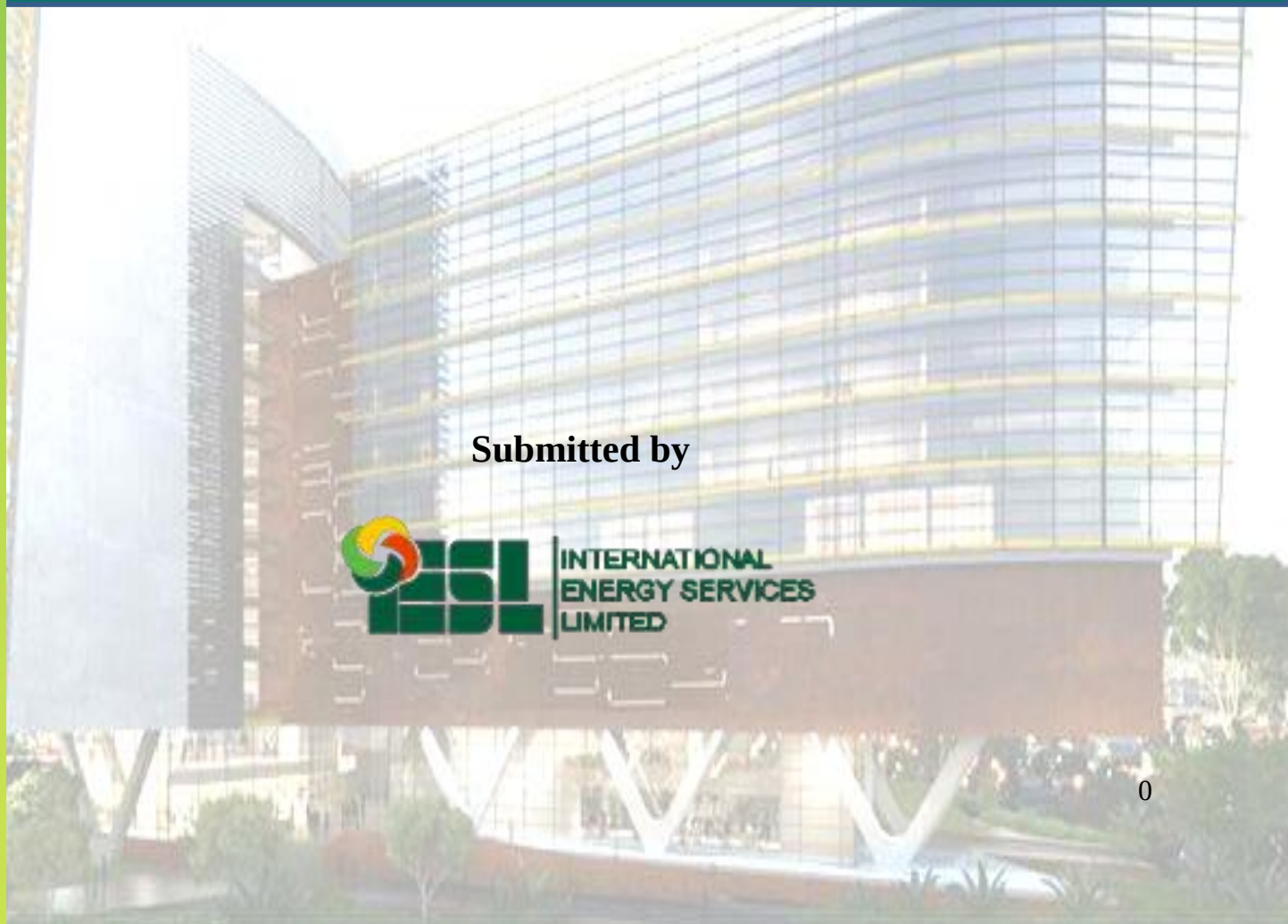
AFREXIMBANK

ENVIRONMENTAL IMPACT ASSESSMENT STUDY for the Construction of the AFREXIM Bank Africa Trade Centre (AATC)



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INTERNATIONAL ENERGY SERVICES LIMITED

