2	6	0	7	
15	*Donax rugosus*	0	8	0	0	3	0	4	
16	*Iphigenia rostrata (Römer , 1869)*	2	0	4	0	1	3	3	
17	*Tellina radiata*	0	0	7	4	0	0	5	
	CLASS SCAPHOPODA								
18	*Dentalium vulgare*	2	0	3	0	0	0	4	154
	Number of Species (S)	17	10	13	16	13	15	14	
	Number of Individuals (N)	108	79	68	99	78	110	106	
	Shannon Weiner's Index	2.567	2.148	2.463	2.573	2.361	2.566	2.473	
	Evenness Index	0.766	0.857	0.903	0.819	0.816	0.867	0.847	
	Margalef's Index	3.417	2.06	2.844	3.264	2.754	2.978	2.788	

SD: Sediment

Phytoplankton abundance and community structure in the wet season at Lekki Lagoon (September, 2020)

S/N	Phytoplankton Taxa	Sampling stations						Control	Total
		SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	DIVISION BACILLARIOPHYTA								
	CLASS BACILLARIOPHYCEAE								
	ORDER - MASTOGLOIALES								
1	*Achnanthes peragalii* Brun & Héribaud	0	0	0	0	0	0	5	
	ORDER - THALASSIOPYSALES								
2	*Amphora sp.*	1	0	0	0	0	3	0	
3	*Amphora coffaeiformis Agardh*	6	2	0	4	0	11	0	
	ORDER - TABELLARIALES								
4	*Asterionella formosa* Hassall	4	7	7	1	0	2	2	
5	*Diatoma vulgaris* Bory	0	0	0	9	5	0	0	

6	*Tabellaria fenestrata* var. *intermedia* Grunow	3	3	4	0	0	0	3	
	ORDER- CYMBELLALES								
7	*Cymbella turgida* Greg.	1	1	0	2	0	1	0	
8	*Gomphonema parvulum* Kützing	0	5	0	5	1	0	0	
9	*Gomphonema sphaerophorum* Ehrenberg	5	0	3	8	0	1	5	
	ORDER - NAVICULALES								
10	*Navicula* sp.	0	2	5	7	0	2	2	
11	*Navicula amphibola* Cleve	0	9	3	12	7	9	1	
12	*Navicula confervacea* Kützing	1	1	0	2	0	1	0	
13	*Navicula cryptocephala* Kutzing	0	0	0	0	11	0	4	
14	*Navicula elegans* Smith	11	0	4	15	0	0	1	
15	*Navicula mutica* Kützing	3	0	0	3	6	5	3	
16	*Navicula placentula* f. *rostrata* Meyer	0	0	0	0	5	0	3	
17	*Navicula pupula* Kützing	3	2	1	6	1	0	0	
18	*Navicula radiosa* Kutzing	9	11	4	24	9	0	0	
19	*Navicula viridula* (Kutzing) van Heurck	1	0	2	3	4	4	0	
20	*Gyrosigma acuminatum* Kutzing	4	0	0	4	1	0	4	
21	*Gyrosigma attenuatum* Kutzing	3	0	0	3	0	0	3	
22	*Gyrosigma balticum* Ehrenberg	0	0	4	4	3	6	3	
23	*Gyrosigma fasciola* Ehrenberg	0	2	2	4	0	6	0	
24	*Gyrosigma spenceri* Smith	2	0	0	2	0	2	0	
25	*Neidium sp.*	4	0	0	4	1	0	0	
26	*Neidium iridis* (Ehr). Cleve	3	0	0	3	0	0	5	
27	*Pinnularia biceps* Gregory	0	0	4	4	3	0	0	
28	*Pinnularia braunii* var. *amphicephala* (Ant.Mayer)	0	2	2	4	0	11	9	
29	*Pinnularia brevicosta* Cleve	2	0	0	2	0	6	0	
30	*Pinnularia major* Kutzing	0	3	0	3	1	0	5	
31	*Pinnularia similis* Hustedt	0	0	2	2	3	0	2	
32	*Pleurosigma angulatum* Smith	16	0	0	16	0	0	2	
33	*Pleurosigma directum* Grunow	2	0	0	2	0	0	0	

	ORDER - SURIRELLALES								
34	*Surirella elegans* Ehrenberg	5	9	11	25	18	21	16	
35	*Surirella muelleri* Hustedt	0	5	0	5	0	0	6	
	ORDER- FRAGILARIALES								
36	*Fragillaria intermedia* Grunow	15	11	16	42	21	9	26	
37	*Synedra acus* Kutzing	0	0	5	5	4	5	2	
38	*Synedra crystallina* Kutzing	1	0	0	1	0	0	2	
39	*Synedra sp.*	0	1	0	1	0	0	0	
	ORDER - MELOSIRALES								
40	*Melosira granulata* Ralfs	3	5	2	10	5	0	2	
	ORDER -BACILLARIALES								
41	*Hantzschiasp.*	9	4	0	13	6	4	0	
42	*Hantzschia sigma* Ehrenberg	0	5	0	5	0	0	0	
43	*Nitzschia accicularis* Smith	0	2	4	6	0	0	6	
44	*Nitzschia bacata* Hustedt	1	0	0	1	0	0	2	
45	*Nitzschia consummate*	3	0	0	3	3	4	2	
46	*Nitzschia intermedia* Cleve & Grunow	2	0	1	3	0	7	3	
47	*Nitzschia lancealota* Smith	0	0	4	4	0	0	0	
48	*Nitzschia palae* Kutzing	0	1	0	1	0	0	0	
49	*Nitzschia sigma* Kutzing	0	0	0	0	11	0	5	
50	*Nitzschia sigmoidea* Grunow	5	0	3	8	0	2	0	
	ORDER- THALASIOSIRALES								
51	*Thalassiosira sp.*	5	2	2	1	0	5	0	
52	*Thalassiosira anguste-lineata* (A.Schmidt)	4	0	0	4	7	4	0	
	ORDER - LICMOPHORALES								
53	*Ulnaria ulna* (Nitzsch) Ehrenberg	2	5	0	1	6	0	0	
	CLASS MEDIOPHYCEAE								
	ORDER - BIDDUPHIALES								
	Biddulphia laevis Ehrenberg	0	1	2	3	6	0	9	
	Order - Stephanodiscales								

54	*Cyclotella* sp.	1	0	5	6	0	5	0	
55	*Cyclotella kutzi ngiaria* var. *planetophora* Fricke	1	0	0	1	0	0	0	
56	*Cyclotella striata* Kützing	0	0	0	2	0	0	0	
57	ORDER - EUPODISCALES								
58	*Odontella aurita* (Lyngbe) Brebisson	3	0	0	3	6	2	11	
59	*Odontella mobiliensis* (Bailey) Grunow	0	0	0	0	5	0	0	
	ORDER - ANAULALES								
60	*Terpsinoe musica* (Her.) Hustedt	0	2	2	4	0	4	4	
	CLASS COSCINODISCOPHYTINA								
	ORDER - COSCINODISCALES								
61	*Actinoptychus undulatus* (Kützing) Ralfs	1	0	2	3	4	11	0	
62	*Actinotyphus senarius* Ehrenberg	4	0	0	4	1	0	0	
63	*Cocconeis diminuta* Pantocsek	3	0	0	3	0	0	3	
64	*Cocconeis placentula* Ehrenberg	0	0	4	4	3	0	1	
65	*Coscinodiscus centralis* Ehrenberg	0	2	2	4	0	0	0	
66	*Coscinodiscus concinnus* Smith	7	6	4	2	2	4	0	
67	*Coscinodiscus marginatus* Ehrenberg	5	9	0	5	0	4	6	
68	*Coscinodiscus radiatus* Ehrenberg	2	2	6	1	2	4	0	
	ORDER - AULACOSEIRALES								
69	*Aulacoseria granulata* Ehrenberg	2	0	5	7	2	1	2	
70	*Aulacoseria granulata* var. *angustissima* (Ehrenberg) Ralfs	0	0	3	3	1	0	5	
71	*Aulacoseria granulata* var. *angustissima* f. spiralis Muller	0	1	0	1	1	0	0	1290
	DIVISION CHRYSOPHYTA								
	CLASS CHRYSOPHYCEAE								
72	*Tetrasporopsis* sp.	7	4	4	0	8	2	7	32
	DIVISION CYANOBACTERIA								
	CLASS CYANOPHYCEAE								
	ORDER - Chroococcales								
73	*Chroococcus disperses* Keissler	1	0	0	0	0	4	4	

	ORDER - OSCILATORIALES								
74	*Lyngbya* sp.	2	8	0	1	0	0	6	
75	*Lyngbya contorta* Lemmermann	0	7	0	4	0	0	1	
76	*Lyngbya limnetica* Lemm	0	12	0	0	0	3	1	
77	*Merismopedia glavica* Ehrenberg	0	10	0	0	4	1	4	
78	*Merismopedia sp.*	6	0	4	2	17	6	8	
79	*Microcystis aureginosa* Kutzing	4	0	10	2	0	4	12	
80	*Oscillatoria agardhii* Gomont	5	0	0	0	0	1	5	
81	*Oscillatoria curviceps* .Agardh	4	0	0	8	0	0	7	
82	*Oscillatoria limnosa* Agardh	7	10	5	11	0	0	0	
83	*Oscillatoria nigra* Vaucher ex Gomont	0	9	13	21	18	12	9	
84	*Oscillatoria princeps* Vauch	0	2	2	6	5	8	14	
85	*Oscillatoria* sp.	0	0	2	0	3	8	2	
86	*Oscillatoria tenuis* Agardh	0	4	2	0	3	0	0	
87	*Spirulina* sp.	6	0	7	0	1	2	0	370
	DIVISION EUGLENOPHYTA								
	CLASS EUGLENOPHYCEAE								
	Order - Euglenales	1	3	0	2	0	0	1	
88	*Euglena sp.*	3	0	0	0	0	9	0	
89	*Euglena ehrenberghii* Klebs	3	0	2	5	4	5	3	
90	*Euglena granulata* (Klebs) Schmitz	0	2	0	0	7	3	8	
91	*Euglena limnophila* Lemmermann	3	0	3	0	3	0	1	
92	*Euglena oxyuris* Schmarda	5	2	0	5	1	6	2	
93	*Lepocinclis ovum* Ehrenberg	0	0	1	3	1	0	4	
94	*Phacus* sp.	0	7	7	0	0	0	0	
95	*Trachelomonas hispida* Perty	3	3	0	9	5	1	0	
96	*Trachelomonas similis* Stokes	0	3	0	0	3	4	0	146
	DIVISION CHLOROPHYTA								

	CLASS CHLOROPHYCEAE								
	ORDER -CHLAMYDOMONALES								
97	*Pandorina morum* Müller	8	0	0	3	3	0	2	
	ORDER - SPHAEROPEALES								
98	*Hydrodictyon* sp.	6	0	0	1	0	0	0	
99	*Radiococcus nimbatus* De Wildeman	1	0	4	0	0	2	6	
	CLASS TREBOUXIOPHYCEAE								
	ORDER - CHLORELLALES								
100	*Chlorella sorokiniana* Shih. et Krauss	0	2	1	2	3	6	0	50
	DIVISION CHAROPHYTA								
	Class Conjugatophyceae								
	Order - Desmidiales								
101	*Closterium kutzingii* Breb.	7	7	3	2	2	9	6	
102	*Closterium ehrenbergii* Meneghini ex Ralfs	0	0	5	5	9	0	1	
	ORDER -ZYGNEMATALES								
103	*Spirogyra africana* Fritsch Cruda	5	3	6	5	8	2	11	96
Total number of Species (S)		62	49	51	83	55	53	61	
Total number of Individuals (N)		255	221	211	450	283	264	300	
Shannon- Weiner Index		3.886	3.653	3.724	4	3.687	3.731	3.814	
Evenness Index (H/S)		0.7855	0.7877	0.8123	0.6579	0.7261	0.7875	0.7432	
Margalef Index (d)		11.01	8.892	9.343	13.42	9.565	9.326	9.326	

Phytoplankton abundance and community structure in the Lekki Lagoon during the dry season (Feb, 2021)

		Sampling stations						Contr	Total
S/N	Phytoplankton Taxa	SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	DIVISION BACILLARIOPHYTA								
	CLASS BACILLARIOPHYCEAE								
	ORDER – THALASSIOPYSALES								

1	*Amphora sp.*	0	0	0	0	1	7	2	
2	*Amphora coffaeiformis Agardh*	3	0	0	3	0	9	2	
	ORDER – TABELLARIALES								
3	*Asterionella formosa* Hassall	2	9	4	8	0	0	8	
4	*Diatoma vulgaris* Bory	4	0	1	4	0	0	1	
5	*Tabellaria fenestrata* var. *intermedia* Grunow	2	0	0	0	0	0	1	
	ORDER- CYMBELLALES								
6	*Cymbella turgida* Greg.	4	0	1	3	0	11	7	
7	*Gomphonema parvulum* Kützing	0	3	2	3	6	0	4	
8	*Gomphonema sphaerophorum* Ehrenberg	0	3	0	1	2	0	4	
	ORDER – NAVICULALES								
9	*Navicula amphibola* Cleve	3	4	3	8	0	4	4	
10	*Navicula confervacea* Kützing	6	0	0	9	0	8	0	
11	*Navicula cryptocephala* Kutzing	4	4	0	0	2	7	3	
12	*Navicula elegans* Smith	7	6	0	7	5	0	0	
13	*Navicula placentula* f. *rostrata* Meyer	4	0	0	0	0	0	0	
14	*Navicula pupula* Kützing	0	5	0	0	9	0	5	
15	*Navicula radiosa* Kutzing	13	8	8	11	4	6	6	
16	*Navicula viridula* (Kutzing) van Heurck	4	2	2	2	2	9	4	
17	*Gyrosigma acuminatum* Kutzing	4	0	0	4	1	0	4	
18	*Gyrosigma attenuatum* Kutzing	0	11	0	0	8	0	18	
19	*Gyrosigma balticum* Ehrenberg	3	3	9	2	5	4	0	
20	*Gyrosigma fasciola* Ehrenberg	0	7	2	8	11	0	14	
21	*Gyrosigma spenceri* Smith	0	3	0	0	0	5	2	
22	*Neidium iridis* (Ehr). Cleve	0	1	0	5	0	0	2	
23	*Pinnularia biceps* Gregory	5	8	4	0	0	3	8	
24	*Pinnularia braunii* var. *amphicephala* (Ant.Mayer)	2	5	2	13	16	8	5	
25	*Pinnularia brevicosta* Cleve	1	5	0	0	1	4	1	
26	*Pinnularia major* Kutzing	12	0	0	9	1	4	5	

27	*Pleurosigma angulatum* Smith	10	9	0	9	0	0	7	
28	*Pleurosigma directum* Grunow	4	0	0	0	4	1	0	
	ORDER – SURIRELLALES								
29	*Surirella elegans* Ehrenberg	0	2	9	16	27	33	12	
30	*Surirella muelleri* Hustedt	0	7	4	3	4	6	11	
	ORDER- FRAGILARIALES								
31	*Fragillaria intermedia* Grunow	11	9	22	18	15	9	21	
32	*Synedra acus* Kutzing	7	0	10	0	11	10	7	
33	*Synedra sp.*	11	12	0	3	0	11	15	
	ORDER – MELOSIRALES								
34	*Melosira granulata* Ralfs	9	12	0	10	18	4	4	
	ORDER -BACILLARIALES								
35	*Hantzschia sigma* Ehrenberg	4	0	0	11	0	7	0	
36	*Nitzschia accicularis* Smith	4	2	0	1	2	4	0	
37	*Nitzschia bacata* Hustedt	0	7	0	1	0	0	0	
38	*Nitzschia consummate*	0	1	7	8	5	9	10	
39	*Nitzschia intermedia* Cleve & Grunow	0	0	6	2	0	4	3	
40	*Nitzschia lancealota* Smith	2	0	1	0	0	0	0	
41	*Nitzschia palae* Kutzing	0	4	3	9	0	0	0	
42	*Nitzschia sigma* Kutzing	6	0	0	0	8	0	2	
43	*Nitzschia sigmoidea* Grunow	3	2	0	4	2	4	2	
	ORDER- THALASIOSIRALES								
44	*Thalassiosira sp.*	1	0	4	1	3	3	0	
45	*Thalassiosira anguste-lineata* (A.Schmidt)	3	0	7	1	11	0	2	
	ORDER – LICMOPHORALES								
46	*Ulnaria ulna* (Nitzsch) Ehrenberg	0	3	0	0	0	0	0	
	CLASS MEDIOPHYCEAE								
	ORDER – BIDDUPHIALES								
47	*Biddulphia laevis* Ehrenberg	0	0	0	0	3	0	5	

	Order – Stephanodiscales								
48	*Cyclotella* sp.	0	0	0	1	0	3	0	
49	*Cyclotella kutzi ngiaria* var. *planetophora* Fricke	8	0	0	1	2	1	0	
50	*Cyclotella striata* Kützing	0	2	0	1	0	0	4	
	ORDER – EUPODISCALES								
51	*Odontella aurita* (Lyngbe) Brebisson	0	0	0	3	3	1	7	
52	*Odontella mobiliensis* (Bailey) Grunow	0	0	0	0	3	0	0	
	ORDER - ANAULALES								
53	*Terpsinoe musica* (Her.) Hustedt	0	5	0	0	0	0	0	
	CLASS COSCINODISCOPHYTINA								
	ORDER - COSCINODISCALES								
54	*Actinoptychus undulatus* (Kützing) Ralfs	0	0	5	2	0	3	0	
55	*Actinotyphus senarius* Ehrenberg	0	0	0	2	7	0	0	
56	*Cocconeis diminuta* Pantocsek	6	0	0	2	0	0	0	
57	*Cocconeis placentula* Ehrenberg	0	0	2	0	0	0	9	
58	*Coscinodiscus centralis* Ehrenberg	0	9	2	0	0	3	0	
59	*Coscinodiscus concinnus* Smith	1	11	0	5	3	1	0	
60	*Coscinodiscus marginatus* Ehrenberg	0	0	0	5	0	0	2	
61	*Coscinodiscus radiatus* Ehrenberg	0	0	9	2	5	5	0	
	ORDER - AULACOSEIRALES								
62	*Aulacoseria granulata* var. *angustissima* f. spiralis Muller	3	1	6	0	0	0	0	1371
	DIVISION CHRYSOPHYTA								
	CLASS CHRYSOPHYCEAE								
63	*Tetrasporopsis* sp.	9	3	1	2	3	0	5	23
	DIVISION CYANOBACTERIA								
	CLASS CYANOPHYCEAE								
	ORDER – Chroococcales								

64	*Chroococcus disperses* Keissler	5	1	3	0	0	1	2	
	ORDER – OSCILATORIALES								
65	*Lyngbya* sp.	0	3	0	3	2	2	0	
66	*Lyngbya contorta* Lemmermann	0	11	0	5	0	0	1	
67	*Lyngbya limnetica* Lemm	6	4	0	0	6	0	0	
68	*Merismopedia glavica* Ehrenberg	0	7	0	0	2	0	2	
69	*Microcystis aureginosa* Kutzing	3	0	6	5	0	0	2	
70	*Oscillatoria* sp.	5	2	2	0	4	2	2	
71	*Oscillatoria agardhii* Gomont	1	0	0	0	0	9	5	
72	*Oscillatoria curviceps* .Agardh	13	14	10	4	0	6	7	
73	*Oscillatoria limnosa* Agardh	7	3	8	10	0	0	0	
74	*Oscillatoria princeps* Vauch	11	2	13	4	5	10	9	
75	*Oscillatoria tenuis* Agardh	0	4	0	0	0	0	0	
76	*Spirulina* sp.	0	0	3	3	2	0	1	263
	DIVISION EUGLENOPHYTA								
	CLASS EUGLENOPHYCEAE								
	Order – Euglenales								
77	*Euglena sp .*	0	5	0	0	4	3	0	
78	*Euglena ehrenberghii* Klebs	2	0	3	2	1	0	4	
79	*Euglena granulata* (Klebs) Schmitz	0	0	0	0	3	0	2	
80	*Euglena limnophila* Lemmermann	4	0	3	0	0	2	1	
81	*Lepocinclis ovum* Ehrenberg	0	0	3	5	0	0	0	
82	*Phacus* sp.	0	2	3	0	3	0	0	
83	*Trachelomonas hispida* Perty	3	8	0	6	4	2	4	
84	*Trachelomonas similis* Stokes	0	2	0	0	4	3	0	91
	DIVISION CHLOROPHYTA								
	CLASS CHLOROPHYCEAE								

	ORDER -CHLAMYDOMONALES								
85	*Pandorina morum* Müller	2	0	0	5	0	0	1	
	ORDER - SPHAEROPEALES								
86	*Hydrodictyon* sp.	9	0	0	5	0	0	0	
87	*Radiococcus nimbatus* De Wildeman	0	1	0	0	0	0	3	
	CLASS TREBOUXIOPHYCEAE								
	ORDER - CHLORELLALES								
88	*Chlorella sorokiniana* Shih. et Krauss	4	2	1	3	3	0	0	39
	DIVISION CHAROPHYTA								
	Class Conjugatophyceae								
	Order - Desmidiales								
89	*Closterium kutzingii* Breb.	3	4	6	0	1	4	11	
90	*Closterium ehrenbergii* Meneghini ex Ralfs	0	0	2	0	2	0	0	
	ORDER -ZYGNEMATALES								
91	*Spirogyra africana* Fritsch Cruda	3	0	4	11	0	3	4	58
Total number of Species (S)		52	52	42	57	50	46	57	
Total number of Individuals (N)		266	263	206	294	259	258	299	
Shannon- Weiner Index		3.761	3.733	3.466	3.782	3.565	3.548	3.752	
Evenness Index (H/S)		0.826	0.804	0.762	0.77	0.707	0.755	0.748	
Margalef Index (d)		9.134	9.153	7.695	9.853	8.818	8.104	9.824	

SW: Surface water

Zooplankton abundance and community structure in the Lekki Lagoon (September, 2020)

S/N	Zooplankton Taxa	Stations						Control	Total
		SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	PHYLUM ARTHROPODA								
	SUBPHYLUM CRUSTACEA								
	CLASS COPEPODA								

	ORDER 1- CALANOIDA								
1	*Acartia tonsa* Dana	7	3	6	0	0	4	9	
2	*Euchaeta tonsa* Giesbrecht	0	0	1	4	0	8	0	
3	*Paracalanus parvus* Claus	3	5	4	0	2	1	4	
4	*Pseudocalanus elongates* Boeck	4	7	3	0	0	5	1	
	ORDER II-CYCLOPOIDA								
5	*Cyclopina longicornis* Boeck	3	1	2	5	0	0	3	
6	*Oncaeasp.*	0	4	1	0	4	1	1	
7	*Oncaea venusta* Philippi	1	2	11	9	0	0	4	
	ORDER III- HERPACTICOIDA								
8	*Enterpina acutifrons* Dana	3	0	2	0	3	8	4	
9	*Canthocamptus staphylinus* Jurine	5	2	7	2	1	3	3	
	CLASS BRANCHIOPODA								
	ORDER CLADOCERA								
10	*Moina macrocopa*	0	0	0	4	7	0	1	
	CLASS MAXILLOPODA								
	ORDER SESSILIA								
11	*Balanus balanoides* Linnaeus	0	7	0	0	5	4	2	
	SUBPHYLUM INSECTA								
	ORDER COLEOPTERA								
12	*Neochetina eichhorniae*	4	5	1	3	0	0	6	225
	PHYLUM ROTIFERA								
	CLASS EUROTATORIA								
	ORDER PLOIMA								
13	*Albertia sp.*	2	0	0	1	4	6	3	
14	*Albertia naidis* Bousfield	2	1	0	0	5	2	1	
15	*Brachionus urceolaris* Muller	0	4	0	7	0	8	4	
16	*Euchlaris lyra* Hudson	0	3	6	9	0	5	0	

17	*Mytilina ventralis* Ehrenberg	3	1	1	4	5	0	0	
18	*Rotaria rotatoria* Pallas	2	0	5	3	0	2	4	
19	*Trichocerca longiseta* Schrank	5	4	3	2	1	5	3	126
	PHYLUM MOLLUSCA								
	CLASS GASTROPODA								
	ORDER PTEROPODA								
20	*Hyalocylis striata* Rang	8	0	2	1	5	0	0	16
	PHYLUM CILIOPHORA								
	CLASS OLIGOTRICHEA								
	ORDER CHORIOTRICHIDA								
21	*Tintinnopsis* sp.	0	0	5	2	0	0	5	12
	JUVENILE STAGES/EGGS								
22	Fish eggs	5	7	8	1	1	0	4	
23	Fish larvae	13	4	6	3	0	0	1	
24	Cirriped larvae	4	1	5	0	3	0	3	
25	Copepod naupius larvae	0	0	0	0	6	5	0	
26	Cypris larvae	2	10	5	3	2	8	4	114
Total number of Species (S)		18	18	20	17	15	16	21	
Total number of Individuals (N)		76	71	84	63	54	75	70	
Shannon- Weiner Index		2.711	2.546	2.795	2.632	2.386	2.472	2.663	
Evenness Index (H/S)		0.8357	0.709	0.819	0.818	0.729	0.741	0.897	
Margalef Index (d)		3.925	3.988	4.288	3.862	3.51	3.474	2.352	

Zooplankton abundance and community structure in the Lekki Lagoon during the dry season (Feb, 2021)

		Stations						Control	Total
S/N	Zooplankton Taxa	SW1	SW2	SW3	SW4	SW5	SW6	SWC	
	PHYLUM ARTHROPODA								
	SUBPHYLUM CRUSTACEA								
	CLASS COPEPODA								
	ORDER 1- CALANOIDA								
1	*Acartia tonsa* Dana	3	11	2	1	0	0	3	
2	*Euchaeta tonsa* Giesbrecht	0	0	0	8	2	2	2	
3	*Paracalanus parvus* Claus	6	2	3	0	0	2	1	
4	*Pseudocalanus elongates* Boeck	0	5	4	4	1	9	2	
	ORDER II-CYCLOPOIDA								
5	*Cyclopina longicornis* Boeck	0	5	3	1	2	0	1	
6	*Oncaea sp.*	2	1	3	6	1	0	1	
	ORDER III- HERPACTICOIDA								
7	*Enterpina acutifrons* Dana	5	2	0	1	8	5	5	
8	*Canthocamptus staphylinus* Jurine	0	2	3	2	9	1	0	
	CLASS BRANCHIOPODA								
	ORDER CLADOCERA								
9	*Moina macrocopa*	0	0	1	2	2	0	2	
	CLASS MAXILLOPODA								
	ORDER SESSILIA								
10	*Balanus balanoides* Linnaeus	6	7	3	11	2	0	2	
	SUBPHYLUM INSECTA								
	ORDER COLEOPTERA								
11	*Neochetina eichhorniae*	2	3	2	2	0	3	2	194
	PHYLUM ROTIFERA								
	CLASS EUROTATORIA								

	ORDER PLOIMA								
12	*Albertia sp.*	2	0	0	1	4	6	3	
13	*Albertia naidis* Bousfield	2	1	0	0	5	2	1	
14	*Brachionus urceolaris* Muller	0	4	0	7	0	8	4	
15	*Mytilina ventralis* Ehrenberg	3	1	1	4	5	0	0	
16	*Rotaria rotatoria* Pallas	2	0	5	3	0	2	4	
17	*Trichocerca longiseta* Schrank	5	2	3	2	1	5	3	101
	PHYLUM MOLLUSCA								
	CLASS GASTROPODA								
	ORDER PTEROPODA								
18	*Hyalocylis striata* Rang	4	1	2	3	4	0	2	16
	JUVENILE STAGES/EGGS								
19	Fish eggs	11	9	16	8	11	8	13	
20	Fish larvae	11	15	4	5	2	0	0	
21	Cirriped larvae	3	4	3	6	2	0	4	
22	Copepod naupius larvae	3	3	1	0	4	5	2	
23	Cypris larvae	5	3	4	0	4	8	2	179
Total number of Species (S)		17	19	18	19	18	14	20	
Total number of Individuals (N)		75	81	63	77	69	66	59	
Shannon- Weiner Index		2.663	2.629	2.615	2.707	2.649	2.471	2.738	
Evenness Index (H/S)		0.844	0.7294	0.759	0.789	0.786	0.846	0.773	
Margalef Index (d)		3.706	4.096	4.103	4.144	4.015	3.103	4.66	

SW- Surface water

Macrobenthic fauna abundance and community structure in the Lekki Lagoon (September, 2020)

S/N	TAXA	Sampling locations						Control	Total
		SD1	SD2	SD3	SD4	SD5	SD6	SDC	
	PHYLUM MOLLUSCA								
	CLASS Gastropoda								
	ORDER CAENOGASTROPODA								
1	*Tympanotomus fuscatus*	3	3	0	7	1	9	0	
2	*Cerithium atriatum*	1	0	7	0	0	0	0	
	ORDER CYCLONERITIIDA								
3	*Neritina sp.*	2	5	5	1	0	3	5	
	CLASS BIVALVIA								
	ORDER ACIDA								
4	*Anadara senilis*	0	0	0	3	0	0	0	
	ORDER OSTREIDA								
5	*Crassoterea tulipa*	0	2	2	0	0	5	2	
6	*Graphaea gasar*	8	0	6	3	0	1	4	
	ORDER MYTILIDA								
7	*Mytilus perna*	0	0	4	0	0	0	0	
	ORDER VENERIDA								
8	*Pitaria tumens*	3	5	1	1	2	3	0	107
	PHYLUM ANNELIDA								
	CLASS POLYCHAETA								
	ORDER CAPITIDA								
9	*Capitella capitata*	4	0	1	2	2	0	0	
10	*Neries sp.*	0	0	0	0	4	0	3	16
	PHYLUM ARTHROPODA								
	CLASS CRUSTECEA								
	ORDER DECAPODA								

11	*Callinectes amnicola*	2	0	1	4	1	0	1	9
Total number of Species (S)		6	4	7	6	4	5	4	
Total number of Individuals (N)		21	15	26	17	9	21	14	
Shannon- Weiner Index		1.608	1.323	1.745	1.563	1.273	1.406	1.33	
Evenness Index (H/S)		0.8325	0.939	0.818	0.7953	0.893	0.816	0.95	
Margalef Index (d)		1.642	1.108	1.842	1.765	1.365	1.091	1.14	

Macrobenthic fauna abundance and community structure in the Lekki Lagoon during the dry season (Feb, 2021)

S/N	TAXA	SD1	SD2	SD3	SD4	SD5	SD6	Control (SDC)	Total
	PHYLUM MOLLUSCA								
	CLASS Gastropoda								
	ORDER CAENOGASTROPODA								
1	*Tympanotomus fuscatus*	4	6	0	7	1	3	0	
2	*Pachynelania aurita*	2	4	5	0	2	1	0	
3	*Cerithium atriatum*	2	0	1	0	0	0	0	
	ORDER CYCLONERITIIDA								
4	*Neritina sp.*	0	0	7	3	0	0	8	
	CLASS BIVALVIA								
	ORDER ACIDA								
5	*Anadara senilis*	0	3	1	0	4	4	2	
	ORDER OSTREIDA								
6	*Graphaea gasar*	5	2	4	2	0	0	2	
	ORDER MYTILIDA								
7	*Mytilus perna*	1	9	2	1	0	3	2	
	ORDER VENERIDA								
8	*Pitaria tumens*	7	2	3	2	1	1	0	119

	PHYLUM ANNELIDA								
	CLASS POLYCHAETA								
	ORDER CAPITIDA								
9	*Capitella capitata*	3	0	5	0	2	0	0	10
	PHYLUM ARTHROPODA								
	CLASS CRUSTECEA								
	ORDER DECAPODA								
10	*Callinectes amnicola*	3	0	0	1	4	2	4	14
Total number of Species (S)		8	6	8	6	6	6	5	
Total number of Individuals (N)		27	27	28	16	14	14	18	
Shannon- Weiner Index		1.941	1.637	1.906	1.542	1.649	1.673	1.427	
Evenness Index (H/S)		0.871	0.857	0.841	0.779	0.867	0.888	0.833	
Margalef Index (d)		2.124	1.535	2.101	1.803	1.895	1.895	1.384	

SD: Sediment

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16th March, 2021.

The Managing Director,
Global Environmental Limited,
Lagos.

Dear Sir,

ANALYSIS RESULT

Please find attached the results of the analysis of water, soil and Sediment samples received on the 22nd of February, 2021.

Thank you.

Yours faithfully,

Tolu Adeniyi
Searchgate Lab. Ltd

Laboratories Ltd.
Environmental Laboratories & Consultancy Services
38, Diya Street, Ifako, Gbagada, Lagos, Nigeria. Tel: 08032648205, 08029548006, 07088424268
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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.
Table 1: Surface Soil Sample Results

S/N	PARAMETERS	SS 1 0-15 cm	SS 2 0-15cm	SS 3 0-15cm	SS 4 0-15cm	SS 5 0-15cm	SS 6 0-15cm	SS 7 0-15cm	SS 8 0-15cm	SS 9 0-15cm	SS 10 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Dark Brown	Dark	Dark Brown	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	8.12	8.09	7.91	7.82	8.01	7.96	8.01	8.03	7.89	8.11
3	Conductivity (µs/cm)	174.0	165.0	177.0	188.0	179.0	338.0	163.0	109.0	95.0	112.0
4	TOC (%)	0.70	0.40	0.20	1.30	0.30	1.00	0.90	0.70	0.50	0.70
5	THC (mg/kg)	1.60	1.30	1.10	0.70	0.90	0.50	1.50	0.85	0.95	1.50
6	Sand (%)	96.20	97.10	98.30	98.50	97.70	97.30	98.10	96.70	97.50	98.60
7	Silt (%)	3.70	2.10	1.10	1.20	1.50	2.40	1.70	2.60	2.40	1.00
8	Clay (%)	0.10	0.80	0.60	0.30	0.80	0.30	0.20	0.70	0.10	0.40
9	Nitrate (mg/kg)	11.05	12.61	11.16	12.09	11.62	13.44	14.32	9.08	10.22	6.67
10	Ammonia(mg/kg)	7.50	8.0	6.80	8.20	7.90	8.55	17.0	29.0	24.0	26.0
11	Sulphate (mg/kg)	61.0	53.0	44.9	23.5	49.3	35.0	30.90	10.50	11.65	31.45
12	Phosphate (mg/kg)	0.32	0.50	0.30	0.28	0.15	0.25	0.37	0.40	0.53	0.45
13	Chloride (mg/kg)	164.84	175.48	127.62	95.72	138.26	523.50	304.90	3678.60	208.40	197.30
	HEAVY METALS										
14	Arsenic	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
15	Cadmium (mg/kg)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
16	Chromium (mg/kg)	0.16	0.12	0.15	0.10	0.13	0.10	0.15	0.10	0.16	0.20
17	Copper (mg/kg)	0.08	0.01	0.01	0.01	0.05	0.03	0.06	0.04	0.01	0.02
18	Iron (mg/kg)	6.36	7.18	7.11	6.22	10.82	12.80	11.76	8.33	4.35	10.12
19	Nickel (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	0.42	0.06	0.13	0.11	0.35	0.40	0.22	0.28	0.30	0.25
22	Magnesium (mg/kg)	0.09	0.06	0.13	0.10	0.05	0.18	0.13	0.07	0.04	0.15
23	Calcium (mg/kg)	0.64	0.55	0.66	0.63	0.61	1.04	1.38	1.07	1.03	1.01
24	Manganese	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

	(mg/kg)										
25	Sodium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	1.10×10^3	1.05×10^3	1.20×10^3	1.00×10^3	1.21×10^3	1.25×10^3	1.10×10^3	1.50×10^3	1.21×10^3	1.10×10^3
28	THF	3.1×10^2	3.5×10^2	2.7×10^2	4.1×10^2	3.2×10^2	1.2×10^2	2.2×10^2	1.7×10^2	1.1×10^2	1.0×10^2
29	HUF	1.1×10^1	1.0×10^1	1.05×10^1	0.5×10^1	1.2×10^1	1.0×10^1	1.5×10^1	1.2×10^1	1.5×10^1	1.2×10^1
30	HUB	6.1×10^2	4.5×10^2	6.5×10^2	3.7×10^2	3.5×10^2	7.8×10^2	3.0×10^2	3.2×10^2	5.5×10^2	5.0×10^2
31	Coliform	6.7×10^2	5.5×10^2	6.1×10^2	6.5×10^2	2.5×10^2	2.2×10^2	3.1×10^2	3.9×10^2	3.2×10^2	3.5×10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Soil Sample Results Table 1: Surface soil

S/N	PARAMETERS	SS 11 0-15 cm	SS 12 0-15cm	SS 13 0-15cm	SS 14 0-15cm	SS 15 0-15cm	SS 16 0-15cm	SS 17 0-15cm	SS 18 0-15cm	SS 19 0-15cm	SS 20 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Dark Brown	Dark	Dark Brown	Dark Brown	Dark Brown	Dark	Grey	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	8.15	8.06	8.03	8.01	8.5	7.7	8.6	7.2	7.5	6.1
3	Conductivity (µs/cm)	37.0	48.8	66.9	91.9	81.3	117.0	143.3	239.0	163.1	240.2
4	TOC (%)	0.23	0.17	0.15	0.19	0.25	0.19	0.20	0.35	0.50	0.30
5	THC (mg/kg)	0.18	0.15	0.10	0.12	0.20	0.30	0.60	0.70	0.30	0.40
6	Sand (%)	96.90	97.60	97.40	97.60	98.50	97.80	98.30	98.10	98.30	98.40
7	Silt (%)	2.80	1.90	2.40	2.10	1.30	1.50	1.30	1.20	1.10	1.30
8	Clay (%)	0.30	0.5	0.20	0.30	0.20	0.70	0.40	0.70	0.60	0.30
9	Nitrate (mg/kg)	7.0	5.0	11.1	9.50	5.0	5.90	3.20	11.0	9.50	12.30
10	Ammonia(mg/kg)	4.10	5.5	3.40	5.10	4.70	4.15	15.0	20.0	23.0	33.0
11	Sulphate (mg/kg)	14.11	13.48	19.3	11.5	29.3	35.0	40.90	20.50	21.65	17.45
12	Phosphate (mg/kg)	0.51	0.70	0.10	0.20	0.15	0.05	0.70	0.55	0.40	0.25
13	Chloride (mg/kg)	117.50	115.40	90.60	118.70	180.20	233.60	215.80	388.60	268.50	255.30
	HEAVY METALS										
14	Arsenic	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
15	Cadmium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
16	Chromium (mg/kg)	0.13	0.05	0.10	0.05	0.07	0.10	0.15	0.17	0.12	0.15
17	Copper (mg/kg)	0.20	0.10	0.10	0.15	0.12	0.09	0.07	0.05	0.05	0.07
18	Iron (mg/kg)	5.90	5.20	6.20	7.52	9.02	13.70	11.30	7.30	8.15	12.50
19	Nickel (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead (mg/kg)	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
21	Zinc (mg/kg)	0.15	0.13	0.11	0.10	0.03	0.20	0.10	0.10	0.10	0.12
22	Magnesium (mg/kg)	0.12	0.09	0.02	0.21	0.30	0.15	0.30	0.11	0.13	0.10
23	Calcium (mg/kg)	0.62	0.45	0.60	0.51	0.51	0.55	0.10	0.50	0.15	0.20
24	Manganese	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

	(mg/kg)										
25	Sodium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
26	Potassium (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Microbiology Test (cfu/g)										
27	THB	1.16×10^3	1.00×10^3	1.20×10^3	1.25×10^3	1.30×10^3	1.23×10^3	1.10×10^3	1.30×10^3	1.20×10^3	1.10×10^3
28	THF	2.8×10^2	3.1×10^2	1.0×10^2	3.5×10^2	3.2×10^2	3.1×10^2	3.1×10^2	3.5×10^2	2.2×10^2	3.2×10^2
29	HUF	1.0×10^1	1.3×10^1	2.3×10^1	2.0×10^1	2.1×10^1	2.0×10^1	2.5×10^1	2.9×10^1	3.1×10^1	4.4×10^1
30	HUB	7.5×10^2	5.5×10^2	7.1×10^2	5.2×10^2	6.1×10^2	8.8×10^2	4.3×10^2	5.0×10^2	6.1×10^2	7.2×10^2
31	Coliform	4.1×10^2	3.0×10^2	4.5×10^2	4.3×10^2	5.1×10^2	4.5×10^2	5.5×10^2	5.2×10^2	3.9×10^2	4.7×10^2

CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Soil Sample Results Table 1: Surface soil

S/N	PARAMETERS	SS 21 0-15 cm	SS 22 0-15cm	SS 23 0-15cm	SS 24 0-15cm	SS 25 0-15cm	SS 26 0-15cm	SS 27 0-15cm	SS 28 0-15cm	SS 29 0-15cm	SS 30 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Brown	Brown	Dark	Brown	Dark	Dark	Dark	Brown	Dark Brown	Brown
2	pH(soil-water ratio, 1:1)	7.51	7.46	7.54	8.01	8.06	7.92	8.09	8.06	8.02	7.15
3	Conductivity (µs/cm)	41.0	47.0	51.0	48.0	55.0	78.0	69.0	72.0	103.0	110.0
4	TOC (%)	0.14	0.21	0.31	0.40	0.35	0.50	0.30	0.20	0.10	0.25
5	THC (mg/kg)	0.60	0.65	0.50	0.45	0.60	0.50	0.60	0.70	0.40	0.65
6	Sand (%)	88.30	85.50	89.20	85.10	90.40	88.70	91.70	93.60	93.40	95.10
7	Silt (%)	11.40	13.80	10.60	14.60	8.20	10.10	7.50	5.30	5.30	3.30
8	Clay (%)	0.30	0.70	0.20	0.30	1.40	1.30	0.80	1.10	1.30	1.60
9	Nitrate (mg/kg)	6.0	4.5	5.0	5.3	6.1	6.5	6.20	8.0	8.20	7.10
10	Ammonia(mg/kg)	5.5	3.1	2.10	4.20	3.90	3.35	5.20	6.40	7.20	6.10
11	Sulphate (mg/kg)	29.5	17.0	29.9	39.9	27.3	31.0	40.60	40.10	51.09	53.40
12	Phosphate (mg/kg)	1.08	1.15	0.95	0.84	0.50	0.70	0.90	1.10	0.80	0.50
13	Chloride (mg/kg)	97.20	95.40	87.60	90.70	103.20	110.0	105.80	101.50	93.20	115.20
	HEAVY METALS										
14	Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
15	Cadmium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
16	Chromium (mg/kg)	0.30	0.10	0.20	0.10	0.20	0.10	0.10	0.30	0.10	0.20
17	Copper (mg/kg)	0.06	0.03	0.05	0.01	0.04	0.01	0.05	0.01	0.06	0.02
18	Iron (mg/kg)	62.10	68.80	57.20	86.30	80.70	82.80	75.30	79.50	85.30	70.50
19	Nickel (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	0.13	0.15	0.11	0.05	0.02	0.20	0.15	0.10	0.12	0.09
22	Magnesium (mg/kg)	0.20	0.25	0.15	0.19	0.22	0.25	0.20	0.11	0.15	0.12

23	Calcium (mg/kg)	1.22	1.37	1.40	1.30	1.41	1.45	1.35	1.47	1.20	1.32
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
25	Sodium (mg/kg)	1.22	1.44	1.85	1.01	1.11	1.30	1.16	1.09	1.20	1.15
24	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
26	THB	1.10 x 10^3	1.50 x 10^3	1.20 x 10^3	1.15 x 10^3	1.10 x 10^3	1.05 x 10^3	1.10 x 10^3	1.3 x 10^3	1.10 x 10^3	1.20 x 10^3
27	THF	3.1 x 10^2	3.5 x 10^2	3.0 x 10^2	3.2 x 10^2	3.7 x 10^2	2.1 x 10^2	2.0 x 10^2	1.5 x 10^2	2.2 x 10^2	2.5 x 10^2
28	HUF	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29	HUB	7.1 x 10^2	7.0 x 10^2	7.2 x 10^2	2.2 x 10^2	3.0 x 10^2	5.5 x 10^2	3.5 x 10^2	3.1 x 10^2	3.2 x 10^2	3.2 x 10^2
30	Coliform	3.3 x 10^2	3.0 x 10^2	3.5 x 10^2	4.1 x 10^2	2.7 x 10^2	2.2 x 10^2	5.1 x 10^2	5.1 x 10^2	3.5 x 10^2	4.4 x 10^2