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ENVIRONMENTAL IMPACT ASSESSMENT STUDY for the Construction of the AFREXIM Bank Africa Trade Centre (AATC)
Draft Report

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ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR THE CONSTRUCTION OF THE AFREXIM BANK AFRICA TRADE CENTRE (AATC)

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DRAFT REPORT **August, 2020**

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EXECUTIVE SUMMARY

ES1 INTRODUCTION

This is the draft report of Environmental Impact Assessment (EIA) for the proposed AFREXIMBANK–Africa Trade Centre (AATC), Abuja Municipal Area Council, Federal Capital Territory Abuja. The approach to this EIA was structured such as to cover the requirements under the EIA Act CAP E12, LFN 2004, the EIA Regulations as stipulated under the Federal Republic of Nigeria official Gazette No. 73, Vol.79, and the World Bank Safeguard Policies.

THE PROPONENT

African Export-Import Bank (AFREXIMBANK) is headquartered in Cairo, the capital of the Arab Republic of Egypt, a pan-African, multilateral financial institution which was established in 1993 by Governments, African private and institutional investors, non-African institutions and private investors for financing, promoting and expanding intra-African and extra-African trade , commenced operations on 30 September 1994, following the signature of a Headquarters Agreement with the host Government in August 1994.

PURPOSE AND CONTENTS OF THIS REPORT

The purpose of this Environmental Impact Assessment (EIA) report is to identify the major environmental and social impacts associated with the project development of AFREXIMBANK–Africa Trade Centre (AATC) as well as identifying mitigation measures to reduce or avoid anticipated impacts.

PROJECT LOCATION

The proposed site is located on a parcel of land in Abuja, Nigeria. It can be found on the southern portion on the intersection of Independence Avenue and Sani Abacha Way. The proposed site is also bordered by the National Ecumenical Centre. The site is measured at 5,856 square meters and is in the Central Business District (CBD) (Plate 1.3), Abuja within the geographical coordinates of latitude 9.05422 and longitude 7.49719 sitting on an elevation of approximately 497metres above sea level and surrounded by a 287meter perimeter fencing guarded by security guards attached to the company. The site facing the northwest direction is bordered to the west by the Labour House and to the east, compound belonging to the Ministry of finance, while to the south it is flanked by a property owned by African Renaissance (Africa-Re) and to the north, the Independence avenue.

SCOPE OF THE PROJECT

It is proposed that the development will accommodate the following key facilities

- AFREXIMBANK Offices

- Contingency Offices
- Tenant Offices (long term corporate rental)
- Trade Centre Offices
- Conference Hall/ Exhibition
- Seminar and Meeting Rooms
- SME Business Innovation/ Incubation Hub (including Knowledge Centre & Library)
- Hotel (120 keys) including associated public areas, restaurants, light retail & gym
- Car Parking

EIA OBJECTIVES

The objectives of the EIA for the project are:

- To provide information and evidence needed for developing an Environmental Impact Statement (EIS) for the proposed project in its entirety;
- To establish the baseline environmental, identify any sensitive components of the environment and social setting of the project site and its surroundings.
- To identify adverse environmental problems that may be encountered in the development of the proposed project which may cause negative environmental, social, health and economic effect on the immediate environment.
- To incorporate mitigation measures on environmental management programme of the proposed project development process.
- To resolve conflict that may occur between social, economic, visual, ecological and engineering requirements during all stages of project development.
- Assist project design and planning by identifying and quantifying aspects of construction, operation and decommissioning which may cause adverse environmental, social, health and economic effects and recommend measures to avoid and mitigate adverse effects and enhance beneficial impacts.
- To identify the best practicable environmental options that requires that the chosen option should result in the least environmental damage
- To develop an Environmental Management Plan (EMP) for all phases of the project including compliance, monitoring, auditing, and contingency planning.
- To meet the FMEnv requirements on EIA procedure for approval/certification before project commencement and implementation.

BENEFITS OF THE EIA

The EIA is a tool for generating information and assessing developmental activities for potential environmental risk that may result from such activities. The proponent in her mandate to undertake

this project when approved is committed to environmental protection, resource conservation, poverty alleviation through employment generation and people's involvement in infrastructural and services provision within FCT. The EIA will boost confidence of the communities within the project area; and its implementation will engender accrued benefits to AFREXIM Bank and the government, in the following ways:

Integration of environmental consideration in the development plan, construction and use; of infrastructural and engineering facilities within the project area.