Searchgate Laboratories Ltd.
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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Table 1: Surface Soil Sample Results

S/N	PARAMETERS	SS 31 0-15 cm	SS 32 0-15cm	SS 33 0-15cm	SS 34 0-15cm	SS 35 0-15cm	SS 36 0-15cm	SS 37 0-15cm	SS 38 0-15cm	SS 39 0-15cm	SS 40 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Brown	Brown	Pale cream	Dark Brown	Dark Brown	Pale Cream	Pale cream	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	7.6	7.3	7.6	7.4	7.1	6.9	7.5	7.2	7.0	7.8
3	Conductivity (µs/cm)	144	177	168	202	208	198	207	277	128	112
4	TOC (%)	0.18	0.11	0.15	0.12	0.17	0.23	0.33	0.29	0.25	0.20
5	THC (mg/kg)	0.74	0.63	0.68	0.15	0.62	0.17	0.19	0.23	0.20	0.30
6	Sand (%)	95.00	98.20	98.50	97.50	99.00	99.10	99.30	99.40	98.60	99.20
7	Silt (%)	4.60	1.70	1.50	2.40	1.00	0.70	0.60	0.50	1.20	0.50
8	Clay (%)	0.40	0.10	0.00	0.10	0.00	0.20	0.10	0.10	0.20	0.30
9	Nitrate (mg/kg)	8.30	8.18	8.23	8.03	8.76	7.26	7.62	7.38	7.50	7 .30
10	Ammonia(mg/kg)	6.50	6.7	6.80	7.20	7.90	7.35	6.0	8.0	6.0	6.0
11	Sulphate (mg/kg)	59.0	57.0	59.9	39.5	49.3	55.0	50.90	50.50	51.65	43.45
12	Phosphate (mg/kg)	1.19	1.10	1.23	1.10	1.16	1.05	1.25	1.11	1.05	1.25
13	Chloride (mg/kg)	95.40	90.60	95.10	98.30	95.70	92.70	90.84	73.50	88.30	81.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.11	0.15	0.15	0.10	0.22	0.20	0.21	0.18	0.14	0.20
17	Copper (mg/kg)	3.10	3.01	3.01	3.50	3.05	3.70	3.05	3.50	3.20	3.10
16	Iron (mg/kg)	95.2	93.1	84.40	91.60	82.90	90.80	91.30	88.50	89.35	95.50
17	Nickel (mg/kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
18	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Zinc (mg/kg)	1.10	1.05	1.13	1.09	1.01	1.11	1.01	1.03	1.05	1.03
20	Magnesium (mg/kg)	0.21	0.15	0.19	0.20	0.17	0.15	0.19	0.17	0.12	0.13
21	Calcium (mg/kg)	0.20	0.21	0.15	0.23	0.25	0.10	0.08	0.10	0.25	0.22
22	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
23	Sodium (mg/kg)	5.24	5.45	5.70	5.20	5.10	5.10	4.70	4.20	4.80	5.12
24	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
25	THB	2.61×10^3	3.10×10^3	3.22×10^3	4.10×10^3	3.35×10^3	2.27×10^3	3.20×10^3	3.35×10^3	2.25×10^3	3.15×10^3
26	THF	4.5×10^2	4.7×10^2	2.9×10^2	4.4×10^2	4.1×10^2	3.0×10^2	3.3×10^2	2.5×10^2	2.2×10^2	3.0×10^2
28	HUF	3.2×10^1	3.5×10^1	3.7×10^1	4.5×10^1	3.2 x	3.9 x	4.1×10^1	2.5 x	3.7 x	4.5 x

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						10^1	10^1		10^1	10^1	10^1
29	HUB	6.2×10^2	4.8×10^2	5.0×10^2	5.5×10^2	4.1×10^2	7.7×10^2	4.5×10^2	4.2×10^2	5.7×10^2	5.5×10^2
30	Coliform	3.0×10^2	2.1×10^2	4.5×10^2	3.5×10^2	2.2×10^2	3.0×10^2	3.2×10^2	4.2×10^2	3.2×10^2	2.5×10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Soil Sample Results Table 1: Surface soil

	PARAMETERS	SS 41 0-15 cm	SS 42 0-15cm	SS 43 0-15cm	SS 44 0-15cm	SS 45 0-15cm	SS 46 0-15cm	SS 47 0-15cm	SS 48 0-15cm	SS 49 0-15cm	SS 50 0-15cm
A	PHYSICO CHEMICAL TEST										
1	Appearance	Dark Brown	Brown	Dark	Pale cream	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	4.1	5.3	5.9	5.1	5.02	5.10	5.5	5.9	5.7	5.3
3	Conductivity (µs/cm)	112	72	88.0	67	62	68	57	62	116	134
4	TOC (%)	0.26	0.29	0.22	0.27	0.31	0.41	0.33	0.36	0.16	0.21
5	THC (mg/kg)	0.27	0.22	0.31	0.31	0.29	0.22	0.25	0.23	0.20	0.33
6	Sand (%)	98.30	98.50	99.00	99.30	98.10	99.00	98.20	98.60	98.30	98.70
7	Silt (%)	1.60	1.20	1.00	0.60	1.40	0.70	1.70	1.10	1.50	1.00
8	Clay (%)	0.10	0.30	0.00	0.10	0.50	0.30	0.10	0.30	0.20	0.30
9	Nitrate (mg/kg)	6.7	6.77	5.92	5.83	10.0	6.17	7.43	9.03	11.33	10.71
10	Ammonia(mg/kg)	11.50	13.7	11.80	14.20	12.90	12.35	9.0	12.0	12.0	13.0
11	Sulphate (mg/kg)	12.66	11.76	12.44	11.02	12.77	14.31	12.39	11.9	12.17	11.09
12	Phosphate (mg/kg)	7.0	9.5	5.0	3.5	9.00	7.02	7.40	6.50	7.20	6.50
13	Chloride (mg/kg)	84.60	145.40	97.65	109.70	105.30	152.60	87.84	88.60	98.50	74.70
	HEAVY METALS										
14	Arsenic (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.12	0.10	0.11	0.12	0.15	0.13	0.09	0.07	0.10	0.15
17	Copper (mg/kg)	3.10	3.05	3.01	2.50	2.30	2.10	2.05	2.10	3.20	3.00
18	Iron (mg/kg)	69.40	60.18	57.50	81.65	80.90	82.80	71.40	69.30	65.40	50.65
19	Nickel (mg/kg)	0.03	0.03	0.02	0.01	0.01	0.05	0.01	0.03	0.03	0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	2.12	2.19	1.17	1.15	1.30	1.20	1.30	1.18	1.31	2.09
22	Magnesium (mg/kg)	1.35	1.28	1.21	1.25	1.55	1.65	1.60	1.53	1.33	1.25
23	Calcium (mg/kg)	0.91	0.95	0.92	0.89	0.84	0.88	0.90	1.29	1.26	1.22
24	Manganese (mg/kg)	1.05	1.00	1.03	1.10	1.01	1.30	1.30	1.17	1.25	1.50
25	Sodium (mg/kg)	2.77	3.03	2.30	2.36	2.55	2.86	2.57	2.75	2.90	2.65
26	Potassium (mg/kg)	<0.002	<0.002	<0.00	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

				2							
	Microbiology Test (cfu/g)										
27	THB	1.40 x 10^3	1.35 x 10^3	1.30 x 10^3	1.25 x 10^3	1.20 x 10^3	1.10 x 10^3	1.20 x 10^3	1.10 x 10^3	1.09 x 10^3	1.05 x 10^3
28	THF	2.6 x 10^2	2.5 x 10^2	1.85 x 10^2	4.5 x 10^2	3.5 x 10^2	2.5 x 10^2	3.2 x 10^2	2.7 x 10^2	1.5 x 10^2	1.3 x 10^2
29	HUF	1.5 x 10^1	1.2 x 10^1	1.5 x 10^1	1.15 x 10^1	2.5 x 10^1	2.3 x 10^1	2.0 x 10^1	2.3 x 10^1	1.1 x 10^1	2.1 x 10^1
30	HUB	1.5 x 10^2	1.7 x 10^2	1.2 x 10^2	1.1 x 10^2	1.0 x 10^2	1.10 x 10^2	1.3 x 10^2	1.05 x 10^2	1.25 x 10^2	1.10 x 10^2
31	Coliform	3.0 x 10^2	3.2 x 10^2	3.5 x 10^2	2.0 x 10^2	2.5 x 10^2	3.05 x 10^2	2.10 x 10^2	1.5 x 10^2	1.0 x 10^2	1.1 x 10^2

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SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Table 2: Sub-Surface Soil Sample Results

S/N	PARAMETERS	SS 1 15 - 30 cm	SS 2 15 - 30 cm	SS 3 15 - 30 cm	SS 4 15 - 30 cm	SS 5 15 - 30 cm	SS 6 15 - 30 cm	SS 7 15 - 30 cm	SS 8 15 - 30 cm	SS 9 15 - 30 cm	SS 10 15 - 30 cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	8.19	8.14	8.16	8.21	8.18	8.09	8.06	8.21	8.08	8.21
3	Conductivity (µs/cm)	334	275	247	298	291	249	295	239	225	262
4	TOC (%)	0.59	0.27	0.24	0.22	0.27	0.32	0.24	0.29	0.36	0.23
5	THC (mg/kg)	0.15	0.13	0.35	0.20	0.10	0.14	0.11	0.09	0.18	0.21
6	Sand (%)	97.10	97.60	98.50	98.80	98.30	98.70	98.50	98.20	98.10	97.80
7	Silt (%)	2.30	2.10	1.20	1.10	1.50	1.20	1.30	1.20	1.60	2.00
8	Clay (%)	0.60	0.30	0.30	0.10	0.20	0.10	0.20	0.60	0.30	0.20
9	Nitrate (mg/kg)	8.5	7.8	8.70	8.5	8.0	7.90	8.20	8.3	7.50	8.30
10	Ammonia(mg/kg)	4.50	4.7	2.80	4.20	3.90	5.35	10.0	21.0	17.0	11.0
11	Sulphate (mg/kg)	50.0	42.0	49.9	45.5	40.3	42.0	35.90	37.50	16.70	15.50
12	Phosphate (mg/kg)	0.25	0.50	0.52	0.48	0.37	0.45	0.39	0.53	0.45	0.45
13	Chloride (mg/kg)	107.20	115.50	97.60	101.20	133.60	123.50	114.90	129.60	120.40	117.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.05	0.10	0.05	0.10	0.12	0.10	0.12	0.15	0.12	0.15
17	Copper (mg/kg)	1.01	1.50	1.10	1.30	1.11	1.12	2.10	2.05	1.70	1.75
18	Iron (mg/kg)	37.73	38.08	37.10	36.02	30.02	41.15	31.06	58.30	55.55	30.80
19	Nickel (mg/kg)	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.01	0.01	0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	1.50	1.15	1.17	1.25	1.20	1.25	1.30	1.40	1.15	1.15
22	Magnesium (mg/kg)	0.20	0.22	0.18	0.20	0.15	0.20	0.10	0.20	0.17	0.15

23	Calcium (mg/kg)	1.12	1.10	1.13	1.17	1.15	1.20	1.22	1.25	1.30	1.35
24	Manganese (mg/kg)	1.05	1.55	1.01	1.10	1.50	1.30	1.20	1.50	1.10	1.05
25	Sodium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	1.30×10^3	1.10×10^3	1.25×10^3	1.20×10^3	1.30×10^3	1.10×10^3	1.15×10^3	1.40×10^3	1.30×10^3	1.20×10^3
28	THF	4.2×10^2	4.5×10^2	2.0×10^2	3.5×10^2	5.0×10^2	3.0×10^2	4.1×10^2	3.5×10^2	2.0×10^2	1.1×10^2
29	HUF	2.5×10^1	3.1×10^1	3.0×10^1	3.2×10^1	3.5×10^1	3.0×10^1	3.7×10^1	3.3×10^1	2.9×10^1	2.7×10^1
30	HUB	8.0×10^2	7.7×10^2	6.9×10^2	5.5×10^2	6.0×10^2	7.2×10^2	4.0×10^2	5.0×10^2	6.5×10^2	6.0×10^2
31	Coliform	6.1×10^2	6.5×10^2	7.0×10^2	6.0×10^2	4.1×10^2	3.2×10^2	5.1×10^2	6.2×10^2	5.5×10^2	4.5×10^2

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Table 2: Sub - Surface soil sample Results

S/	PARAMETERS	SS 11 15 - 30 cm	SS 12 15 - 30 cm	SS 13 15 - 30 cm	SS 14 15 - 30 cm	SS 15 15 - 30 cm	SS 16 15 - 30 cm	SS 17 15 - 30 cm	SS 18 15 - 30 cm	SS 19 15 - 30 cm	SS 20 15 - 30 cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Pale Brown	Dark Brown	Dark	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Pale Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	5.1	5.3	5.9	5.4	5.6	5.9	5.5	4.9	4.7	4.9
3	Conductivity (µs/cm)	50.5	51.8	65.9	50.9	59.3	57.0	55.3	53.0	53.1	55.2
4	TOC (%)	0.80	0.75	0.85	0.65	0.89	0.90	0.50	0.60	0.70	0.65
5	THC (mg/kg)	0.21	0.19	0.15	0.10	0.20	0.11	0.14	0.12	0.17	0.11
6	Sand (%)	96.70	95.60	97.40	98.60	99.30	90.40	86.50	88.10	87.10	91.60
7	Silt (%)	3.00	3.70	2.40	1.30	0.50	8.50	12.50	11.30	18.20	8.10
8	Clay (%)	0.30	0.70	0.20	0.10	0.20	1.10	1.00	0.60	0.70	0.40
9	Nitrate (mg/kg)	6.5	4.0	4.8	7.1	6.2	5.5	5.10	5.9	5.5	6.5
10	Ammonia(mg/kg)	4.50	4.7	2.80	5.50	5.90	4.35	7.0	11.0	13.0	7.0
11	Sulphate (mg/kg)	35.5	30.0	27.3	22.5	29.3	35.0	40.90	41.50	31.65	26.45
12	Phosphate (mg/kg)	0.12	0.10	0.15	0.26	0.17	0.25	0.31	0.27	0.20	0.25
13	Chloride (mg/kg)	219.50	208.40	198.60	228.70	280.20	223.60	305.80	278.60	238.50	215.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
16	Chromium (mg/kg)	0.15	0.10	0.12	0.10	0.25	0.21	0.30	0.21	0.20	0.22
17	Copper (mg/kg)	1.07	1.05	1.09	1.05	1.01	0.07	1.05	1.03	1.02	1.02
18	Iron (mg/kg)	89.0	83.50	85.60	79.82	81.12	85.50	89.30	86.30	75.15	80.50
19	Nickel (mg/kg)	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.01
20	Lead (mg/kg)	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
21	Zinc (mg/kg)	0.15	0.13	0.11	0.10	0.15	0.20	0.10	0.11	0.10	0.15
22	Magnesium (mg/kg)	0.40	0.22	0.15	0.12	0.31	0.13	0.17	0.20	0.54	0.16

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23	Calcium (mg/kg)	1.1	1.3	1.8	1.9	1.38	1.41	1.40	1.35	1.24	1.39
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
25	Sodium (mg/kg)	1.72	1.55	1.50	1.60	1.45	1.40	1.65	1.25	1.70	1.20
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	1.25×10^3	1.10×10^3	1.30×10^3	1.20×10^3	1.35×10^3	1.32×10^3	1.4×10^3	1.33×10^3	1.25×10^3	1.09×10^3
28	THF	2.2×10^2	2.0×10^2	2.15×10^2	4.05×10^2	4.20×10^2	4.25×10^2	3.2×10^2	4.1×10^2	2.2×10^2	4.5×10^2
29	HUF	2.1×10^1	2.0×10^1	3.0×10^1	3.2×10^1	2.1×10^1	2.5×10^1	2.0×10^1	3.1×10^1	3.40×10^1	4.20×10^1
30	HUB	2.5×10^2	2.0×10^2	3.1×10^2	3.5×10^2	3.2×10^2	4.5×10^2	2.5×10^2	2.0×10^2	2.5×10^2	3.1×10^2
31	Coliform	1.1×10^2	1.0×10^2	1.2×10^2	1.5×10^2	2.0×10^2	1.8×10^2	1.9×10^2	1.0×10^2	2.1×10^2	2.2×10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Soil Sample Results Table 2: Sub-Surface soil

S/N	PARAMETERS	SS 21 15 - 30 cm	SS 22 15 - 30 cm	SS 23 15 - 30 cm	SS 24 15 - 30 cm	SS 25 15 - 30 cm	SS 26 15 - 30 cm	SS 27 15 - 30 cm	SS 28 15 - 30 cm	SS 29 15 - 30 cm	SS 30 15 - 30 cm
A	PHYSICO CHEMICAL TEST										
1	Appearance	Brown	Brown	Dark Brown	Brown	Brown	Dark	Dark	Brown	Pale Brown	Pale Brown
2	pH(soil-water ratio, 1:1)	7.61	7.65	7.54	8.09	8.11	8.14	8.04	8.03	8.16	8.06
3	Conductivity (µs/cm)	36	44	51	48	57	49	66	68	108	102
4	TOC (%)	0.14	0.17	0.19	0.27	0.32	0.39	0.33	0.28	0.25	0.29
5	THC (mg/kg)	0.12	0.15	0.70	0.60	0.40	0.42	0.10	0.16	0.35	0.30
6	Sand (%)	97.10	97.70	97.30	97.60	97.40	97.20	96.80	98.50	98.70	98.20
7	Silt (%)	2.20	1.80	2.60	2.10	1.20	1.60	2.50	1.30	1.10	1.30
8	Clay (%)	0.70	0.50	0.10	0.30	1.40	1.20	0.70	0.20	0.20	0.50
9	Nitrate (mg/kg)	10.0	8.0	3.70	8.5	6.0	7.90	4.20	11.0	5.50	8.30
10	Ammonia(mg/kg)	5.50	6.7	4.80	6.20	5.90	5.35	5.20	5.00	4.90	5.60
11	Sulphate (mg/kg)	9.5	7.0	9.9	9.5	9.3	5.0	0.90	0.50	1.65	1.45
12	Phosphate (mg/kg)	1.89	1.80	0.90	1.74	1.10	1.20	0.80	0.70	0.60	0.50
13	Chloride (mg/kg)	35.80	105.40	47.60	90.70	108.20	125.0	134.80	178.50	138.20	114.20
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.20	0.10	0.10	0.10	0.20	0.20	0.10	0.10	0.10	0.20
17	Copper (mg/kg)	3.20	3.10	2.20	2.80	2.50	3.02	1.05	1.03	2.01	2.01
18	Iron (mg/kg)	82.30	88.18	87.40	86.60	50.90	72.85	61.36	59.30	55.40	50.50
19	Nickel (mg/kg)	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	1.32	1.02	1.07	1.05	0.29	0.58	0.52	0.38	0.51	0.29
22	Magnesium (mg/kg)	0.19	0.13	0.10	0.11	0.15	0.13	0.10	0.12	0.12	0.10

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23	Calcium (mg/kg)	1.11	1.10	1.24	1.20	1.01	1.05	1.15	1.19	1.05	1.02
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
25	Sodium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Potassium (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Microbiology Test (cfu/g)										
27	THB	1.25×10^3	1.30×10^3	1.20×10^3	1.32×10^3	1.22×10^3	1.15×10^3	1.10×10^3	1.30×10^3	1.24×10^3	1.50×10^3
28	THF	2.5×10^2	2.9×10^2	2.8×10^2	3.0×10^2	2.5×10^2	1.5×10^2	2.3×10^2	2.5×10^2	1.5×10^2	2.2×10^2
29	HUF	1.0×10^1	1.3×10^1	2.3×10^1	1.5×10^1	2.1×10^1	1.1×10^1	2.5×10^1	3.3×10^1	1.4×10^1	2.1×10^1
30	HUB	6.5×10^2	5.9×10^2	6.5×10^2	2.5×10^2	5.1×10^2	6.8×10^2	3.9×10^2	4.2×10^2	5.8×10^2	5.4×10^2
31	Coliform	5.3×10^2	5.0×10^2	5.5×10^2	4.3×10^2	2.5×10^2	1.3×10^2	5.1×10^2	3.8×10^2	4.5×10^2	4.1×10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.
Table 2: Sub - Surface Soil Sample Results

S/N	PARAMETERS	SS 31 0-15 cm	SS 32 0-15cm	SS 33 0-15cm	SS 34 0-15cm	SS 35 0-15cm	SS 36 0-15cm	SS 37 0-15cm	SS 38 0-15cm	SS 39 0-15cm	SS 40 0-15cm
A	PHYSICO CHEMICAL TEST										
1	Appearance	Pale Cream	Brown	Brown	Dark Brown	Dark Brown	Dark Brown	Dark	Grey	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	7.5	7.7	7.8	7.5	7.4	7.9	7.7	7.6	7.9	7.6
3	Conductivity (µs/cm)	190.0	158.0	165.9	98.9	87.5	138.0	123.3	179.0	193.10	150.20
4	TOC (%)	0.50	0.45	0.30	0.15	0.29	0.50	0.55	0.20	0.10	0.15
5	THC (mg/kg)	0.20	0.12	0.10	0.10	0.005	0.15	0.22	0.20	0.25	0.20
6	Sand (%)	96.40	96.10	96.60	97.90	97.50	97.60	97.80	97.30	98.30	98.60
7	Silt (%)	2.20	3.80	2.40	1.20	2.40	2.10	1.70	2.00	0.80	1.10
8	Clay (%)	1.40	0.10	1.00	0.90	0.10	0.30	0.50	0.70	0.90	0.30
9	Nitrate (mg/kg)	4.0	6.0	3.30	5.5	3.0	4.50	3.20	7.0	3.50	3.30
10	Ammonia(mg/kg)	3.50	2.7	3.80	5.20	3.90	4.35	4.0	3.0	3.0	4.0
11	Sulphate (mg/kg)	35.0	27.0	29.9	19.5	12.3	31.0	20.90	30.50	41.65	21.45
12	Phosphate (mg/kg)	0.18	0.15	0.13	0.10	0.16	0.15	0.15	0.11	0.12	0.25
13	Chloride (mg/kg)	65.40	60.60	65.10	68.30	65.70	72.70	60.84	63.50	78.30	71.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.10	0.02	0.01	0.05	0.10	0.05	0.10	0.21	0.12	0.10
17	Copper (mg/kg)	1.10	1.01	1.01	1.50	2.05	1.70	1.05	1.20	1.10	1.10
18	Iron (mg/kg)	67.36	78.18	87.40	66.62	80.92	55.85	86.36	73.33	75.35	70.52
19	Nickel (mg/kg)	0.02	0.01	0.02	0.02	0.01	0.02	0.01	0.02	0.02	0.02
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	0.11	0.10	0.12	0.11	0.10	0.11	0.09	0.11	0.05	0.10
22	Magnesium (mg/kg)	0.05	0.03	0.05	0.10	0.05	0.03	0.05	0.03	0.01	0.02
23	Calcium (mg/kg)	0.20	0.21	0.13	0.17	0.19	0.05	0.03	0.02	0.10	0.15
24	Manganese	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

	(mg/kg)										
25	Sodium (mg/kg)	14.24	14.45	13.70	13.20	13.10	14.10	13.70	14.20	13.80	14.12
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	1.66×10^3	2.15×10^3	2.20×10^3	3.08×10^3	2.33×10^3	1.25×10^3	2.10×10^3	2.37×10^3	1.24×10^3	2.14×10^3
28	THF	3.6×10^2	3.9×10^2	1.8×10^2	3.5×10^2	3.2×10^2	2.1×10^2	2.5×10^2	1.7×10^2	1.4×10^2	1.2×10^2
29	HUF	3.0×10^1	3.3×10^1	3.5×10^1	4.3×10^1	3.1×10^1	3.7×10^1	3.9×10^1	2.0×10^1	3.4×10^1	4.1×10^1
30	HUB	7.2×10^2	5.8×10^2	6.0×10^2	6.5×10^2	5.1×10^2	8.7×10^2	5.5×10^2	5.2×10^2	6.7×10^2	6.5×10^2
31	Coliform	3.0×10^2	2.0×10^2	4.0×10^2	4.5×10^2	3.2×10^2	2.9×10^2	3.6×10^2	4.7×10^2	3.5×10^2	2.7×10^2

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CLIENT: **Global Environmental Limited**
SAMPLE TYPE: **Soil**
DATE OF RECEIPT: **22nd February, 2021.**
PERIOD OF ANALYSIS: **25th February – 12th March, 2021.**
QA/QC CHECK DATE: **16th March, 2021.**

Soil Sample Results Table 2: Sub-Surface soil

	PARAMETERS	**SS 41 15-30 cm**	**SS 42 15-30 cm**	**SS 43 15-30cm**	**SS 44 15-30cm**	**SS 45 15-30cm**	**SS 46 15-30cm**	**SS 47 15-30cm**	**SS 48 15-30cm**	**SS 49 15-30cm**	**SS 50 15-30cm**
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Brown	Dark	Pale cream	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	5.1	5.3	5.9	5.1	5.02	5.10	5.5	5.9	5.7	5.3
3	Conductivity (µs/cm)	134	125	94.0	118	103	88	63	80	93	80
4	TOC (%)	0.26	0.30	0.35	0.20	0.28	0.31	0.29	0.26	0.16	0.21
5	THC (mg/kg)	0.20	0.19	0.30	0.35	0.21	0.10	0.17	0.15	0.31	0.20
6	Sand (%)	98.20	98.50	99.30	97.40	98.70	99.10	99.00	98.70	98.80	99.60
7	Silt (%)	1.40	1.00	0.50	2.00	1.20	0.80	0.80	1.30	1.10	0.30
8	Clay (%)	0.40	0.50	0.20	0.60	0.10	0.20	0.20	0.00	0.10	0.10
9	Nitrate (mg/kg)	6.0	9.0	4.0	5.0	9.0	4.0	3.0	7.0	5.0	9.0
10	Ammonia(mg/kg)	11.50	13.7	12.90	17.20	12.90	11.35	10.0	14.0	13.0	17.0
11	Sulphate (mg/kg)	24.0	50.0	41.0	35.0	30.0	45.0	40.0	32.0	39.0	43.0
12	Phosphate (mg/kg)	7.0	9.5	5.0	3.5	9.00	9.02	9.40	8.50	8.20	7.50
13	Chloride (mg/kg)	104.60	125.40	110.65	102.70	105.30	142.60	118.84	98.60	95.50	74.70
	HEAVY METALS										
14	Arsenic (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
15	Cadmium (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16	Chromium (mg/kg)	0.15	0.11	0.10	0.11	0.13	0.15	0.03	0.05	0.005	0.11
17	Copper (mg/kg)	1.30	1.11	1.05	1.10	1.50	1.30	1.05	1.70	1.30	1.10
18	Iron (mg/kg)	97.40	78.18	67.50	86.65	90.90	92.80	81.40	89.30	85.40	80.65
19	Nickel (mg/kg)	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	1.52	1.09	1.17	1.15	1.30	1.10	1.35	1.28	1.31	1.29
22	Magnesium (mg/kg)	1.07	1.03	1.01	1.07	1.13	1.15	1.10	1.13	1.03	1.02
23	Calcium (mg/kg)	0.91	0.85	0.82	0.79	0.84	0.88	0.70	1.09	1.06	1.10
24	Manganese (mg/kg)	1.05	1.00	1.03	0.50	1.01	1.50	1.30	1.25	1.50	1.70
25	Sodium (mg/kg)	4.50	4.03	4.30	4.35	4.55	3.86	3.57	3.75	3.90	3.65
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.003	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	0.25×10^3	0.20×10^3	0.10×10^3	0.22×10^3	0.15×10^3	0.20×10^3	0.21×10^3	0.12×10^3	1.11×10^3	0.50×10^3
28	THF	1.3×10^2	1.5×10^2	1.7×10^2	2.1×10^2	1.1×10^2	1.0×10^2	1.05×10^2	1.15×10^2	1.10×10^2	1.2×10^2
29	HUF	1.1×10^1	0.9×10^1	0.5×10^1	1.15×10^1	2.5×10^1	2.3 x	2.1 x	2.4 x	2.0×10^1	2.1×10^1

							10^1	10^1	10^1		
30	HUB	1.0×10^2	1.1×10^2	0.5×10^2	1.1×10^2	0.5×10^2	1.5×10^2	1.1×10^2	0.9×10^2	1.03×10^2	1.05×10^2
31	Coliform	2.0×10^2	2.2×10^2	2.5×10^2	2.0×10^2	2.1×10^2	1.05×10^2	0.10×10^2	1.1×10^2	0.5×10^2	1.0×10^2

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16th March, 2021.

The Managing Director,
Global Environmental Limited,
Lagos.

Dear Sir,

ANALYSIS RESULT

Please find attached the results of the analysis of Water, Soil and Sediment samples received on the 22nd of February, 2021.

Thank you.

Yours faithfully,

Tolu Adeniyi
Searchgate Lab. Ltd

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CLIENT: **Global Environmental Limited**
SAMPLE TYPE: **Fresh Water**
DATE OF RECEIPT: **22nd February, 2021.**
PERIOD OF ANALYSIS: **25th February – 12th March, 2021.**
QA/QC CHECK DATE: **16th March, 2021.**

Fresh Water Sample Results Table 1:

S/N	PARAMETERS	LW 1	LW 2	LW 3	LW 4	LW 5	LW 6	LW 7
A	**PHYSICO CHEMICAL TEST**							
1	Temp (^oC)	30.04	30.23	30.05	30.15	30.43	30.88	31.47
2	pH	7.76	6.94	7.21	7.08	6.96	6.88	6.94
3	Conductivity(mS/cm)	0.180	0.136	0.274	0.250	0.264	0.252	0.250
4	Turbidity (NTU)	12.7	10.1	14.6	8.15	9.87	10.1	16.5
5	DO (mg/L)	15.74	15.25	10.05	11.89	11.87	15.05	14.71
6	TDS (g/L))	0.111	0.081	0.178	0.161	0.172	0.162	0.161
7	Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	BOD (mg/L)	6.40	6.20	6.10	6.30	6.60	7.30	7.50
9	COD (mg/L)	25.0	21.0	23.0	20.0	27.0	26.0	32.0
10	Chloride (mg/L)	109.90	105.20	101.10	107.30	103.50	102.60	106.35
11	Alkalinity (mg/L)	16.0	12.0	14.0	11.0	8.0	13.0	10.0
12	Nitrate (mg/L)	4.40	4.10	3.70	4.20	3.60	11.90	13.70
13	Phosphate (mg/L)	0.04	0.02	0.01	0.01	0.02	0.01	0.02
14	Sulphate (mg/L)	15.0	12.0	10.0	9.0	11.0	8.0	13.0
15	Total Hardness(mg/L)	45.0	40.0	43.0	44.0	39.0	35.0	42.0
16	Ammonia-Nitrogen (mg/L)	0.21	0.17	0.20	0.15	0.30	0.27	0.36
17	Calcium (mg/L)	9.02	8.12	8.33	7.85	8.40	8.37	8.42
18	Magnesium (mg/L)	4.06	4.01	3.50	3.60	3.40	3.70	3.79
19	THC (mg/L)	4.02	3.80	3.60	2.30	2.66	2.71	2.80
B	**Heavy Metals (mg/L)**							
20	Sodium	18.80	15.30	17.42	14.85	11.20	11.91	12.48
21	Potassium	0.62	0.55	0.51	0.60	0.35	0.31	0.41
22	Iron	0.060	0.030	0.010	0.040	0.105	0.101	0.110
23	Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Manganese	0.261	0.240	0.237	0.250	0.137	0.141	0.156
25	Zinc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Nickel	0.036	0.021	0.030	0.026	0.032	0.050	0.054
27	Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
28	Copper	0.008	0.005	0.003	0.001	0.010	0.006	0.014
29	Chromium	0.051	0.045	0.041	0.035	0.027	0.022	0.030
30	Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
C	**Microbiology Test (CFU/ml)**							
31	THB	1.83×10^2	1.71×10^2	1.80×10^2	1.75×10^2	1.65×10^2	1.50×10^2	1.51×10^2
32	THF	2.2×10^1	2.2×10^1	2.0×10^1	2.1×10^1	1.80×10^1	1.20×10^1	1.0×10^1
33	HUB	1.35×10^2	1.31×10^2	1.25×10^2	1.30×10^2	1.15×10^2	1.05×10^2	1.17×10^2
34	HUF	ND	ND	ND	ND	ND	ND	ND
35	Coliforms	4.2×10^1	4.1×10^1	4.0×10^1	3.5×10^1	3.7×10^1	3.2×10^1	3.1×10^1

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Marine Water
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Marine Water Sample Results Table 2:

S/N	PARAMETERS	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7
A	**PHYSICO CHEMICAL TEST**							
1	Temp (^{0}C)	29.22	29.10	29.43	29.34	29.38	29.06	29.49
2	pH	8.72	8.74	8.77	8.81	8.83	8.71	8.90
3	Conductivity (mS/cm)	92.7	93.3	96.3	93.3	93.6	95.0	97.1
4	Turbidity (NTU)	28.6	21.7	24.0	29.7	18.2	23.9	27.4
5	DO (mg/L)	7.26	7.98	5.85	7.18	8.08	8.38	7.08
6	TDS (g/L))	55.6	56.0	56.0	56.0	56.2	52.0	56.3
7	Salinity (ppt)	66.6	67.1	67.1	67.1	67.3	63.0	60.8
8	BOD	7.80	10.60	8.20	7.50	8.50	9.0	9.80
9	COD	625	550	630	650	690	670	650
10	Chloride (mg/L)	12994.0	12300.0	13500.0	14500.0	13350.0	14150.0	13350.0
11	Alkalinity (mg/L)	87.2	83.6	85.8	74.4	89.3	81.5	86.8
12	Nitrate (mg/L)	0.8	0.6	0.8	0.8	0.6	0.8	1.0
13	Phosphate (mg/L)	0.15	0.10	0.10	0.10	0.20	0.20	0.20
14	Sulphate (mg/L)	316.0	346.0	322.0	440.0	474.0	494.0	454.0
15	Ammonia-Nitrogen (mg/L)	0.61	0.65	0.75	0.63	0.73	0.80	0.82
16	Total Hardness (mg/L)	15.1	9.8	10.6	8.50	9.90	11.8	10.9
17	THC (mg/L)	0.12	0.17	0.20	0.30	0.15	0.25	0.19
18	Calcium (mg/L)	0.80	0.55	0.60	0.50	0.60	0.70	0.62
B	**Heavy Metals (mg/L)**							
19	Iron	0.35	0.43	0.70	0.55	0.47	0.62	0.59
20	Manganese	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21	Zinc	0.10	0.12	0.05	<0.001	<0.001	0.05	0.05
22	Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
23	Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Copper	0.20	0.15	0.10	0.16	0.20	0.10	0.15
25	Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Nickel	1.71	1.55	1.20	1.25	1.60	1.50	1.35
27	Lead	<0.03	<0.03	<0.01	<0.03	<0.01	<0.01	<0.02
28	Magnesium	7.80	6.70	5.80	5.50	5.70	7.50	7.60
29	Sodium	35.90	37.50	39.60	35.20	37.10	36.50	36.20
30	Potassium	0.85	0.80	0.71	0.62	0.50	0.65	0.65
C	**Microbiology Test (cfu/ml)**							
31	THB	6.5×10^2	5.7×10^2	5.1×10^2	5.3×10^2	5.0×10^2	3.5×10^2	4.5×10^2
32	Coliform	2.1×10^1	1.5×10^1	2.2×10^1	2.5×10^1	2.0×10^1	3.1×10^1	2.7×10^1
33	HUF	3.0×10^1	2.5×10^1	1.1×10^1	2.1×10^1	2.3×10^1	2.5×10^1	2.0×10^1
34	HUB	2.5×10^1	3.5×10^1	2.9×10^1	2.7×10^1	1.8×10^1	3.2×10^1	2.5×10^1
35	THF	1.5×10^1	2.5×10^1	2.6×10^1	1.3×10^1	2.5×10^1	2.1×10^1	2.6×10^1

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Groundwater
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Ground Water Sample Results Table 3:

S/N	PARAMETERS	OKU 1	OKU 2	ALA 1	ALA 2	IDO 1	IDO 2	ITO 1	ITO 2	OKE 1	OKE 2	MAG 1	MAG 2	LEK 1	LEK 2
A	**PHYSICO CHEMICAL TEST**														
1	Temp (^{0}C)	28.89	27.90	28.97	28.84	29.38	29.40	32.00	28.71	29.30	28.20	29.35	30.10	29.40	29.25
2	pH	7.85	6.64	6.49	6.02	5.77	5.79	6.38	6.48	6.60	6.40	7.51	7.90	8.10	7.80
3	Conductivity(mS/cm)	0.113	0.044	0.058	0.045	0.145	0.267	0.039	0.096	0.061	0.141	0.166	0.159	0.197	0.139
4	Turbidity (NTU)	8.32	6.28	2.71	0.94	1.27	5.93	6.00	10.6	10.80	7.90	7.50	14.13	12.7	9.80
5	DO (mg/L)	12.28	15.45	13.25	12.41	13.58	15.07	19.09	17.74	18.51	9.50	10.35	11.20	8.35	9.80
6	TDS (g/L))	0.074	0.023	0.036	0.027	0.088	0.161	0.023	0.061	0.071	0.085	0.105	0.065	0.105	0.066
7	Salinity(ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	BOD	4.2	4.9	4.6	4.0	4.7	4.8	4.5	3.9	6.8	6.1	4.1	5.7	3.8	3.6
9	COD	112	121	119	114	119	125	220	150	250	136	145	135	149	133
10	Chloride (mg/L)	72.44	68.12	66.09	71.81	85.20	83.71	65.11	62.91	50.10	62.25	75.11	61.09	60.50	68.30
11	Nitrate (mg/L)	0.20	1.20	0.60	1.90	1.20	1.20	1.60	1.40	1.30	1.10	1.20	1.40	1.70	1.50
12	Phosphate (mg/L)	0.55	0.49	0.40	0.30	0.50	0.35	0.71	0.65	0.45	0.30	0.30	0.15	0.80	0.75
13	Sulphate (mg/L)	24.2	26.5	23.1	22.8	12.2	23.4	21.16	21.25	23.2	22.8	15.20	12.30	13.92	13.90
14	Total Hardness (mg/L)	1.50	1.62	1.53	1.65	1.41	1.32	0.80	0.55	6.120	6.101	0.060	0.067	0.74	0.71
15	THC (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16	Calcium (mg/L)	0.61	0.82	0.88	0.79	0.68	0.61	0.53	0.50	0.10	0.05	0.15	0.30	0.20	0.60
B	**Heavy Metals (mg/L)**														
17	Iron	0.07	0.10	0.15	0.14	0.15	0.13	0.01	0.10	0.10	0.15	0.12	0.05	0.10	0.15

18	Manganese	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
19	Zinc	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
20	Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21	Chromium	0.002	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001
22	Copper	0.045	0.057	0.065	0.055	0.035	0.049	0.055	0.063	0.071	0.069	0.051	0.051	0.071	0.083
23	Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Nickel	0.421	0.51	0.45	0.24	0.11	0.22	0.18	0.30	0.031	0.050	0.141	0.61	0.37	0.35
25	Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Magnesium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
27	Sodium	25.30	22.60	16.95	23.50	20.30	19.90	20.50	17.80	22.60	18.70	25.50	19.80	23.60	19.70
28	Potassium	0.90	0.81	0.52	0.70	0.61	0.85	0.75	0.82	0.72	0.91	0.77	0.62	0.83	0.81
C	**Microbiology Test (cfu/ml)**														
29	THB	2.1 x 10^2	3.2 x 10^2	2.0 x 10^2	1.1 x 10^2	1.0 x 10^2	2.1 x 10^2	1.5 x 10^2	2.1 x 10^2	1.0 x 10^2	2.0 x 10^2	3.5 x 10^2	3.1 x 10^2	2.0 x 10^2	1.0 x 10^2
30	Coliform	1.1 x 10^1	2.1 x 10^1	2.2 x 10^1	3.5 x 10^1	1.5 x 10^1	3.5 x 10^1	3.1 x 10^1	2.3 x 10^1	2.0 x 10^1	1.7.1 x 10^1	1.9 x 10^1	1.2 x 10^1	1.62 x 10^1	2.0 x 10^1
31	HUF	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
32	HUB	2.3 x 10^1	1.5 x 10^1	1.3 x 10^1	1.0 x 10^1	2.1 x 10^1	1.7 x 10^1	1.5 x 10^1	2.2 x 10^1	1.0 x 10^1	2.7 x 10^1	2.05 x 10^1	1.15 x 10^1	1.35 x 10^1	2.2 x 10^1
33	THF	2.5 x 10^1	2.7 x 10^1	1.0 x 10^1	1.0 x 10^1	1.5 x 10^1	1.5 x 10^1	1.05 x 10^1	1.0 x 10^1	1.1 x 10^1	0.5 x 10^1	0.5 x 10^1	1.1 x 10^1	1.0 x 10^1	1.0 x 10^1

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Sediment
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Fresh water Sediment Sample Results Table 4:

S/N	PARAMETERS	BS 1	BS 2	BS 3	BS 4	BS 5	BS 6	BS 7
A	**PHYSICO CHEMICAL TEST**							
1	Appearance	Dark Black	Dark Brown	Black	Black	Black	Black	Dark Black
2	pH (ratio 1:1,soil-water)	5.54	5.50	5.60	5.52	5.61	5.65	5.67
3	Conductivity (µs/cm)	323.0	283.0	311.0	279.0	171.0	181.0	187.6
4	TOC (%)	1.72	1.55	1.47	1.65	1.71	1.63	1.83
5	Sand (%)	29.90	29.30	28.60	28.20	25.60	23.50	23.70
6	Silt (%)	32.60	32.20	31.70	33.50	36.40	37.20	38.40
7	Clay (%)	37.50	38.50	39.70	38.30	38.00	39.30	37.90
8	THC (mg/kg)	169.97	155.62	160.85	164.08	161.73	145.95	150.61
9	Chloride (mg/kg)	230.40	211.60	225.85	217.96	177.54	181.69	186.11
10	Nitrate (mg/kg)	10.50	10.10	10.40	15.50	20.3	25.0	27.0
11	Calcium (mg/kg)	170.3	153.2	149.6	160.3	148.7	122.7	136.25
12	Magnesium (mg/kg)	76.65	69.85	66.20	70.25	55.85	51.75	61.30
13	Phosphate (mg/kg)	0.36	0.30	0.32	0.29	0.34	0.50	0.57
14	Sulphate (mg/kg)	303.0	301.0	285.0	262.0	225.0	185.0	201.0
B	**Heavy Metals (mg/kg)**							
15	Sodium	104.04	101.50	80.30	71.50	55.40	60.33	62.53
16	Potassium	3.20	3.00	2.82	2.45	1.35	1.50	1.95
17	Iron	164.50	155.10	159.80	145.70	180.20	188.40	191.00
18	Lead	0.65	0.60	0.55	0.50	0.35	0.41	0.48
19	Zinc	19.03	17.60	15.20	13.80	19.20	18.30	22.80
20	Arsenic	0.013	0.010	0.012	0.010	0.005	0.007	0.009
21	Chromium	0.23	0.20	0.19	0.15	0.18	0.12	0.15
22	Cadmium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Copper	2.80	2.10	2.50	2.30	3.00	3.15	3.45
24	Nickel	17.45	15.32	13.85	11.59	13.08	12.75	14.75
25	Manganese	50.06	40.10	45.30	42.81	47.60	44.71	41.67
C	**Microbiology Test (cfu/g)**							
26	THB	1.63×10^4	1.50×10^4	1.60×10^4	1.55×10^4	1.35×10^4	1.40×10^4	1.30×10^4
27	THF	6.3×10^3	5.5×10^3	5.0×10^3	4.7×10^3	3.3×10^3	5.3×10^3	4.0×10^3
28	HUB	3.7×10^3	2.5×10^3	2.0×10^3	3.0×10^3	2.7×10^3	4.1×10^3	5.3×10^3
29	HUF	1.83×10^2	1.60×10^2	1.70×10^2	1.65×10^2	1.55×10^2	1.45×10^2	1.51×10^2
30	Coliforms	2.2×10^1	2.0×10^1	2.1×10^1	1.5×10^1	1.7×10^1	1.1×10^1	1.0×10^1

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Sediment
DATE OF RECEIPT: 22nd February, 2021.
PERIOD OF ANALYSIS: 25th February – 12th March, 2021.
QA/QC CHECK DATE: 16th March, 2021.