The proponent will be equipped with necessary information that will guide planning, execution and utilization of the project;

Integration of concerns of all stakeholders through consultation necessary for effective take off, operation, maintenance and decommissioning of the project and

Engagement of a continuous assessment and environmental monitoring to enhance performance of project implementation.

Fulfill regulatory requirements necessary to secure permit(s) from regulatory authorities before the commencement of the Development Project.

Policy, Legal and Administrative Framework

There are number of relevant national and international environmental policies and regulations that are applicable to this project are discussed in chapter one.

- Environmental Impact Assessment (EIA) Act *Cap E12, LFN 2004*
- National Environmental Standards And Regulation Enforcement Agency (NESREA) Act 2007
- AEPB Act of 1997
- Land Use Act
- Development Control guidelines
- Abuja Master Plan of 1976

Applicable Nigerian Laws

- Federal Capital Territory Creation Act, Decree No.6 of 1976
- Federal Capital Territory's (Establishment of functionaries and Departments) and the Federal Capital Territory's (Dissolution) order No. 1 of 2004
- The Abuja Environmental Protection Board Act No. 10 of 1997
- Environmental Impact Assessment Act CAP E12, LFN 2004.

- Harmful Wastes (Special Criminal Provisions etc.) Act No.42 of 1988
- Solid Waste Control/Environmental Monitoring, (AEPB Regulations 2005)
- The Endangered Species (Control of Trade and Traffic) Act in 1985
- Exclusive Economic Zone Act No.42 of 1998
- Territorial Waters Act No.1 of 1998
- Land Use Act (LUA) Cap.202, 1990
- Exchange Control Repeal Act 1995
- Nigerian Enterprises Promotion Repeal Act 1995
- Nigerian Investment Promotion Commission (NIPC) Act No. 16 of 1995, now Cap. N117 LFN 2004)
- Foreign Exchange (Miscellaneous & Monitoring Provisions) Act (No. 16 of 1995, now Cap. F34, LFN 2004

International Environmental Legislation

Nigeria is signatory to several international treaties and conventions. These include those on climate, waste, oil and chemical pollution and others. These conventions and their years of adoption are shown in Table 2.1.

International Finance Corporation (IFC) requirements

The EIA will be consistent with the International Finance Corporation (IFC) requirements. While developing the EIA, the following Policies, Standards and Guidelines will be adhered to:

IFC's Policy and Performance Standards (PS) on Environmental Sustainability (January 2012).

The World Bank Group Environmental, Health, and Safety Guidelines, known as the 'EHS Guidelines' (2012) (see **Table 1.3**).

EIA Report Structure

The main body of the report is presented in 9 (Nine) chapters.

Executive Summary		
Chapter One	-	Introduction
Chapter Two	-	Project Justification
Chapter Three	-	Project and Process Description / Environmental Design
Chapter Four	-	Description of Project Environment
Chapter Five	-	Associated and Potential Environmental Impacts
Chapter Six	-	Mitigation Measures
Chapter Seven	-	Environmental Management Plan

Chapter Eight - Decommissioning and Closure

Chapter Nine - Conclusion

Appendix

References

E.S 2 PROJECT JUSTIFICATION

Need for the Project

In execution of its mandate, AFREXIMBANK uses three broad instruments of intervention namely credit (trade and project finance), risk bearing services and advisory services.

In 2017, the Bank approved its 5th Strategic Plan (2017 – 2021) which places emphasis on the following:

- promoting intra-African trade;
- facilitating industrialization and export development in Africa;
- strengthen Trade Finance Leadership; and
- improve Financial Soundness and Performance

In line with this strategic plan, the Bank has set out to transform its existing and future buildings into business complexes, which will be branded “Afreximbank – Africa Trade Centres”, to provide an integrated one-stop shop for trade services. These are envisaged to be iconic business complexes that will provide a suite of integrated trade services and trade finance. These trade centers are expected to enhance the Bank’s brand equity and play a vital role bridging the intra-African trade information gap on the continent. Additionally, and in order to gain scale, the Bank will consider supporting existing and new TCs in various African cities.