Bottom Sediment Sample (Marine Water) Results Table 5:

S/N	PARAMETERS	BS 1	BS 2	BS 3	BS 4	BS 5	BS 6	BS 7
A	**PHYSICO CHEMICAL TEST**							
1	Appearance	Cream	Cream	Cream	cream	Pale cream	Cream	Pale cream
2	pH(soil-water ratio, 1:1)	6.7	6.5	6.2	6.5	6.3	6.4	6.6
3	Conductivity (µs/cm)	5110.0	6640.0	5420.0	5960.0	6760.0	6321.0	6841.0
4	TOC (%)	0.20	0.25	0.30	0.15	0.19	0.20	0.22
5	THC (mg/kg)	8.10	8.75	7.30	7.10	6.20	6.50	6.10
6	Sand (%)	98.10	97.70	98.20	97.40	98.60	99.00	98.50
7	Silt (%)	1.70	1.90	1.60	1.90	1.20	0.60	0.80
8	Clay (%)	0.20	0.40	0.20	0.70	0.20	0.40	0.70
9	Nitrate (mg/kg)	4.3	4.5	4.2	4.0	3.1	3.2	3.1
10	Ammonia(mg/kg)	1.6	1.9	2.3	2.1	2.0	2.5	2.6
11	Sulphate (mg/kg)	162.0	198.0	60.0	193.0	162.0	150.0	143.0
12	Phosphate (mg/kg)	0.32	0.24	0.18	0.03	0.21	0.25	0.20
13	Chloride (mg/kg)	44312.5	23928.75	18611.25	22333.50	19874.50	23187.0	24965.0
	Heavy Metals							
14	Arsenic	0.01	0.01	0.01	0.01	0.01	0.01	0.01
15	Cadmium (mg/kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
16	Copper (mg/kg)	0.35	0.30	0.20	0.15	0.20	0.25	0.30
17	Iron (mg/kg)	99.0	81.0	92.0	130.0	146.0	139.0	141.0
18	Nickel (mg/kg)	0.50	0.47	0.50	1.30	0.80	0.60	0.90
19	Lead (mg/kg)	0.08	0.12	0.05	0.15	0.12	0.10	0.05
20	Zinc (mg/kg)	1.05	1.01	0.85	1.10	1.20	1.15	1.05
21	Manganese (mg/kg)	0.85	0.40	0.88	0.40	0.80	0.50	0.60
22	Calcium (mg/kg)	11.8	14.2	6.50	4.40	5.11	5.05	6.10
23	Magnesium (mg/kg)	1.44	1.50	1.60	1.48	1.33	1.21	1.30
24	Sodium (mg/kg)	2.61	2.19	4.15	3.65	3.40	3.70	3.10
25	Potassium (mg/kg)	1.30	1.56	0.40	0.65	1.55	1.30	1.50
26	Chromium (mg/kg)	0.07	0.10	0.05	0.03	0.09	0.07	0.05
B	**Microbiology Test (cfu/g)**							
27	THB	1.19×10^3	1.05×10^3	1.20×10^3	1.10×10^3	1.31×10^3	1.15×10^3	1.05×10^3
28	THF	1.2×10^2	3.5×10^2	2.0×10^2	3.1×10^2	2.00×10^2	2.50×10^2	2.25×10^2
29	HUF	1.7×10^1	1.5×10^1	1.2×10^1	1.1×10^1	2.1×10^1	2.0×10^1	2.1×10^1
30	HUB	4.0×10^2	6.2×10^2	6.5×10^2	8.5×10^2	6.0×10^2	4.5×10^2	4.1×10^2
31	Coliform	2.1×10^2	1.5×10^2	1.0×10^2	1.1×10^2	1.0×10^2	1.5×10^2	2.3×10^2

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8th October, 2020.

The Managing Director,
Global Environmental Limited,
Lagos.

Dear Sir,

ANALYSIS RESULT

Please find attached the results of the analysis of soil and Sediment samples received on the 1st of August, 2020.

Thank you.

Yours faithfully,

Tolu Adeniyi
Searchgate Lab. Ltd

Searchgate Laboratories Ltd.
Environmental Laboratories & Consultancy Services
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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 1st August, 2020.
PERIOD OF ANALYSIS: 21st August- 10th September, 2020.
QA/QC CHECK DATE: 8th October, 2020.

Table 1: Surface Soil Sample Results

S/N	PARAMETERS	SS 1 0-15 cm	SS 2 0-15cm	SS 3 0-15cm	SS 4 0-15cm	SS 5 0-15cm	SS 6 0-15cm	SS 7 0-15cm	SS 8 0-15cm	SS 9 0-15cm	SS 10 0-15cm
A	PHYSICO CHEMICAL TEST										
1	Appearance	Brown	Brown	Dark	Dark Brown	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Brown
2	pH(soil-water ratio, 1:1)	7.1	6.5	6.9	6.7	7.6	7.3	6.4	6.1	7.7	6.3
3	Conductivity (µs/cm)	164	155	147	178	169	328	153	99	85	102
4	TOC (%)	0.90	0.60	0.50	1.50	0.40	1.00	0.70	0.50	0.20	0.30
5	THC (mg/kg)	0.60	0.30	0.10	0.20	0.50	0.30	1.10	0.80	0.90	1.30
6	Sand (%)	98.20	97.80	98.60	97.80	98.10	98.30	97.30	98.10	97.50	98.30
7	Silt (%)	1.20	1.80	1.00	2.10	1.50	1.40	1.70	1.30	1.60	1.10
8	Clay (%)	0.60	0.40	0.40	0.10	0.40	0.30	1.00	0.60	0.90	0.60
9	Nitrate (mg/kg)	9.5	9.1	6.70	8.5	7.0	6.90	5.20	8.3	6.50	7.30
10	Ammonia(mg/kg)	6.50	7.7	5.80	7.20	6.90	8.35	19.0	31.0	26.0	29.0
11	Sulphate (mg/kg)	68.0	61.0	49.9	29.5	59.3	55.0	40.90	30.50	21.65	41.45
12	Phosphate (mg/kg)	0.42	0.60	0.50	0.38	0.27	0.45	0.57	0.60	0.63	0.54
13	Chloride (mg/kg)	144.84	148.55	47.62	109.20	133.60	623.50	204.90	3378.60	198.40	177.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.18	0.15	0.10	0.12	0.16	0.11	0.16	0.14	0.12	0.10
17	Copper (mg/kg)	0.11	0.01	0.01	0.02	0.01	0.01	0.03	0.02	0.01	0.01
18	Iron (mg/kg)	7.73	8.08	7.10	6.02	10.02	11.15	11.06	8.30	5.55	10.80
19	Nickel (mg/kg)	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	0.62	0.19	0.27	0.45	0.40	0.45	0.30	0.40	0.35	0.30
22	Magnesium (mg/kg)	0.11	0.03	0.10	0.05	0.09	0.15	0.10	0.25	0.12	0.15
23	Calcium (mg/kg)	0.81	0.62	0.84	0.80	0.71	1.10	1.30	1.09	1.15	1.12
24	Manganese (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
25	Sodium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Potassium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

	Microbiology Test (cfu/g)										
27	THB	1.30 x 10^3	1.10 x 10^3	1.25 x 10^3	1.10 x 10^3	1.31 x 10^3	1.27 x 10^3	1.15 x 10^3	1.40 x 10^3	1.27 x 10^3	1.15 x 10^3
28	THF	3.8 x 10^2	3.0 x 10^2	2.0 x 10^2	4.5 x 10^2	3.5 x 10^2	2.2 x 10^2	3.2 x 10^2	2.7 x 10^2	1.5 x 10^2	1.1 x 10^2
29	HUF	1.5 x 10^1	1.1 x 10^1	1.0 x 10^1	1.2 x 10^1	2.2 x 10^1	2.0 x 10^1	1.7 x 10^1	1.3 x 10^1	1.7 x 10^1	1.5 x 10^1
30	HUB	8.1 x 10^2	6.5 x 10^2	7.5 x 10^2	5.7 x 10^2	6.5 x 10^2	8.8 x 10^2	4.0 x 10^2	5.2 x 10^2	6.5 x 10^2	6.0 x 10^2
31	Coliform	7.7 x 10^2	6.5 x 10^2	7.1 x 10^2	7.5 x 10^2	3.5 x 10^2	2.9 x 10^2	5.1 x 10^2	5.9 x 10^2	5.2 x 10^2	4.5 x 10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 1st August, 2020.
PERIOD OF ANALYSIS: 21st August- 10th September, 2020.
QA/QC CHECK DATE: 8th October, 2020.

Soil Sample Results Table 1: Surface soil

S/	PARAMETERS	SS 11 0-15 cm	SS 12 0-15cm	SS 13 0-15cm	SS 14 0-15cm	SS 15 0-15cm	SS 16 0-15cm	SS 17 0-15cm	SS 18 0-15cm	SS 19 0-15cm	SS 20 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Dark Brown	Dark	Dark Brown	Dark Brown	Dark Brown	Dark	Grey	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	8.1	8.3	8.9	8.4	8.6	7.9	8.5	6.9	7.7	5.9
3	Conductivity (µs/cm)	40.5	58.8	65.9	90.9	79.3	217.0	193.3	339.0	173.1	280.2
4	TOC (%)	0.85	0.65	0.75	0.60	0.85	1.10	0.40	0.30	0.55	0.60
5	THC (mg/kg)	0.18	0.15	0.10	0.12	0.20	0.40	0.70	0.90	0.30	0.50
6	Sand (%)	97.70	98.60	98.40	97.60	98.30	97.30	96.30	98.10	98.10	98.50
7	Silt (%)	1.80	0.90	0.40	2.10	1.10	1.50	2.50	1.30	1.10	1.10
8	Clay (%)	0.50	0.5	1.20	0.40	0.60	1.20	1.20	0.60	0.80	0.40
9	Nitrate (mg/kg)	9.0	7.0	13.1	10.50	6.0	7.90	5.20	10.0	11.50	13.30
10	Ammonia(mg/kg)	5.50	6.7	3.80	5.50	4.90	4.35	19.0	30.0	25.0	35.0
11	Sulphate (mg/kg)	60.5	63.0	69.3	19.5	39.3	45.0	50.90	30.50	31.65	21.45
12	Phosphate (mg/kg)	1.51	0.90	1.10	1.20	1.15	1.05	0.90	0.75	0.70	0.45
13	Chloride (mg/kg)	97.50	105.40	80.60	108.70	160.20	223.60	185.80	378.60	168.50	155.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
16	Chromium (mg/kg)	0.15	0.10	0.12	0.10	0.09	0.11	0.13	0.15	0.10	0.12
17	Copper (mg/kg)	0.10	0.08	0.09	0.05	0.01	0.07	0.05	0.03	0.02	0.02
18	Iron (mg/kg)	3.90	3.50	5.60	6.82	10.12	11.50	9.30	6.30	5.15	10.50
19	Nickel (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead (mg/kg)	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
21	Zinc (mg/kg)	0.15	0.13	0.11	0.10	0.03	0.20	0.10	0.10	0.10	0.12
22	Magnesium (mg/kg)	0.22	0.19	0.10	0.15	0.20	0.15	0.10	0.11	0.05	0.15
23	Calcium (mg/kg)	0.90	0.62	0.70	0.65	0.71	0.95	1.10	0.90	1.15	1.20
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

25	Sodium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
26	Potassium (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Microbiology Test (cfu/g)										
27	THB	1.26×10^3	1.05×10^3	1.30×10^3	1.28×10^3	1.35×10^3	1.29×10^3	1.15×10^3	1.40×10^3	1.25×10^3	1.15×10^3
28	THF	3.8×10^2	3.1×10^2	2.0×10^2	4.5×10^2	4.2×10^2	4.1×10^2	3.5×10^2	4.5×10^2	2.4×10^2	4.2×10^2
29	HUF	2.0×10^1	2.3×10^1	3.3×10^1	3.0×10^1	2.8×10^1	2.5×10^1	2.7×10^1	2.8×10^1	3.4×10^1	4.1×10^1
30	HUB	8.5×10^2	6.5×10^2	7.5×10^2	5.9×10^2	6.4×10^2	8.9×10^2	4.5×10^2	6.0×10^2	6.5×10^2	7.1×10^2
31	Coliform	5.1×10^2	4.0×10^2	4.2×10^2	4.5×10^2	5.5×10^2	4.8×10^2	5.9×10^2	5.0×10^2	3.8×10^2	4.4×10^2

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QA/QC CHECK DATE: 8th October, 2020.

Soil Sample Results Table 1: Surface soil

S/N	PARAMETERS	SS 21 0-15 cm	SS 22 0-15cm	SS 23 0-15cm	SS 24 0-15cm	SS 25 0-15cm	SS 26 0-15cm	SS 27 0-15cm	SS 28 0-15cm	SS 29 0-15cm	SS 30 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Brown	Brown	Dark	Brown	Dark	Dark	Dark	Brown	Dark Brown	Brown
2	pH(soil-water ratio, 1:1)	7.6	7.8	7.1	7.4	7.6	7.9	7.5	7.9	7.7	7.8
3	Conductivity (µs/cm)	56.3	58.8	55.9	61.9	59.3	428.0	343.3	570.0	173.1	180.2
4	TOC (%)	0.51	0.40	0.45	0.14	0.30	0.90	0.50	0.60	0.20	0.35
5	THC (mg/kg)	0.82	0.67	0.71	0.70	0.70	0.60	0.70	0.80	0.60	0.65
6	Sand (%)	86.10	83.50	87.30	85.10	80.60	88.20	84.70	89.30	89.90	89.20
7	Silt (%)	13.40	15.80	11.60	14.60	17.20	10.20	12.70	9.30	8.50	9.60
8	Clay (%)	0.50	0.70	1.10	0.30	2.20	1.60	3.40	1.40	2.60	2.20
9	Nitrate (mg/kg)	9.0	8.5	8.0	8.3	8.1	7.5	7.20	9.0	8.50	8.10
10	Ammonia(mg/kg)	10.10	8.7	7.80	7.20	7.90	6.35	7.20	6.00	7.90	6.60
11	Sulphate (mg/kg)	49.5	47.0	39.9	39.5	29.3	35.0	50.90	50.50	51.65	51.45
12	Phosphate (mg/kg)	0.78	0.80	0.90	0.74	0.10	0.20	0.60	0.60	0.40	0.30
13	Chloride (mg/kg)	71.80	75.40	77.60	70.70	88.20	85.0	84.80	78.50	78.20	74.20
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.20	0.10	0.10	0.10	0.20	0.10	0.10	0.10	0.10	0.20
17	Copper (mg/kg)	3.18	3.10	3.20	3.60	3.20	3.02	2.65	3.05	3.10	3.03
18	Iron (mg/kg)	92.30	88.18	77.40	96.60	90.90	92.85	81.36	89.30	95.40	80.50
19	Nickel (mg/kg)	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	3.12	3.09	2.17	2.15	1.59	1.68	1.62	1.58	1.61	1.49
22	Magnesium (mg/kg)	0.27	0.24	0.20	0.22	0.25	0.25	0.20	0.19	0.17	0.20
23	Calcium (mg/kg)	1.61	1.40	1.44	1.40	1.51	1.55	1.45	1.49	1.35	1.42
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
25	Sodium (mg/kg)	2.33	0.44	3.85	2.01	2.11	2.30	2.16	2.09	2.20	2.15
24	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test										

	(cfu/g)										
26	THB	1.18 x 10^3	1.15 x 10^3	1.10 x 10^3	1.18 x 10^3	1.18 x 10^3	1.15 x 10^3	1.10 x 10^3	1.10 x 10^3	1.14 x 10^3	1.10 x 10^3
27	THF	3.5 x 10^2	3.7 x 10^2	3.3 x 10^2	3.0 x 10^2	3.5 x 10^2	2.2 x 10^2	2.3 x 10^2	2.5 x 10^2	2.1 x 10^2	2.0 x 10^2
28	HUF	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29	HUB	7.5 x 10^2	7.1 x 10^2	7.3 x 10^2	2.5 x 10^2	3.1 x 10^2	5.8 x 10^2	3.9 x 10^2	3.2 x 10^2	3.8 x 10^2	3.4 x 10^2
30	Coliform	4.3 x 10^2	4.0 x 10^2	4.5 x 10^2	5.1 x 10^2	3.7 x 10^2	2.9 x 10^2	7.1 x 10^2	5.8 x 10^2	4.5 x 10^2	5.4 x 10^2

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QA/QC CHECK DATE: 8th October, 2020.

Table 1: Surface Soil Sample Results

S/N	PARAMETERS	SS 31 0-15 cm	SS 32 0-15cm	SS 33 0-15cm	SS 34 0-15cm	SS 35 0-15cm	SS 36 0-15cm	SS 37 0-15cm	SS 38 0-15cm	SS 39 0-15cm	SS 40 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Brown	Brown	Pale cream	Dark Brown	Dark Brown	Pale Cream	Pale cream	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	6.2	6.3	6.6	6.4	6.1	5.9	6.5	6.9	6.7	6.8
3	Conductivity (µs/cm)	44.50	43.0	45.9	48.9	47.5	48.0	43.3	49.0	43.10	40.20
4	TOC (%)	0.80	0.55	0.40	0.85	0.69	0.50	0.84	0.75	0.65	0.70
5	THC (mg/kg)	0.40	0.20	0.30	0.25	0.20	0.15	0.16	0.21	0.25	0.20
6	Sand (%)	100.0	99.10	99.30	99.50	100.0	99.70	99.20	99.00	98.90	99.40
7	Silt (%)	0.0	0.80	0.50	0.40	0.00	0.30	0.60	0.70	0.70	0.50
8	Clay (%)	0.0	0.10	0.20	0.10	0.00	0.00	0.20	0.30	0.40	0.10
9	Nitrate (mg/kg)	10.5	10.0	10.30	10.5	9.0	9.90	10.20	9.5	8.50	10.30
10	Ammonia(mg/kg)	8.50	8.7	6.80	8.20	8.90	8.35	8.0	9.0	7.0	7.0
11	Sulphate (mg/kg)	69.0	67.0	59.9	49.5	59.3	65.0	60.90	60.50	61.65	61.45
12	Phosphate (mg/kg)	1.89	1.30	1.33	1.20	1.26	1.25	1.35	1.21	1.15	1.35
13	Chloride (mg/kg)	85.40	80.60	85.10	88.30	85.70	82.70	70.84	73.50	78.30	71.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.21	0.25	0.15	0.20	0.32	0.30	0.31	0.28	0.24	0.30
17	Copper (mg/kg)	4.10	4.01	4.01	4.50	4.05	4.70	4.05	4.50	4.20	4.10
16	Iron (mg/kg)	90.2	88.1	79.40	86.60	77.90	85.80	86.30	83.50	84.35	90.50
17	Nickel (mg/kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
18	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Zinc (mg/kg)	1.14	1.11	1.15	1.13	1.10	1.12	1.09	1.13	1.05	1.13
20	Magnesium (mg/kg)	0.22	0.16	0.20	0.21	0.19	0.16	0.20	0.19	0.13	0.15
21	Calcium (mg/kg)	0.21	0.22	0.14	0.20	0.21	0.09	0.06	0.09	0.20	0.20
22	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
23	Sodium (mg/kg)	4.24	4.45	3.70	3.20	3.10	4.10	3.70	4.20	3.80	4.12
24	Potassium (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Microbiology Test (cfu/g)										
25	THB	2.66×10^3	3.15×10^3	3.20×10^3	4.08×10^3	3.33×10^3	2.25×10^3	3.10×10^3	3.37×10^3	2.24×10^3	3.14×10^3
26	THF	4.6×10^2	4.9×10^2	2.8×10^2	4.5×10^2	4.2×10^2	3.1×10^2	3.5×10^2	2.7×10^2	2.4×10^2	3.2×10^2

28	HUF	3.0×10^1	3.3×10^1	3.5×10^1	4.3×10^1	3.1×10^1	3.7×10^1	3.9×10^1	2.0×10^1	3.4×10^1	4.1×10^1
29	HUB	7.2×10^2	5.8×10^2	6.0×10^2	6.5×10^2	5.1×10^2	8.7×10^2	5.5×10^2	5.2×10^2	6.7×10^2	6.5×10^2
30	Coliform	3.0×10^2	2.0×10^2	4.0×10^2	4.5×10^2	3.2×10^2	2.9×10^2	3.6×10^2	4.7×10^2	3.5×10^2	2.7×10^2

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Soil Sample Results Table 1: Surface soil

	PARAMETERS	SS 41 0-15 cm	SS 42 0-15cm	SS 43 0-15cm	SS 44 0-15cm	SS 45 0-15cm	SS 46 0-15cm	SS 47 0-15cm	SS 48 0-15cm	SS 49 0-15cm	SS 50 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Brown	Dark	Pale cream	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	3.1	4.3	4.9	4.1	4.02	4.10	4.5	4.9	4.7	4.3
3	Conductivity (µs/cm)	114	105	74.0	108	93	68	43	60	73	70
4	TOC (%)	0.56	0.50	0.55	0.40	0.38	0.51	0.49	0.46	0.36	0.25
5	THC (mg/kg)	0.18	0.15	0.27	0.38	0.26	0.20	0.21	0.19	0.27	0.30
6	Sand (%)	99.10	99.50	99.30	99.40	98.90	99.00	99.20	98.10	98.50	98.60
7	Silt (%)	0.60	0.40	0.70	0.50	1.00	0.80	0.70	1.30	1.30	1.00
8	Clay (%)	0.30	0.10	0.00	0.10	0.10	0.20	0.10	0.60	0.20	0.40
9	Nitrate (mg/kg)	9.0	10.0	7.0	9.0	10.0	8.0	5.0	8.0	6.0	10.0
10	Ammonia(mg/kg)	13.50	14.7	12.80	15.20	13.90	13.35	11.0	15.0	14.0	15.0
11	Sulphate (mg/kg)	54.0	60.0	51.0	45.0	40.0	55.0	50.0	52.0	49.0	53.0
12	Phosphate (mg/kg)	9.0	10.5	7.0	5.5	10.00	10.02	10.40	9.50	9.20	8.50
13	Chloride (mg/kg)	74.60	115.40	87.65	99.70	85.30	122.60	68.84	78.60	88.50	54.70
	HEAVY METALS										
14	Arsenic (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.18	0.15	0.11	0.13	0.16	0.19	0.05	0.08	0.10	0.18
17	Copper (mg/kg)	3.30	3.11	3.01	2.10	2.50	2.30	3.05	2.70	3.50	3.10
18	Iron (mg/kg)	67.40	58.18	47.50	76.65	70.90	62.80	51.40	59.30	55.40	40.65
19	Nickel (mg/kg)	0.05	0.03	0.04	0.01	0.01	0.01	0.01	0.03	0.03	0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	2.52	2.09	2.17	2.15	2.30	1.50	2.32	1.38	2.31	2.29
22	Magnesium (mg/kg)	1.27	1.08	1.11	1.05	1.33	1.25	1.20	1.23	1.13	1.05
23	Calcium (mg/kg)	0.81	0.85	0.72	0.69	0.74	0.78	0.80	1.19	1.16	1.12
24	Manganese (mg/kg)	2.05	2.00	2.03	1.50	2.01	1.80	1.60	1.55	1.75	1.90
25	Sodium (mg/kg)	1.77	2.03	1.30	1.36	1.55	0.86	1.57	1.75	1.90	1.65
26	Potassium (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Microbiology Test										

	(cfu/g)										
27	THB	1.45×10^3	1.40×10^3	1.30×10^3	1.32×10^3	1.24×10^3	1.20×10^3	1.22×10^3	1.15×10^3	1.04×10^3	1.10×10^3
28	THF	3.6×10^2	2.9×10^2	1.8×10^2	4.0×10^2	3.2×10^2	2.1×10^2	3.0×10^2	2.5×10^2	1.4×10^2	1.2×10^2
29	HUF	1.2×10^1	1.0×10^1	1.1×10^1	1.05×10^1	2.8×10^1	2.6×10^1	2.2×10^1	2.5×10^1	2.1×10^1	2.3×10^1
30	HUB	1.2×10^2	1.3×10^2	1.0×10^2	1.5×10^2	1.1×10^2	1.05×10^2	1.1×10^2	0.5×10^2	1.23×10^2	1.15×10^2
31	Coliform	4.0×10^2	4.2×10^2	4.5×10^2	3.0×10^2	3.5×10^2	3.05×10^2	3.10×10^2	2.5×10^2	2.0×10^2	2.1×10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Soil
DATE OF RECEIPT: 1st August, 2020.
PERIOD OF ANALYSIS: 21st August- 10th September, 2020.
QA/QC CHECK DATE: 8th October, 2020.

Table 2: Sub-Surface Soil Sample Results

S/N	PARAMETERS	SS 1 0-15 cm	SS 2 0-15cm	SS 3 0-15cm	SS 4 0-15cm	SS 5 0-15cm	SS 6 0-15cm	SS 7 0-15cm	SS 8 0-15cm	SS 9 0-15cm	SS 10 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	8.30	8.1	8.40	8.17	8.15	8.21	8.32	8.12	8.31	8.37
3	Conductivity (µs/cm)	364	255	247	278	271	229	255	199	185	202
4	TOC (%)	0.65	0.60	0.55	0.50	0.45	0.62	0.40	0.51	0.30	0.45
5	THC (mg/kg)	0.30	0.33	0.35	0.26	0.34	0.31	0.25	0.29	0.16	0.15
6	Sand (%)	96.10	96.40	96.60	96.80	96.30	96.70	96.50	96.20	97.10	97.30
7	Silt (%)	3.20	2.80	2.90	3.10	3.50	3.20	3.30	3.20	2.60	2.10
8	Clay (%)	0.70	0.80	0.50	0.10	0.20	0.10	0.20	0.60	0.40	0.70
9	Nitrate (mg/kg)	10.5	9.8	9.70	9.5	9.0	8.90	9.20	9.3	8.50	9.30
10	Ammonia(mg/kg)	5.50	5.7	3.80	5.20	4.90	6.35	11.0	25.0	20.0	23.0
11	Sulphate (mg/kg)	58.0	51.0	59.9	49.5	50.3	52.0	45.90	37.50	26.70	45.50
12	Phosphate (mg/kg)	0.32	0.70	0.72	0.58	0.47	0.55	0.59	0.63	0.65	0.55
13	Chloride (mg/kg)	89.20	82.50	87.60	79.20	75.60	70.50	84.90	71.60	80.40	77.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.10	0.12	0.10	0.11	0.15	0.11	0.13	0.16	0.10	0.12
17	Copper (mg/kg)	2.01	2.50	2.10	2.30	2.11	2.12	3.10	3.05	2.70	2.75
18	Iron (mg/kg)	47.73	58.08	67.10	56.02	70.02	61.15	41.06	68.30	65.55	40.80
19	Nickel (mg/kg)	0.02	<0.01	<0.01	0.02	0.02	<0.01	0.02	0.02	0.01	0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	1.60	1.19	1.27	1.45	1.40	.45	2.30	2.40	1.35	1.30
22	Magnesium (mg/kg)	0.22	0.24	0.20	0.25	0.19	0.25	0.20	0.22	0.19	0.16
23	Calcium (mg/kg)	1.22	1.20	1.15	1.19	1.05	1.10	1.19	1.15	1.25	1.22
24	Manganese (mg/kg)	2.05	1.75	2.01	1.90	1.70	1.50	1.10	1.70	1.30	1.10
25	Sodium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test										

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	(cfu/g)										
27	THB	1.50×10^3	1.20×10^3	1.35×10^3	1.15×10^3	1.35×10^3	1.30×10^3	1.05×10^3	1.45×10^3	1.29×10^3	1.17×10^3
28	THF	4.8×10^2	4.0×10^2	3.0×10^2	5.5×10^2	5.5×10^2	3.2×10^2	4.2×10^2	3.7×10^2	2.5×10^2	2.1×10^2
29	HUF	2.5×10^1	2.1×10^1	2.0×10^1	2.2×10^1	3.2×10^1	1.0×10^1	2.7×10^1	2.3×10^1	1.9×10^1	1.7×10^1
30	HUB	8.5×10^2	6.7×10^2	7.9×10^2	5.9×10^2	6.2×10^2	8.2×10^2	4.5×10^2	5.5×10^2	6.7×10^2	6.5×10^2
31	Coliform	7.1×10^2	6.2×10^2	7.5×10^2	7.0×10^2	4.5×10^2	3.9×10^2	5.5×10^2	6.1×10^2	5.7×10^2	4.7×10^2

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Table 2: Sub - Surface soil sample Results

S/	PARAMETERS	SS 11 0-15 cm	SS 12 0-15cm	SS 13 0-15cm	SS 14 0-15cm	SS 15 0-15cm	SS 16 0-15cm	SS 17 0-15cm	SS 18 0-15cm	SS 19 0-15cm	SS 20 0-15cm
A	PHYSICO CHEMICAL TEST										
1	Appearance	Pale Brown	Dark Brown	Dark	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Pale Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	4.1	4.3	4.9	4.4	4.6	4.9	4.5	3.9	3.7	3.9
3	Conductivity (µs/cm)	30.5	31.8	35.9	30.9	39.3	37.0	35.3	33.0	33.1	35.2
4	TOC (%)	0.80	0.75	0.85	0.65	0.89	0.90	0.50	0.60	0.70	0.65
5	THC (mg/kg)	0.21	0.19	0.15	0.10	0.20	0.11	0.14	0.12	0.17	0.11
6	Sand (%)	99.70	99.10	99.40	99.60	99.30	69.40	76.30	78.10	81.10	88.60
7	Silt (%)	0.00	0.70	0.40	0.30	0.50	18.50	22.50	21.30	18.20	11.10
8	Clay (%)	0.00	0.30	0.20	0.10	0.20	12.10	1.20	0.60	0.70	0.30
9	Nitrate (mg/kg)	9.5	8.0	7.0	8.5	6.0	5.0	6.10	5.7	5.2	6.1
10	Ammonia(mg/kg)	7.50	9.7	5.80	7.50	7.90	5.35	9.0	13.0	15.0	9.0
11	Sulphate (mg/kg)	58.5	60.0	59.3	59.5	49.3	55.0	60.90	40.50	41.65	31.45
12	Phosphate (mg/kg)	0.42	0.40	0.35	0.20	0.15	0.05	0.30	0.25	0.10	0.15
13	Chloride (mg/kg)	119.50	108.40	98.60	128.70	180.20	123.60	205.80	178.60	138.50	115.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
16	Chromium (mg/kg)	0.25	0.20	0.22	0.19	0.29	0.31	0.33	0.31	0.30	0.32
17	Copper (mg/kg)	2.07	2.05	2.09	2.05	2.01	2.07	2.05	2.03	2.02	2.02
18	Iron (mg/kg)	69.0	73.50	75.60	76.82	80.12	81.50	69.30	56.30	55.15	70.50
19	Nickel (mg/kg)	0.03	0.01	0.03	0.01	0.02	0.03	0.01	0.03	0.01	0.02
20	Lead (mg/kg)	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
21	Zinc (mg/kg)	1.15	1.13	1.11	1.10	1.03	1.20	1.10	1.10	1.10	1.12
22	Magnesium (mg/kg)	0.11	0.13	0.11	0.10	0.09	0.13	0.13	0.12	0.07	0.11
23	Calcium (mg/kg)	1.43	1.52	1.17	1.15	1.33	1.40	1.42	1.29	1.25	1.30
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

25	Sodium (mg/kg)	2.72	2.55	2.50	2.60	2.45	2.40	2.65	2.25	2.70	2.20
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	1.28×10^3	1.09×10^3	1.35×10^3	1.29×10^3	1.37×10^3	1.30×10^3	1.17×10^3	1.45×10^3	1.35×10^3	1.19×10^3
28	THF	2.8×10^2	2.1×10^2	2.05×10^2	4.55×10^2	4.25×10^2	4.17×10^2	3.7×10^2	4.7×10^2	2.5×10^2	4.7×10^2
29	HUF	2.5×10^1	2.2×10^1	3.1×10^1	3.3×10^1	2.9×10^1	2.7×10^1	3.0×10^1	3.2×10^1	3.45×10^1	4.15×10^1
30	HUB	3.5×10^2	2.5×10^2	3.5×10^2	3.9×10^2	3.4×10^2	4.9×10^2	2.5×10^2	3.0×10^2	3.5×10^2	4.1×10^2
31	Coliform	2.1×10^2	2.0×10^2	2.2×10^2	2.5×10^2	2.5×10^2	2.8×10^2	2.9×10^2	2.0×10^2	2.8×10^2	2.4×10^2

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Soil Sample Results Table 1: Surface soil

S/N	PARAMETERS	SS 21 0-15 cm	SS 22 0-15cm	SS 23 0-15cm	SS 24 0-15cm	SS 25 0-15cm	SS 26 0-15cm	SS 27 0-15cm	SS 28 0-15cm	SS 29 0-15cm	SS 30 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Brown	Brown	Dark Brown	Brown	Brown	Dark	Dark	Brown	Pale Brown	Pale Brown
2	pH(soil-water ratio, 1:1)	6.6	6.8	6.1	6.4	6.6	6.9	6.5	6.9	6.7	6.8
3	Conductivity (µs/cm)	16.3	28.8	35.9	31.9	39.3	28.0	33.3	50.0	17.1	18.2
4	TOC (%)	0.46	0.41	0.39	0.34	0.29	0.33	0.35	0.40	0.26	0.31
5	THC (mg/kg)	0.22	0.17	0.51	0.50	0.10	0.40	0.70	0.12	0.30	0.50
6	Sand (%)	96.10	96.50	96.30	97.40	96.80	97.80	96.20	98.20	98.10	98.60
7	Silt (%)	3.40	2.80	1.60	2.20	1.20	1.20	2.70	1.30	1.50	1.60
8	Clay (%)	0.50	0.70	1.10	0.40	2.00	1.00	1.10	0.50	0.40	0.40
9	Nitrate (mg/kg)	10.0	8.0	3.70	8.5	6.0	7.90	4.20	11.0	5.50	8.30
10	Ammonia(mg/kg)	5.50	6.7	4.80	6.20	5.90	5.35	5.20	5.00	4.90	5.60
11	Sulphate (mg/kg)	9.5	7.0	9.9	9.5	9.3	5.0	0.90	0.50	1.65	1.45
12	Phosphate (mg/kg)	1.89	1.80	0.90	1.74	1.10	1.20	0.80	0.70	0.60	0.50
13	Chloride (mg/kg)	35.80	105.40	47.60	90.70	108.20	125.0	134.80	178.50	138.20	114.20
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.30	0.10	0.10	0.10	0.20	0.30	0.10	0.10	0.10	0.30
17	Copper (mg/kg)	5.20	5.10	3.20	3.80	3.50	.02	2.05	3.03	3.01	3.01
18	Iron (mg/kg)	72.30	58.18	27.40	26.60	30.90	52.85	41.36	29.30	25.40	40.50
19	Nickel (mg/kg)	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	1.52	1.09	1.17	1.15	0.59	0.68	0.62	0.58	0.61	0.49
22	Magnesium (mg/kg)	0.17	0.14	0.10	0.12	0.17	0.15	0.10	0.15	0.12	0.10
23	Calcium (mg/kg)	1.41	1.20	1.54	1.30	1.11	1.05	1.35	1.29	1.15	1.12
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
25	Sodium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Potassium (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003

	Microbiology Test (cfu/g)										
27	THB	1.56×10^3	1.35×10^3	1.30×10^3	1.38×10^3	1.38×10^3	1.35×10^3	1.20×10^3	1.40×10^3	1.34×10^3	1.60×10^3
28	THF	4.5×10^2	3.9×10^2	3.8×10^2	5.0×10^2	3.5×10^2	2.5×10^2	3.3×10^2	3.5×10^2	2.5×10^2	3.2×10^2
29	HUF	2.0×10^1	2.3×10^1	3.3×10^1	2.5×10^1	3.1×10^1	2.1×10^1	3.5×10^1	4.3×10^1	2.4×10^1	3.1×10^1
30	HUB	8.5×10^2	6.9×10^2	7.5×10^2	3.5×10^2	6.1×10^2	8.8×10^2	4.9×10^2	5.2×10^2	6.8×10^2	6.4×10^2
31	Coliform	6.3×10^2	6.0×10^2	6.5×10^2	5.3×10^2	3.5×10^2	2.3×10^2	6.1×10^2	4.8×10^2	5.5×10^2	5.1×10^2

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Table 2: Sub - Surface Soil Sample Results

S/N	PARAMETERS	SS 31 0-15 cm	SS 32 0-15cm	SS 33 0-15cm	SS 34 0-15cm	SS 35 0-15cm	SS 36 0-15cm	SS 37 0-15cm	SS 38 0-15cm	SS 39 0-15cm	SS 40 0-15cm
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Pale Cream	Brown	Brown	Dark Brown	Dark Brown	Dark Brown	Dark	Grey	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	7.2	7.3	7.6	7.4	7.1	6.9	7.5	7.9	7.7	7.8
3	Conductivity (µs/cm)	180.0	138.0	145.9	68.9	77.5	128.0	103.3	159.0	173.10	120.20
4	TOC (%)	0.80	0.55	0.40	0.25	0.39	0.60	0.65	0.30	0.20	0.25
5	THC (mg/kg)	0.30	0.22	0.20	0.15	0.10	0.25	0.36	0.31	0.29	0.21
6	Sand (%)	95.40	95.10	96.30	95.90	96.50	96.40	97.20	97.20	98.10	98.40
7	Silt (%)	3.20	4.80	2.40	2.20	3.40	2.70	1.70	2.30	1.60	1.50
8	Clay (%)	1.40	0.10	1.50	0.90	0.10	0.90	1.10	0.50	0.40	0.10
9	Nitrate (mg/kg)	7.0	9.0	5.30	7.5	5.0	6.90	5.20	9.0	6.50	4.30
10	Ammonia(mg/kg)	6.50	5.7	4.80	6.20	5.90	5.35	6.0	5.0	4.0	5.0
11	Sulphate (mg/kg)	55.0	47.0	39.9	29.5	19.3	35.0	30.90	40.50	51.65	31.45
12	Phosphate (mg/kg)	0.31	0.30	0.33	0.20	0.26	0.25	0.35	0.21	0.15	0.35
13	Chloride (mg/kg)	35.40	30.60	45.10	38.30	45.70	32.70	40.84	43.50	48.30	41.30
	HEAVY METALS										
14	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.11	0.05	0.05	0.10	0.12	0.05	0.11	0.20	0.15	0.20
17	Copper (mg/kg)	3.10	2.01	2.01	2.50	3.05	2.70	1.05	1.50	1.20	2.10
18	Iron (mg/kg)	57.36	68.18	77.40	56.62	70.92	45.85	56.36	53.33	55.35	60.52
19	Nickel (mg/kg)	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.02
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Zinc (mg/kg)	0.14	0.11	0.15	0.13	0.10	0.12	0.09	0.13	0.05	0.13
22	Magnesium (mg/kg)	0.08	0.06	0.10	0.11	0.09	0.06	0.10	0.09	0.03	0.05
23	Calcium (mg/kg)	0.21	0.22	0.14	0.20	0.21	0.09	0.06	0.09	0.20	0.20
24	Manganese (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
25	Sodium (mg/kg)	4.24	4.45	3.70	3.20	3.10	4.10	3.70	4.20	3.80	4.12
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	2.66×10^3	3.15×10^3	3.20×10^3	4.08×10^3	3.33×10^3	2.25×10^3	3.10×10^3	3.37×10^3	2.24×10^3	3.14×10^3

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28	THF	4.6 x 10^2	4.9 x 10^2	2.8 x 10^2	4.5 x 10^2	4.2 x 10^2	3.1 x 10^2	3.5 x 10^2	2.7 x 10^2	2.4 x 10^2	3.2 x 10^2
29	HUF	3.0 x 10^1	3.3 x 10^1	3.5 x 10^1	4.3 x 10^1	3.1 x 10^1	3.7 x 10^1	3.9 x 10^1	2.0 x 10^1	3.4 x 10^1	4.1 x 10^1
30	HUB	7.2 x 10^2	5.8 x 10^2	6.0 x 10^2	6.5 x 10^2	5.1 x 10^2	8.7 x 10^2	5.5 x 10^2	5.2 x 10^2	6.7 x 10^2	6.5 x 10^2
31	Coliform	3.0 x 10^2	2.0 x 10^2	4.0 x 10^2	4.5 x 10^2	3.2 x 10^2	2.9 x 10^2	3.6 x 10^2	4.7 x 10^2	3.5 x 10^2	2.7 x 10^2

CLIENT: **Global Environmental Limited**
SAMPLE TYPE: **Soil**
DATE OF RECEIPT: **1st August, 2020.**
PERIOD OF ANALYSIS: **21st August- 10th September, 2020.**
QA/QC CHECK DATE: **8th October, 2020.**

Soil Sample Results Table 1: Surface soil

	PARAMETERS	**SS 41 0-15 cm**	**SS 42 0-15cm**	**SS 43 0-15cm**	**SS 44 0-15cm**	**SS 45 0-15cm**	**SS 46 0-15cm**	**SS 47 0-15cm**	**SS 48 0-15cm**	**SS 49 0-15cm**	**SS 50 0-15cm**
A	**PHYSICO CHEMICAL TEST**										
1	Appearance	Dark Brown	Brown	Dark	Pale cream	Dark Brown	Dark Brown	Dark	Brown	Dark Brown	Dark Brown
2	pH(soil-water ratio, 1:1)	3.1	4.3	4.9	4.1	4.02	4.10	4.5	4.9	4.7	4.3
3	Conductivity (µs/cm)	114	105	74.0	108	93	68	43	60	73	70
4	TOC (%)	0.56	0.50	0.55	0.40	0.38	0.51	0.49	0.46	0.36	0.25
5	THC (mg/kg)	0.18	0.15	0.27	0.38	0.26	0.20	0.21	0.19	0.27	0.30
6	Sand (%)	99.10	99.50	99.30	99.40	98.90	99.00	99.20	98.10	98.50	98.60
7	Silt (%)	0.60	0.40	0.70	0.50	1.00	0.80	0.70	1.30	1.30	1.00
8	Clay (%)	0.30	0.10	0.00	0.10	0.10	0.20	0.10	0.60	0.20	0.40
9	Nitrate (mg/kg)	9.0	10.0	7.0	9.0	10.0	8.0	5.0	8.0	6.0	10.0
10	Ammonia(mg/kg)	13.50	14.7	12.80	15.20	13.90	13.35	11.0	15.0	14.0	15.0
11	Sulphate (mg/kg)	54.0	60.0	51.0	45.0	40.0	55.0	50.0	52.0	49.0	53.0
12	Phosphate (mg/kg)	9.0	10.5	7.0	5.5	10.00	10.02	10.40	9.50	9.20	8.50
13	Chloride (mg/kg)	74.60	115.40	87.65	99.70	85.30	122.60	68.84	78.60	88.50	54.70
	HEAVY METALS										
14	Arsenic (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15	Cadmium (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium (mg/kg)	0.18	0.15	0.11	0.13	0.16	0.19	0.05	0.08	0.10	0.18
17	Copper (mg/kg)	3.30	3.11	3.01	2.10	2.50	2.30	3.05	2.70	3.50	3.10
18	Iron (mg/kg)	67.40	58.18	47.50	76.65	70.90	62.80	51.40	59.30	55.40	40.65
19	Nickel (mg/kg)	0.05	0.03	0.04	0.01	0.01	0.01	0.01	0.03	0.03	0.01
20	Lead (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

21	Zinc (mg/kg)	2.52	2.09	2.17	2.15	2.30	1.50	2.32	1.38	2.31	2.29
22	Magnesium (mg/kg)	1.27	1.08	1.11	1.05	1.33	1.25	1.20	1.23	1.13	1.05
23	Calcium (mg/kg)	0.81	0.85	0.72	0.69	0.74	0.78	0.80	1.19	1.16	1.12
24	Manganese (mg/kg)	2.05	2.00	2.03	1.50	2.01	1.80	1.60	1.55	1.75	1.90
25	Sodium (mg/kg)	1.77	2.03	1.30	1.36	1.55	0.86	1.57	1.75	1.90	1.65
26	Potassium (mg/kg)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.003	<0.002	<0.002
	Microbiology Test (cfu/g)										
27	THB	0.45×10^3	0.40×10^3	0.30×10^3	0.32×10^3	0.24×10^3	0.20×10^3	0.22×10^3	0.15×10^3	1.01×10^3	0.10×10^3
28	THF	1.6×10^2	1.2×10^2	1.5×10^2	2.0×10^2	1.2×10^2	1.1×10^2	1.0×10^2	1.5×10^2	1.1×10^2	1.0×10^2
29	HUF	1.2×10^1	1.0×10^1	1.1×10^1	1.05×10^1	2.8×10^1	2.6×10^1	2.2×10^1	2.5×10^1	2.1×10^1	2.3×10^1
30	HUB	1.1×10^2	1.2×10^2	1.0×10^2	1.2×10^2	1.0×10^2	1.05×10^2	1.1×10^2	0.5×10^2	1.23×10^2	1.15×10^2
31	Coliform	3.0×10^2	3.2×10^2	3.5×10^2	3.0×10^2	3.1×10^2	2.05×10^2	1.10×10^2	1.5×10^2	1.0×10^2	1.1×10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Bottom Sediment (Marine Water)
DATE OF RECEIPT: 1s August, 2020.
PERIOD OF ANALYSIS: 21st August- 10th September, 2020.
QA/QC CHECK DATE: 8th October, 2020.