Objectives for the Project

Broad Objective

To establish an iconic business complex to provide an integrated one-stop shop for trade services and business facilities. The trade services would be provided by way of possible joint ventures/partnerships through co-branding and co-servicing with relevant partners.

Specific Objectives

- To bridge the gap in trade and market information in Africa, especially with regard to intra-African trade;

- To provide an integrated one stop-shop for trade services, trade finance and advisory services to the business community;
- To provide a range of iconic business facilities to support the effective provision of key trade services offered;
- To increase intra-African trade, catalyse value addition and export manufacturing and contribute towards positive economic transformation of the African continent.

Project Development Options

No project option: The "no-project option" implies that the construction of the proposed AFREXIM Bank–Africa Trade Centre (AATC) Abuja will not be. This option is considered if there is economic, technical or human capacity deficiencies or that the proponents are unwilling to commence the project or that the regulatory authorities are unwilling to approve the project; thus leading to a "no project option". This option will translate to non-beneficiary by the FCT in particular and the nation as a whole. This will also mean that the socio-economic impact seen as positive on Abuja and the nation will not be achieved. This is not good for socio-economy, population growth, poverty alleviation, health, expansion and development of the nation. This option was not considered, therefore, the need for the project.

Delayed project option: This option implies that the execution of this project will be delayed until a much later date. Such option is usually taken when conditions are unfavourable for project implementation, such as in a situation where there is war, or host community is deeply resentful of the project. Also, if the economics of the project are unacceptable or unattractive at the time, then a delay may be feasible. But none of these conditions are applicable.

Alternative Site/Location option: The proposed site is located on a parcel of land in Abuja, Nigeria. It can be found on the southern portion on the intersection of Independence Avenue and Sani Abacha Way. The proposed site is also bordered by the National Ecumenical Centre. The site is measured as 5,856 square metres and is in the Central Business District (CBD). The site was carefully selected to meet the criteria for selection of an appropriate site for project of this magnitude which include; minimum possible infringement, availability of adequate space, avoidance of historic sites and environmental sensitive areas. The project site has been surveyed and all necessary site details, site layout drawings, site plan and approvals from the Federal Capital Development Authority have been processed. Thus, alternative site/location is not considered.

Alternative Technology Option: There are various technologies and equipment vendor available in the construction industry. The proponent shall adopt the technology and equipment produced by a technical company with integrity. For consistency with the technological make-up of the existing

equipment and tools, there is no need for consideration of an alternative technology for the proposed project.

Analysis of Alternative Construction Materials and Technology: The proposed project will be constructed using modern, locally and internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements. Equipment that saves energy and water will be given first priority without compromising on cost or availability factors.

E.S 3 PROJECT AND PROCESS DESCRIPTION / ENVIRONMENTAL DESIGN

A Global/pan-Africa Design concept is being developed as part of the Abuja AATC. The design will incorporate the Bank's vision of a landmark, mixed-use, modern, futuristic and iconic one-stop shop Complex which possesses a broad intra-African-Trade, character and appeal. The concept will be scalable and adaptable to the Bank's proposed site while maintaining the core character, appeal, look and feel as we adapt to local constraints such as land size, shape, regulatory provisions or any other restrictions. The Abuja AATC is located on a significantly smaller site footprint. This AATC essentially provides the core functions with a small hotel. As there is no retail offering the conference hall and associated meeting rooms are located on the ground floor with a direct link to the arrival piazza and atrium. Trade centre offices and SME incubation hubs are located on the mezzanine level with offices and accommodation above. The long terms rental offices and apartments are located in the towers which have good visibility from both Independence Avenue highway and the access road. There is a small portion of on grade parking in front of the building for the VIPs. Possible delivery access could be taken from the street on the western side of the site should this be possible in future. This concept has been selected as the preferred Global Concept.

E.S 4 DESCRIPTION OF PROJECT ENVIRONMENT

Study Methodology: The methodology adopted was based on the FMEnv guidelines for EIA study; they are as follows:

Sampling design and strategy: The sampling strategy for this study was based on the land mass (size) which is mostly an excavated land, proximity to the road and other preexisting buildings. A total of 60 soil samples were collected from 30 stations at both top soil of between 0-15cm and bottom soil (15-30cm), 27 stations was collected with grid sampling pattern were within the site while the three control stations were located 166m to the north, 266m to the west and 255m to the east of the site.

Air and noise measurements were carried out at seven stations within the site with emphasis placed on the entrance, part of the site in close proximity to the road and the centre of the site, while three control stations were located 166m to the north, 266m to the west and 255m to the east of the site

Water was sampled at 3 locations with preexisting boreholes in close proximity to the site and two locations at farther proximities as control samples.

Climate and Meteorology: Information on the climate of the study area was obtained largely from existing literature from Nigerian Meteorological Agency of the Federal Ministry of Aviation, Maitama Abuja; eleven years data (2004 – 2014) were used for rainfall, relative humidity, temperature, sunshine, wind speed and wind direction. The two weather conditions that exist in the year in the Federal Capital Territory as well as the Central Business District (CBD) in Abuja Municipal area council are extremely dry season, and rainy season. In between these seasons, is a short period of harmattan accompanied by the North East Trade Wind with features of dust haze. The climatic characteristics of the area studied are: rainfall, temperature, humidity, sunshine and wind speed and direction.

Weather: The study area has two main seasons; the rainy season (April-October) and the dry season (November-March). The high influence of undulating terrain of the area act to provide a regulating influence on its weather. During the dry season, temperature records are at peak in the month of March. During the rainy season, temperature records drop considerably due to large cover of thick convective clouds like Cumulonimbus and Nimbostratus. This is notable in the months of July-August. The Relative Humidity of the study area tends to be high during the rainy season as compared to low records during the dry season. The weather elements of the area studied are: rainfall, temperature, humidity, sunshine and, wind speed and direction. All the data were sourced from Nigerian Meteorology Agency, Abuja (NIMET).

Air and Noise Quality

Average ambient temperature was 36.77^{0}C, average relative humidity was 20.31% in the dry season and in the wet season the values for ambient temperature and relative humility were 30.37^{0}C and 53.36% respectively, average wind speed recorded was 1.47m/s in the dry season and 0.97m/s in the wet season, the mean noise level in around the site was recorded in the dry season as 69.80dBA with high values of 85.2dBA(AQ5) and 82.1dBA (AQCtrl 2) recorded due to their proximity to the highway while in the wet season average noise levels was 65dBA.

Suspended particulate matter: Suspended particulate matter across the ten (10) sampling locations around the project site was relatively low, the average particulate matter recorded was 32µg/m^3 for $PM_{2.5}$ and 65.5µg/m^3 for PM_{10} in the dry season and in the wet season; the levels were 20.14 µg/m^3 and 122.14 µg/m^3 for $PM_{2.5}$ and PM_{10} respectively.

Pollutant Gases: SO_2 and O_3 were not detected in air quality parameters measured in both seasons, average NO_2 measured in the dry and wet season were 0.06 and 0.03 µg/m^3 respectively, average CO was 0.008 and 0.01 µg/m^3 in the dry and wet season respectively, average H_2S in the

dry was 0.0002 µg/m^3as H_2S was not detected in the wet season, average VOC in the dry and wet season was 0.0009 and 0.001µg/m^3

Nitrogen dioxide (NO_2) is one of the most prominent air pollutants. In this study, however, it occurs minimally within the range of 0.00 – 0.2 µg/m^3 in the dry season and 0.00 – 0.1 µg/m^3 in the wet season.

Carbon monoxide The concentration recorded in this study falls within 0.00 – 0.02 µg/m^3 for the dry season and 0.00 – 0.01 µg/m^3 in the wet season.

Sulfur oxide. In this study however SO_2 was not detected in both seasons.

Volatile organic compounds (VOC): VOC level recorded in all the ten (10) sampling points in the study area averaged at 0.004 µg/m^3 and 0.001 µg/m^3 in the dry and wet season respectively.