Bottom Sediment Sample (Marine Water) Results Table 1:

S/N	PARAMETERS	BS 1	BS 2	BS 3	BS 4	BS 5	BS 6	BS 7
A	**PHYSICO CHEMICAL TEST**							
1	Appearance	Pale Cream	Grey	Pale Cream	Light Brown	Light Brown	Light Brown	Light Brown
2	pH(soil-water ratio, 1:1)	6.5	6.3	6.0	6.2	6.0	6.1	6.4
3	Conductivity (µs/cm)	4240.0	3610.00	3730.0	4160.0	4441.0	4321.0	3841.0
4	TOC (%)	0.16	0.05	0.15	0.10	0.11	0.15	0.13
5	THC (mg/kg)	7.30	8.25	6.30	6.10	5.20	5.50	5.10
6	Sand (%)	99.10	98.70	98.90	98.40	99.60	99.00	99.30
7	Silt (%)	0.50	0.90	0.80	0.90	0.20	0.60	0.50
8	Clay (%)	0.30	0.40	0.30	0.7	0.20	0.40	0.20
9	Nitrate (mg/kg)	3.3	2.5	4.2	3.0	1.1	1.2	1.1
10	Ammonia(mg/kg)	1.3	1.5	1.3	2.1	1.0	2.0	2.0
11	Sulphate (mg/kg)	143.0	175.0	55.0	173.0	142.0	130.0	133.0
12	Phosphate (mg/kg)	0.30	0.22	0.16	0.10	0.20	0.15	0.10
13	Chloride (mg/kg)	41312.5	22928.75	15611.25	22033.50	17874.50	22187.0	21965.0
	Heavy Metals							
14	Arsenic	0.01	0.01	0.01	0.01	0.01	0.01	0.01
15	Cadmium (mg/kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
16	Copper (mg/kg)	0.30	0.20	0.10	0.05	0.10	0.15	0.10
17	Iron (mg/kg)	81.0	75.0	82.0	110.0	136.0	119.0	121.0
18	Nickel (mg/kg)	0.40	0.43	0.50	1.10	0.60	0.50	0.30
19	Lead (mg/kg)	0.05	0.10	0.03	0.10	0.10	0.05	0.01
20	Zinc (mg/kg)	1.01	0.90	0.65	1.05	1.10	1.10	1.01
21	Manganese (mg/kg)	0.70	0.30	0.80	0.30	0.60	0.30	0.50
22	Calcium (mg/kg)	10.8	13.2	4.50	3.40	3.11	3.05	3.10
23	Magnesium (mg/kg)	1.50	1.70	1.80	2.10	1.60	1.30	1.20
24	Sodium (mg/kg)	2.19	2.05	4.15	3.80	3.10	3.50	2.80
25	Potassium (mg/kg)	1.30	1.51	0.20	0.25	1.45	1.10	1.20
26	Chromium (mg/kg)	0.05	0.07	0.01	0.01	0.02	0.05	0.01
B	**Microbiology Test (cfu/g)**							
27	THB	1.25×10^3	1.10×10^3	1.30×10^3	1.20×10^3	1.41×10^3	1.20×10^3	1.15×10^3
28	THF	1.5×10^2	3.7×10^2	2.9×10^2	3.7×10^2	2.50×10^2	2.70×10^2	2.65×10^2

29	HUF	2.7×10^1	1.0×10^1	1.0×10^1	1.5×10^1	4.1×10^1	3.0×10^1	2.5×10^1
30	HUB	6.0×10^2	8.2×10^2	7.5×10^2	9.5×10^2	7.0×10^2	5.5×10^2	5.1×10^2
31	Coliform	3.1×10^2	2.5×10^2	1.0×10^2	1.5×10^2	1.1×10^2	1.3×10^2	3.3×10^2

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CLIENT: Global Environmental Limited
SAMPLE TYPE: Bottom Sediment (Fresh Water)
DATE OF RECEIPT: 1s August, 2020.
PERIOD OF ANALYSIS: 21st August- 10th September, 2020.
QA/QC CHECK DATE: 8th October, 2020.

Bottom Sediment Sample (Fresh Water) Results Table 1:

S/N	PARAMETERS	BS 1	BS 2	BS 3	BS 4	BS 5	BS 6	BS 7
	PHYSICO CHEMICAL TEST							
1	Appearance	Dark Grey	Black	Black	Grey Black	Black	Dark Grey	Black
2	pH (ratio 1:1,soil-water)	6.50	6.70	6.60	6.40	6.50	6.70	6.90
3	Conductivity (µs/cm)	3520.0	3640.0	3635.0	3730.0	3870.0	3890.0	4070.0
4	TOC (%)	1.01	1.09	1.03	1.02	1.01	1.02	1.04
5	THC (mg/kg)	0.001	0.001	0.001	0.001	0.001	0.001	0.001
6	Sand (%)	45.0	42.0	38.0	48.0	40.0	36.0	41.0
7	Silt (%)	50.0	56.0	61.0	51.0	57.0	59,0	55.0
8	Clay (%)	5.0	2.0	1.0	1.0	3.0	5.0	4.0
9	Chloride (mg/kg)	2,254.00	2,384.00	2282.00	2,449.10	2,576.30	2566.10	2,649.50
10	Nitrate (mg/kg)	6.50	8.50	6.00	6.80	7.10	7.80	9.50
11	Ammonia							
12	Calcium (mg/kg)	190.1	200.2	188.5	210.0	215.0	202.50	240.0
13	Phosphate (mg/kg)	0.40	0.42	0.35	0.30	0.10	0.10	0.15
14	Sulphate (mg/kg)	315.0	348.0	320.0	405.0	330.0	411.10	420.50
B	**Heavy METALS**							
15	Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Chromium	0.20	0.10	0.10	0.10	0.20	0.10	0.40
17	Cadmium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
18	Copper	7.20	7.60	9.10	9.50	8.80	9.20	9.80
19	Manganese	4.25	4.05	5.05	4.35	4.20	4.85	5.15
20	Iron	240.0	238.0	230.0	235.0	241.0	242.0	248.0
21	Zinc	3.10	2.50	3.05	2.80	2.50	2.90	3.80
22	Lead	0.10	0.05	0.10	0.12	0.10	0.08	0.05
23	Nickel	0.50	0.55	0.30	0.60	0.40	0.50	0.45
24	Magnessium	1.32	1.51	1.12	1.02	1.22	1.20	1.15
25	Sodium	1.53	1.80	1.55	1.05	1.28	1.20	1.10
26	Potassium	0.15	0.20	0.25	0.11	0.16	0.22	0.10
B	**Microbiology Test (cfu/g)**							
27	THB	1.14×10^3	1.24×10^3	1.20×10^3	1.21×10^3	1.12×10^3	1.10×10^3	1.16×10^3
28	THF	4.5×10^2	4.8×10^2	4.1×10^2	4.0×10^2	3.2×10^2	3.0×10^2	3.7×10^2
29	HUB	8.0×10^2	8.6×10^2	8.2×10^2	6.2×10^2	6.0×10^2	6.1×10^2	6.9×10^2
30	HUF	ND	ND	ND	ND	ND	ND	ND
31	Coliforms	5.2×10^2	5.8×10^2	5.0×10^2	5.5×10^2	5.1×10^2	5.3×10^2	7.3×10^2

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8th October, 2020.

The Managing Director,
Global Environmental Limited,
Lagos.

Dear Sir,

ANALYSIS RESULT

Please find attached the results of the analysis of water, soil and Sediment samples received on the 1st of August, 2020.

Thank you.

Yours faithfully,

Tolu Adeniyi
Searchgate Lab. Ltd

Searchgate Laboratories Ltd.
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38, Diya Street, Ifako, Gbagada, Lagos, Nigeria. Tel: 08032648205, 08029548006, 07088424268
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CLIENT: Global Environmental Limited
SAMPLE TYPE: Fresh Water
DATE OF RECEIPT: 1st August, 2020.
PERIOD OF ANALYSIS: 21st August- 10th September, 2020.
QA/QC CHECK DATE: 8th October, 2020.

Fresh Water Sample Results Table 1:

S/N	PARAMETERS	LW 1	LW 2	LW 3	LW 4	LW 5	LW 6	LW 7
A	**PHYSICO CHEMICAL TEST**							
1	Temp (^{o}C)	26.88	27.31	26.88	26.75	26.41	27.63	27.31
2	pH	8.48	8.13	7.97	8.06	8.15	8.20	7.84
3	Conductivity (mS/cm)	0.641	0.652	0.647	0.590	0.513	0.570	0.637
4	Turbidity (NTU)	48.5	34.5	36.0	40.9	43.5	42.9	62.7
5	DO (mg/L)	10.24	12.05	14.79	11.42	12.66	13.00	11.41
6	TDS (g/L))	0.409	0.417	0.414	0.377	0.329	0.365	0.407
7	Salinity (ppt)	0.3	0.3	0.3	0.3	0.2	0.3	0.3
8	BOD	3.9	4.6	10.2	6.7	3.6	6.1	7.2
9	COD	322	265	305	511	326	480	485
10	Chloride (mg/L)	184.3	207.4	172.9	180.7	201.5	181.2	196.4
11	Alkalinity (mg/L)	62.0	78.0	57.2	65.2	71.3	66.4	56.3
12	Nitrate (mg/L)	8.10	8.40	8.05	8.01	8.20	8.30	7.50
13	Phosphate (mg/L)	0.04	0.08	0.01	0.01	0.02	0.01	0.05
14	Sulphate (mg/L)	29.0	28.0	25.0	27.0	22.0	24.0	20.0
15	Ammonia-Nitrogen (mg/L)	0.79	0.91	0.75	0.70	0.73	0.80	0.82
16	Total Hardness (mg/L)	16.2	11.5	14.1	9.2	10.1	12.4	10.8
17	THC (mg/L)	0.15	0.11	0.13	0.10	0.16	0.10	0.15
18	Calcium (mg/L)	15.4	14.2	13.6	12.1	15.2	13.8	14.0
B	**Heavy Metals (mg/L)**							
19	Iron	0.490	0.472	0.480	0.450	0.420	0.460	0.470
20	Manganese	0.121	0.115	0.110	0.120	0.118	0.105	0.113
21	Zinc	0.180	0.150	0.171	0.175	0.140	0.120	0.160
22	Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Copper	0.130	0.120	0.110	0.120	0.120	0.110	0.120
25	Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Nickel	1.66	1.43	0.88	0.65	0.59	0.94	0.58
27	Lead	<0.03	<0.01	<0.03	<0.02	<0.01	<0.03	<0.01
28	Magnesium	7.66	5.21	3.86	3.51	3.75	7.60	7.30
29	Sodium	31.29	30.57	32.70	30.03	32.11	31.51	30.65
30	Potassium	0.537	0.341	0.206	0.123	0.202	0.102	0.302
C	**Microbiology Test (cfu/ml)**							
31	THB	4.3×10^2	6.5×10^2	5.8×10^2	6.1×10^2	5.0×10^2	4.0×10^2	5.2×10^2
32	Coliform	3.4×10^1	2.2×10^1	4.2×10^1	3.5×10^1	3.1×10^1	3.7×10^1	2.5×10^1
33	HUF	2.3×10^1	1.3×10^1	1.1×10^1	1.5×10^1	1.0×10^1	1.1×10^1	1.3×10^1
34	HUB	2.1×10^1	2.3×10^1	1.9×10^1	1.5×10^1	1.7×10^1	2.0×10^1	2.5×10^1
35	THF	1.5×10^1	1.3×10^1	1.1×10^1	1.0×10^1	1.2×10^1	1.7×10^1	1.2×10^1

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CLIENT: **Global Environmental Limited**
SAMPLE TYPE: **Marine Water**
DATE OF RECEIPT: **1st August, 2020.**
PERIOD OF ANALYSIS: **21st August- 10th September, 2020.**
QA/QC CHECK DATE: **8th October, 2020.**

Marine Water Sample Results Table 2:

S/N	PARAMETERS	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7
A	**PHYSICO CHEMICAL TEST**							
1	Temp (^{o}C)	24.87	25.70	25.10	24.84	24.88	25.06	25.49
2	pH	8.61	8.83	8.67	8.45	8.66	8.66	8.93
3	Conductivity (mS/cm)	42.9	56.2	64.6	54.9	55.8	100.0	93.1
4	Turbidity (NTU)	47.0	43.9	50.2	50.0	46.5	48.9	50.4
5	DO (mg/L)	13.10	18.68	8.15	12.85	5.65	4.38	6.08
6	TDS (g/L))	22.6	34.8	36.7	12.85	33.5	60.0	55.3
7	Salinity (ppt)	42.9	56.2	42.2	36.4	37.0	70.0	66.8
8	BOD	7.1	10.4	7.9	6.5	7.5	8.2	9.1
9	COD	614	590	610	620	680	570	550
10	Chloride (mg/L)	994.0	10300.0	11500.0	10500.0	12350.0	12150.0	11350.0
11	Alkalinity (mg/L)	83.2	81.6	80.8	75.4	81.3	79.5	82.8
12	Nitrate (mg/L)	0.6	0.4	0.6	0.5	0.8	0.6	0.5
13	Phosphate (mg/L)	0.10	0.05	0.05	0.05	0.05	0.10	0.10
14	Sulphate (mg/L)	314.0	336.0	312.0	420.0	454.0	474.0	434.0
15	Ammonia-Nitrogen (mg/L)	0.59	0.51	0.65	0.60	0.53	0.60	0.62
16	Total Hardness (mg/L)	14.2	9.5	11.1	7.2	9.1	10.4	9.8
17	THC (mg/L)	0.10	0.15	0.15	0.10	0.05	0.05	0.10
18	Calcium (mg/L)	0.65	0.45	0.40	0.30	0.40	0.50	0.45
B	**Heavy Metals (mg/L)**							
19	Iron	0.32	0.41	0.67	0.49	0.42	0.52	0.55
20	Manganese	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21	Zinc	0.15	0.10	<0.001	<0.001	<0.001	0.10	0.10
22	Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
23	Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Copper	0.15	0.10	0.12	0.10	0.15	0.15	0.10
25	Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Nickel	1.61	1.53	1.18	1.15	1.59	1.44	1.28
27	Lead	<0.05	<0.05	<0.05	<0.03	<0.05	<0.03	<0.05
28	Magnesium	7.50	6.20	4.80	4.50	4.70	7.30	7.10
29	Sodium	32.60	33.50	34.60	32.20	33.10	32.50	31.60
30	Potassium	0.64	0.45	0.31	0.22	0.20	0.25	0.35
C	**Microbiology Test (cfu/ml)**							
31	THB	4.5×10^2	6.7×10^2	6.1×10^2	6.3×10^2	6.0×10^2	4.5×10^2	5.5×10^2
32	Coliform	2.4×10^1	2.1×10^1	3.2×10^1	3.1×10^1	3.0×10^1	3.5×10^1	2.1×10^1
33	HUF	3.3×10^1	2.1×10^1	1.5×10^1	2.5×10^1	2.0×10^1	2.1×10^1	2.3×10^1
34	HUB	2.3×10^1	2.5×10^1	2.0×10^1	1.7×10^1	1.5×10^1	2.9×10^1	2.0×10^1
35	THF	2.0×10^1	2.3×10^1	2.1×10^1	1.5×10^1	2.2×10^1	1.9×10^1	2.2×10^1

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CLIENT: **Global Environmental Limited**
SAMPLE TYPE: **Ground Water**
DATE OF RECEIPT: **1st August, 2020.**
PERIOD OF ANALYSIS: **21st August- 10th September, 2020.**
QA/QC CHECK DATE: **8th October, 2020.**
Ground Water Sample Results Table 3:

S/N	PARAMETERS	OKU 1	OKU 2	ALA 1	ALA 2	IDO 1	IDO 2	ITO 1	ITO 2	OKE 1	OKE 2	MAG 1	MAG 2	LEK 1	LEK 2
A	**PHYSICO CHEMICAL TEST**														
1	Temp (^{O}C)	29.14	28.05	27.59	27.07	27.30	27.89	27.27	27.13	27.28	27.27	27.25	28.01	27.42	27.25
2	pH	6.73	7.10	6.66	6.75	7.51	7.47	6.81	7.21	6.20	7.11	7.33	7.83	8.20	7.60
3	Conductivity (mS/cm)	0.131	0.249	0.189	0.079	0.222	0.352	0.355	0.132	0.089	0.151	0.171	0.151	0.192	0.109
4	Turbidity (NTU)	40.6	43.3	2.19	38.3	56.3	40.3	32.4	30.0	34.8	57.9	37.5	44.1	32.5	29.8
5	DO (mg/L)	10.88	10.32	6.36	7.75	9.14	6.00	7.3	8.20	16.45	6.11	7.29	13.07	9.31	5.83
6	TDS (g/L))	0.085	0.162	0.123	0.051	0.144	0.229	0.231	0.086	0.050	0.098	0.111	0.091	0.125	0.071
7	Salinity (ppt)	0.1	0.1	0.1	0.0	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.1
8	BOD	4.9	4.6	4.5	3.9	4.4	4.1	3.5	3.3	7.5	6.9	4.5	4.7	2.8	2.6
9	COD	102	118	109	104	110	115	210	120	220	106	125	115	119	113
10	Chloride (mg/L)	52	63	61	51	55	43	35	32	40	32	25	21	50	48
11	Nitrate (mg/L)	3.16	3.01	3.37	3.90	3.20	3.20	6.60	6.40	6.30	6.10	6.20	6.40	4.70	4.60
12	Phosphate (mg/L)	0.37	0.45	0.30	0.10	0.20	0.25	0.65	0.60	0.25	0.20	0.10	0.05	0.60	0.55
13	Sulphate (mg/L)	15.2	16.5	13.1	12.8	12.2	13.4	11.16	11.25	13.2	12.8	11.20	11.30	11.92	11.95
14	Total Hardness (mg/L)	1.30	1.52	1.33	1.57	1.36	1.22	0.12	0.15	7.125	7.121	0.020	0.017	0.54	0.51
15	THC (mg/L)	1.06	1.03	0.011	0.021	0.015	0.019	0.210	0.213	1.056	1.054	0.120	0.125	0.060	0.066
16	Calcium (mg/L)	1.61	0.91	0.68	0.75	0.62	0.65	0.63	0.60	<0.001	<0.001	<0.001	<0.001	0.160	0.163
B	**Heavy Metals (mg/L)**														

17	Iron	0.05	0.07	0.05	0.04	0.05	0.03	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	1.211	1.215
18	Manganese	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
19	Zinc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
20	Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21	Chromium	0.003	0.002	0.003	0.001	0.001	0.003	0.001	0.002	0.001	0.003	0.001	0.002	0.001	0.002
22	Copper	0.041	0.051	0.062	0.050	0.015	0.044	0.053	0.060	0.070	0.065	0.049	0.059	0.066	0.065
23	Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Nickel	0.121	1.51	0.15	0.049	0.01	1.221	1.08	0.20	0.039	0.05	0.121	1.51	0.07	0.055
25	Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Magnesium	1.340	<0.0001	<0.0001	<0.0001	1.650	<0.0003	<0.0003	<0.0003	<0.0002	1.540	<0.0002	<0.0001	<0.0001	<0.0001
27	Sodium	21.30	12.60	6.95	13.50	10.30	19.20	10.50	7.80	12.60	8.70	15.50	9.80	13.60	9.70
28	Potassium	0.350	0.820	0.320	0.60	0.41	0.55	0.55	0.520	0.620	0.51	0.57	0.620	0.730	0.61
C	**Microbiology Test (cfu/ml)**														
29	THB	3.1×10^2	4.2×10^2	3.0×10^2	2.1×10^2	3.0×10^2	3.1×10^2	2.5×10^2	3.1×10^2	2.0×10^2	3.0×10^2	1.5×10^2	1.1×10^2	1.0×10^2	2.0×10^2
30	Coliform	2.1×10^1	3.1×10^1	3.2×10^1	3.5×10^1	1.1×10^1	4.5×10^1	4.1×10^1	3.3×10^1	3.0×10^1	$2.7.1 \times 10^1$	1.5×10^1	1.0×10^1	1.2×10^1	3.0×10^1
31	HUF	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
32	HUB	1.3×10^1	0.5×10^1	1.0×10^1	1.2×10^1	1.1×10^1	1.1×10^1	1.0×10^1	1.2×10^1	1.5×10^1	1.7×10^1	1.05×10^1	1.5×10^1	1.3×10^1	1.8×10^1
33	THF	1.5×10^1	1.7×10^1	1.1×10^1	1.0×10^1	0.5×10^1	1.2×10^1	1.1×10^1	1.0×10^1	1.2×10^1	1.0×10^1	1.0×10^1	1.5×10^1	1.1×10^1	0.5×10^1

SOCIO-ECONOMIC (SIA) SURVEY QUESTIONNAIRE FOR IMPACT ASSESSMENT STUDY

Name of Settlement/Community:…………………………….
Settlement Type: ……………………………………………..
(Town, Village, Fishing Port, Hamlet, other)
L.G.A/State:…………………………………………………….
Ethnic Group:…………………………………………………
Name of Interviewer:…………………………………………
Date:………………………………………………………………

Section A: Respondent's Socioeconomic/Health Data

1. Sex
1.1. Male
1.2. Female

2. Age
2.1 20-29 years
2.2 30-39 years
2.3 40-49 years
2.4 50-59 years
2.5 60-69 years
2.6 70+ and above

3. Respondent's highest level of education
3.1 Primary school
3.2 Secondary school
3.3 Vocational/Technical school
3.4 Tertiary school
3.5 No Formal Education
3.6 Any other (please specify) …………………….

4. Highest level of education of respondent's spouse
4.1 Primary school
4.2 Secondary school
4.3 Vocational/Technical school
4.4 Tertiary school
4.5 No Formal Education
4.6 Any other (please specify) …………………….

5. Marital Status of Respondent
5.1 Single
5.2 Married
5.3 Divorced
5.4 Separated
5.5 Widowed

6. If married: i. Number of wives (if male): ………………………..
ii. Number of children: ………………………………………………
iii. No. of males: ……………. Females: …………………………
iv. Number of dependants: ………………………..
v. Total number of persons in Household: ……………………………………………………………………

7. Age and Sex structure of household members

Age in years	Male	Female	Total
0-4			
5-12			
13-18			
19-25			
26-59			
60-69			
70+ and above			

8. How many of your children presently attend the following categories of schools?

School	Boys	Girls	Total
Primary			
Secondary	`		
Vocational/Tech			
Tertiary			
Any other			

9. Please state your religion:………………………………………

10. How long have you lived in the settlement/community?
10.1 Less than 1 year
10.2 1-5 years
10.3 6-10 years
10.4 11-15 years
10.5 16-20 years
10.6 Above 20 years
10.7 Since birth

11. If non-native, where do you come from: ………………………………… (Village/LGA/State)?

12. What is your main source of income (Occupation)
12.1 Farming
12.2 Fishing
12.3 Technician/Artisan
12.4 Trading
12.5 Business/Contractor
12.6 Civil Servant
12.7 Retired
12.8 Student/Apprentice
12.9 Unemployed
12.10 Others (specify):……………………………………………

13. Which is/are your other source(s) of income (secondary occupations)?
13.1 Farming
13.2 Fishing
13.3 Trading
13.4 Technician/Artisan (specify): ……………………………
13.5 Others (specify): …………………………………………

14 Estimated income of Respondent in a month (N)
14.1 Less than 20,000
14.2 20,000-30,000
14.3 40,000 - 50,000
14.4 80,000-100,000
14.5 100,000-150,000
14.6 150,000-200,000
14.7 200,000-250,000
14.8 300,000-400,000
14.9 450,000- 500,0000
14.10 Above 550,000

15 If engaged in more than one economic activity, please estimate amount and percentage income from each:

Occupation	Amount	%
Farming		
Fishing		
Trading		
Business/Contract		
Civil Servant		
Technician/Artisan		
Others (please specify)		

16 If you are a farmer, how did you acquire the land on which you farm?
16.1 Family inheritance
16.2 Rented/leased it
16.3 Bought it
16.4 Sharecropping
16.5 Others (Specify) ………………………………

17 What crops do you grow in your farm? (Please mention according to importance)
17.1:…………………………………………………………………………
17.2: ………………………………………………………………………..
17.3: ………………………………………………………………………..

17.4: ………………………………………………………………………
17.5: ………………………………………………………………………

18. How would you describe your crop harvest in the most recent past (five years back)?
18.1 Increasing
18.2 Decreasing
18.3 The same

19 If decreasing, what in your opinion is responsible? (Record verbatim)
…………………………………………………………………………
…………………………………………………………………………
…………………………………………………………………………
………………………………………………………………………..

20. As a farmer, what constraints do you experience that work against maximum productivity?
20.1 Insufficient land to farm
20.2 Inadequate/lack of capital/money
20.3 Poor technology/local tools used
20.4 Insufficient labour hands
20.5 Any other (specify): ………………………………………………

21 If fishing is your primary or subsidiary occupation, where do you carry out your fishing?
21.1 River/Creek (please name river/creek) …………………
21.2 Ponds
21.3 Flooded areas
21.4 Sea/Ocean

22. What fishing gear(s) do you use?
22.1 Net (with canoe)
22.2 Hook
22.3 Trap/basket
22.4 All of the above
22.5 Any other (specify) …………………………………………………

23. How would you describe your fish catch/harvest in the most recent times (past five years)?
23.1 Increasing
23.2 Decreasing
23.3 The same

24. If decreasing, what in your opinion do you think is responsible?
………………………………………………………………………
……………………………………………………………………….
……………………………………………………………………….

25. Is there any restriction on where you fish?
25.1 Yes
25.2 No

26. If yes, what is/are the restriction(s)?
………………………………………………………………….
………………………………………………………………….
………………………………………………………………….

27. Which of the following type of house do you own or live in?
27.1 Sticks/bamboo with thatch roof
27.2 Mud with thatch roof
27.3 Mud with zinc roof (indicate if plastered) ……………..
27.4 Wood/plank with zinc roof
27.5 Zinc with zinc roof
27.6 Concrete/block with thatch roof
27.7 Concrete/block with zinc roof
27.8 Others (specify). …………………………………..

28 Which is your MAIN source of water supply in the DRY SEASON
28.1 Rain water
28.2 River/Creek/Stream/pond water (please specify which and name) …………………..
28.3 Public hand-dug well system
28.4 Own hand-dug well in residence/compound
28.5 Public tap
28.6 Piped water in residence/compound
28.7 Community Bore-hole (provided by whom?) ………………………………………………………..
28.8 Vendor/buys from private borehole
28.9 Others (specify). …………………………………

29 Which is your MAIN source of water supply in the RAINY SEASON
29.1 Rain water
29.2 River/Creek/Stream/pond water (please specify which and name) ……………………………………
29.3 Public hand-dug well system
29.4 Own hand-dug well in residence/compound
29.5 Public tap
29.6 Piped water in residence/compound
29.7 Community bore-hole (provided by whom?) …………………………………………………………
30.8 Personal borehole/buys from private borehole (please specify which): ………………………………………….
29.8 Others (specify). ………………………………………

30 Where do you or spouse (wife) go for child delivery?
30.1 Attends hospital/clinic/Community health center (tick exact one)
30.2 Attended to by Traditional birth attendant (TBA)
30.3 Delivers in religious houses /Church
30.4 Any other (specify): …………………………………………

31 How many births have occurred in your household in the last 1year? ………… (Male: …… Female:…..)

32 How many deaths have occurred in the last 12 months in your house? …………… (Male: …….. Female: ……….)

33. What was the cause of the death?…………………......................

34. What kind of toilet facility (sewage disposal) does your household use?
34.1 No facility/open bush
34.2 Pit latrine
34.3 Flush toilet
34.4 Pier/jetty toilet
34.5 Others (specify)..

34. Where do you dispose of your domestic refuse/garbage?
34.1 Depositing refuse at backyard of house
34.2 Dumping in river/creek
34.3 Dumping in community refuse/garbage pit/burying
34.4 Local incineration (burning) when dry
34.5 Others (specify): …………………………………………………

35. To what other use do you put the River/Creek water close to your community?
35.1 Washing of clothes/household articles
35.2 Swimming/bathing
35.3 Fishing
35.4 Sand extraction

36. Which health services are available in your settlement/community?
36.1 Chemist/Pharmacy
36.2 Traditional care
36.3 Private Clinic/Hospital
36.4 Govt./Community Health Centre
36.5 Govt. Hospital
36.6 None
36.7 Other (specify)……………………………………………………

37. Which of the above do you personally use when you or family member are ill?
37.1 Chemist/Pharmacy
37.2 Traditional care
37.3 Private Clinic/Hospital
37.4 Govt. /Community Health Centre
37.5 Govt. Hospital
37.6 None
37.7 Other (specify)………………………………………………………

38. Why do you use the health service mentioned above?
………………………………………………………………………………
………………………………………………………………………………

39. What is the name of the nearest Health Facility to you? …………………………………………………………………………………

40. Which is your USUAL means of transport to the health facility?
40.1 I do not use orthodox health service
40.2 Trekking
40.3 Hand-dug Canoe
40.4 Speed boat
40.5 Bicycle
40.6 Motorcycle/Car/bus (specify): …………………………………..
40.7 Other (specify)……………………………………………………

41. How long does it take for you to get to the place?.....................1) Hour: ……..... 2) Minutes……..

42. What are the common types of ailment you suffer from MOST FREQUENTLY?
………………………………………………………………………
………………………………………………………………………

43. How would you describe your present state of health?
43.1 Well/healthy
43.2 Not well /sick

44 If you are ''not well/sick'', what is the problem/nature of sickness?
………………………………………………………………………

Section B: Socioeconomic Sensitivity/ Attitudes/Perceptions

45. What period of the year is important to you/ your community for:
45.1 Farming ……………………………………………………………..
45.2 Fishing ……………………………………………………………..
45.3 Trading ……………………………………………………………
45.4 Festivals ……………………………………………………………

46. Which of the following important environmental resources in your community do you value most?
46.2 Forest resources
46.3 River/Creek water
46.4 Ancestral sites
46.5 Animals
46.6 Others (please specify): .....………………………….......................

47. Please indicate the environmental problems which your settlement/community experiences
47.2 Soil infertility
47.3 Pest attack/invasion
47.4 Erosion problems
47.5 Flooding
47.6 Oil pollution/spillage of water resources/fisheries
47.7 Others (specify): …………………………………………………..

48. Would you say your economic activity has been affected in any way in the past (5 years or so?
48.2 Yes
48.3 No

49. If yes, in what specific way(s) have you been affected?
…………………………………………………………………………
…………………………………………………………………………
…………………………………………………………………………..

50. What in your opinion may have caused the situation?
………………………………………………………………………
………………………………………………………………………
………………………………………………………………………

51. Do you think that the proposed project activities and subsequent use would affect you in any way?
51.1 Yes
51.2 No

52 If yes, in what specific way?…………………………………………

53 Do you have any objection to the proposed project?
53.1 Yes
53.2 No

54 If 'yes", please state reason(s)
…………………………………………………………………..
…………………………………………………………………...

55 Which of the under-listed social problems have your community experienced in the recent past (tick as many as applicable)?
55.1 Youth delinquency
55.2 Land dispute
55.3 Chieftaincy tussle
55.4 Inter-family problems
55.5 Inter-village tribal conflicts
55.6 Unemployment
55.7 Alcoholism/prostitution

56 Please state reasons or causes of observed behaviors/problems
…………………………………………………………………………
…………………………………………………………………………

57 What are your recommended solutions to observed community problem(s)?
………………………………………………………………………
………………………………………………………………………

58 Please state your expectations from the proposed project construction and eventual commissioning for use in this your area
…………………………………………………………………………
…………………………………………………………………………
…………………………………………………………………………

SOCIO – ECONOMICS STUDIES FOR THE LAGOS FREE ZONE ENVIRONMENTAL DATA REVALIDATION / EIA UPGRADE

ATTENDANCE LIST

NAME OF COMMUNITY: LEKURU.

LOCAL GOVERNMENT AREA: IBEJU- LEKKI

DATE : 19 – 08 – 2020

S/NO	NAME	POSITION IN THE COMMUNITY	TELEPHONE NUMBER	SIGNATURE
1	Sanusi Adelaja	~~[illegible]~~ Lekuru	08021053082	
2	Ojunde solomon	lekuru	08085495190	
3	Mr Kolawole Q.	lekuru	08105021517	
4	MR HAMZAT ·W·O	~~Secretary~~ Lekuru LEKURU	08260824363	
5	Bandele ramotah	Lekuru	08169582669	
6	olufolabi Saheed	Lekuru	08087413499	
7	Monsuru Alashe	Lekuru	08114984466	
8	Alashe Ahmed		07069567495	
9	Quadri Yahya.		07032699020	
10	Olabode omotola		09027758890	
11	Sakah musilimu			

1.

(12) Prince musilimu O.	Lekuru		
(13) moruf Alashe	Lekuru		
(14) Oloja Taofeek	✓ ✓	07042125362	
15 Olt Kabiru	✓ ✓	09092615-0233	
(16) Abiodun Kadiri	✓ ✓		
(17) Oloja Adijat	✓ ✓		
(18) Alowolo Wakilu Alashe	✓ ✓	07046067443	
(19) Arowolo Abosy	✓ ✓	07044942577	
(20) Oloja Mary	✓ ✓	08083009178	
(21) Molik Olumakemi	✓ ✓	09039541799	
(22) Taiwo oloja	✓ ✓		
(23) Oloja Adewale	✓ ✓	07034772147	
(24) WALIU SALAMI . A .	LEKURU	08062698308	
25 Eleto Olabode	lekuru	09057406574	
26 Alhaji T. Eleto	lekuru	09026042541	Eleto
27 Dr. Meshach Ojile	SIA Consultant	08033410061	
28 Dimgi Bodunde	SIA/GET	07056853195	

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SOCIO – ECONOMICS STUDIES FOR THE LAGOS FREE ZONE ENVIRONMENTAL DATA REVALIDATION / EIA UPGRADE

ATTENDANCE LIST

NAME OF COMMUNITY: ALASIA

LOCAL GOVERNMENT AREA: IBEJU-LEKKI

DATE : 20-08-2020.

S/NO	NAME	POSITION IN THE COMMUNITY	TELEPHONE NUMBER	SIGNATURE
1	Ajisebutu Babatunde	Chief	08133321122	[signature]
2	Kemi Ibrahim			
3	Abayo Toicunbo	Church Priest	08105241789	[signature]
4.	Temidayo Busari	Chief	08035501400	[signature]
5	Jimoh Adebayo	LandLord.	07055051423	[signature]
6	Banjo Morayo	Tenant	09078477765	[signature]
7	Bernard Emeka	Coach	08026343075	[signature]
8	HENRY-N. JOE	Tenat	08062794138	[signature]
9	Olamiju Komolafe	Tenant	08026343075	[signature]
10	Ajisebutu Omolola	Wife		[signature]
11	Akinleye Mariam	Wife		[signature]

12	Ajisebutu Mariam	Wife	07049641141	
13	Adeye Ifeoluwa	Wife	07046061627	
14	Olatokunbo Adefunke	Wife	07052620057	
15	Comfort Dzuamo	Wife	08062339637	
16	Popoola Funmilayo	Wife	07042411627	
17	Mary Kasali	Wife(LandLady)	08124556138	
18	Kikelomo Samson	LandLady	09027181960	
19	Ajisebutu Mutiat	Wife		
20	Ajisebutu Sekinat	Wife		
21	Kehinde Regola	Wife		
22	Temitope Funmilola	Wife	08062803635	
23	Ajisebutu Kehinde	Wife		
24	Adigbona Dupe	Wife	08136483590	DUPE
25	Salome Kave	Wife	08136987154	
26	Saba Samson	LandLord	07068673286	
27	Saba Salawu	Wife	07060697032	
28	Adeye Adesola	Landlord	07046061627	
29	Olawadi Opoju	Wife	07088217843	

30	Samson	land lord	09026656926	
31	AKINTAYU		08134780140	
32	ALIDU AMEN		09041413066	
33	Odunayo temitope	Student	08084147976	
34	Kasali Ilesanmi		08138599557	
35	Bose Bamjo	lalife	07014860232	
36	Ajisebutu Shola	lalife	08053305753	
37	Ajisebutu Samson	Land lord	08100949123	
38	Ajisebutu Idowu	Land lord	080597583	
39	ALABA	land lord		
40	Ajisebutu lanre	land lord	09035525082	
41	Ajisebutu Bose	LandLady	09035355793	
42	Adegbona Femi	Landlord	08168211779	Fm
43	Ajisebutu Mama	LandLady		
44	Sulaimon Asegere	LandLord	07041674545	
45	Danial Oluwatobi	Land Lord	07088804375	
46	Kareem Nurudeen	LandLord	07026874006	
47	Oriyomi Adenuga	LandLady	08084878116	
48	Dr. Meshach Ogile	Consultant GETSTA	08033410061 07056853195.	
49	Dimeji Bodunde			
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SOCIO – ECONOMICS STUDIES FOR THE LAGOS FREE ZONE ENVIRONMENTAL DATA REVALIDATION / EIA UPGRADE

ATTENDANCE LIST

NAME OF COMMUNITY: OKUNRAIYE

LOCAL GOVERNMENT AREA: IBEJU – LEKKI

DATE : 20-08-2020.

S/NO	NAME	POSITION IN THE COMMUNITY	TELEPHONE NUMBER	SIGNATURE
1.	chief Jamiu Akani	chief Baale	07036117359 07088429835	
2.	chief Jubiribo K.	chief Balogun	08074658918	
3.	Balogun Sakiru	committe.	08034206532	
4.	Akimu saka	✓	07051842859	
5.	onikosi Mujoridu	✓	08074717638	
6.	Ibraheem sedin	C.D.A. secerary	07084190082	
7	Adegbola M.K	CDA Secretary	08055254788	
8.	Olasogba Murilu	committe.	08075169556	
9.	~~Balogun~~ Alago Samsi	✓	08158652345	
10.	Saliu saidi	Youth sec.	08065839573	
11.	Balogun Fagu	✓ V. chiaman	08062252622	FA

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11.	Jubirila Latifu	Igbofiri Chairman	07054444153	Lat
12-	Adekoya Yusuf	Idirokoku chairman	08125106977	
13.	Akanni Isimola	Ipatun chairman	09011723840	
14.	Badejo Safura	Multiple Editor	07018040040	
15	Adesola Adegoke	Igbowe chairman	09014367612	
16-	Salin Isimola	super, for Enitor	08053546216	
17.	Mukailu Sikirat Sikirat	Iya Oloja	08118051498	Sikirat
18-	Adele Kikelomo	comm. to Iya Oloja Comm Iya Oloja	0808723049 8	Kikelomo
19.	Seyidat Balogun	comm. to Iya Oloja	08124340421	Seidat
20	Samodu Morifa	comm to Iya Oloja Member Marketing	09042406461	Morifa
21-	Akibu Rasaki	Committe to Baale	08052397473	R A
22	Alh. Surajudeen Olaleyan S.	Rep. of Baale in Council	08051822976	
23-	Jimoh Nofiu	Okunraye Member	07011710049	
24.	Adele Kasimu	Tresurer	08156829927	
25	Dr. Meshach Ojile	S/A Consultant	08033410061	
26	Dimgi Bolude	GET/S/A	07056853195	

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SOCIO – ECONOMICS STUDIES FOR THE LAGOS FR[illegible] ENVIRONMENTAL DATA [illegible]VALIDATION / EIA UPGRADE

ATTENDANCE LIST

NAME OF COMMUNITY: MAGBON- SEGUN.

LOCAL GOVERNMENT AREA: IBEJU- LEKKI

DATE : 22-08-2020.

S/NO	NAME	POSITION IN THE COMMUNITY	TELEPHONE NUMBER	SIGNATURE
1	CHIEF MUFUTAU DAUDA	BAALE/COMMUNITY HEAD	08032434404	
2	MR GARUBA BASHIRU	COMMUNITY LEADER	08082539997	
3	MR. SANNI SAMUSI	COMMUNITY REPRESENTATIVE	09066825097	
4	MR. OSENI TAJUDEEN	COMMUNITY REPRESENTATIVE	08160372401	
5.	MR. BALOGUN ISIAKA O	COMMUNITY REPRESENTATIVE	08037466434	
6	ALH. ALIDU SHUAIB	LEADER	09099708667	
7	MR. AREPO AZEEZ	YOUTH CHAIRMAN	08175434314	
8	MR. WASIU SANNI		08056212160	
9	MR RAMON ADEKUNLE		08059167216	
10	MR. ODUKOYA OLAYINKA	COMM. REP.	07030365006	
11	MR. RAMON AYO		08054558190	AYO

1.

12	MR. BELLO SAKIRU	ELDER	07039439015	~~0490~~ S Bell
13	MRS BADMUS FUNMAYO	ELDER	07055724537	0710567848927
14	MRS AFUSAT BADA	MEMBER	09021923689	
15	MR. SAMBA BELLO	COMM REP	09031780663	
16	MR. BALOGUN MORUFU	MEMBER	07088683616	
17	MR ALOGBA SAMUEL	WARD CHAIRMAN	07044004414	
18	MRS WARIKAT DAUDA	MEMBER	08143520573	
19	MRS ABIODUN DAUDA	MEMBER	08106837266	
20	MRS. AKEREELE IDAYAT	MEMBER	08084050878	
21	DR. MESHACH OJILE	Socioeconomic Consultant	08033410061	

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SOCIO – ECONOMICS STUDIES FOR THE LAGOS FREE ZONE ENVIRONMENTAL DATA REVALIDATION / EIA UPGRADE

ATTENDANCE LIST

NAME OF COMMUNITY: OKE - SEGUN

LOCAL GOVERNMENT AREA: IBEJU- LEKKI

DATE : 22 - 08 - 2020.

S/NO	NAME	POSITION IN THE COMMUNITY	TELEPHONE NUMBER	SIGNATURE
1	Chief Adeyemi S.A	Baale Oke-Segun	08146855233	[signature]
2.	Mr. Dada M.I	Community leader	09064972858	[signature]
3	Mr. Dada Moruff.	Assistant Baale	09018010965	DADA
4	Tijani K.A (MR)	Community Rep.	07035367169	[signature]
5	Adeyemi Ismaila	Assistant Youth chair.	07082254713	Adeyemi
6	Tijani M. Ayodeji	Assistant Comm. Rep.	08060949869	Tijani
7	Muritala Waidat	Member	08020148110	[thumbprint]
8	Dada Ranti	Women leader	07084127622	.DR
9	Adeyemi Folake	Member	08062708161	[signature]
10	Adeyemi Idrat	Member		[thumbprint]
11	Dada Waliat	Member		[thumbprint]

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12	Dada Falali	Member		
13	Adeyemi Kikelomo	Member	08149709628	
14	Tijani Sherifat	Member	08092718456	
15	Taiwo Muritala	Member	08026567848	
16	Dr. Meshach Ojile	Socioeconomic Consultant	08033410061	
17	Dimgi Boduda.	SIA	07056853195	
18				