Water Quality Study

pH: The average pH value recorded in this water study from the project site was 8.0 in the dry season and 7.5 in the wet season and is within NESREA effluent limit thereby indicating almost neutral nature of the water.

Turbidity, Colour, Odour and Mineral oil: The turbidity recorded was 2.2 NTU for both dry and wet season, the water sample from the site is clear, transparent, colourless and free of any offensive odour. Mineral oil was not detected.

Conductivity and Total Dissolved Solids (TDS): In this study, average TDS detected were 47.46 mg/l in the dry season and 43.2mg/L in the wet season, while conductivity recorded was 95 and 93.4 µS/cm in the dry and wet season respectively.

Organics and Microbiology: Organics (Oil and grease and Total hydrocarbon) recorded in both dry and wet season was below 0.01mg/L as shown in fig 6.11, average microbial parameters shows in the dry and wet season respectively; 2.33x10^2 cfu/ml and 1.8x10^2 cfu/ml for Total heterotropic bacteria, 2.06 x10^2 cfu/ml and 3.5 cfu/ml for Hydrocarbon utilizing bacteria, 1.26 x10^2 cfu/ml and 6.42 x10^2 cfu/ml for Total heterotropic fungi, 1.44 x10^1 cfu/ml and 4.2 cfu/ml for Hydrocarbon utilizing fungi.

Heavy Metals: Heavy metals investigated in this water study shows that chromium, lead, cobalt, silver and vanadium were below the instrument detection limit of 0.001mg/L. Mean Nickel concentrations were found to 0.09 mg/L in the dry season and 0.21 mg/L in wet season, cadmium levels were 0.005 mg/L and 0.05 mg/L in the dry and wet season respectively, copper levels were 0.001 mg/L and 0.105 mg/L in the dry and wet season respectively, iron levels were 0.055 mg/L and 0.044 mg/L in the dry and wet season respectively, zinc levels were 0.001 mg/L and 0.029 mg/L in

the dry and wet season respectively and manganese was detected only in the dry season with average concentration of 0.018mg/L.

Geology of the Study Area

The geology at the proposed development is comprised of migmatites. The mineralogical composition is up to 70% quartz hence sandy soils are expected to have developed from the migmatite. The ground was found to be comprised of sands, sandy gravels, sandy clays and gravelly clays, with bedrock in excess of 5m deep

Soil of the Study Area

Soil samples for analysis were collected, randomly from twenty seven (27) different locations of the project site at a depth of 0 – 15cm and 15 – 30cm and three (3) control points in each of the sampling point using soil auger.

pH: The soil pH values recorded in thirty (30) sampling points of this study show that pH increases with increase in soil depth with an average of 7.6 and 7.58 in the dry and wet season for the top soil and 7.63 and 7.66 in the dry and wet season for bottom soil and all within the range of (7.1 - 7.9) with the highest in sampling point S8 Top around the south western area of the site and the lowest in sampling point S16 Top around the northern axis of the project site. These values show characteristics of slightly alkaline soil.

Nitrate (NO_3^-): Nitrate from the sampling points vary between 0.1 to 20.9 mg/kg and an average of 1.19mg/kg and 0.56mg/kg in the top and sub soil respectively in the dry season and an average of 0.82mg/kg and 1.56mg/kg in the top and sub soil respectively in the wet season.

Sulphate (SO_4^{2-}): The concentrations of sulphate ion in this study across the four sampling points are in the range of 1 to 65 mg/kg and an average of 6.23mg/kg in both the dry season and wet season with the highest of 65mg/kg recorded at sampling point S6 Top.

Exchangeable Cations: Mean concentration of the cations in the study area was measured: Calcium 1077.21mg/kg and 1048.13 mg/kg for top and sub soil respectively; potassium at 6308.87 mg/kg and 5940.23 mg/kg for top and sub soil respectively .Sodium has average concentration range of 2555.94 mg/kg for the top soil and 2240.38 mg/kg for the sub soil.

Organics and Microbiology: The average microbial parameters shown in the dry and wet season respectively; $2.64x10^6$ cfu/ml and $9.76\ x10^6$ cfu/ml in the top soil and $2.54\ x10^6$ cfu/ml and $2.54\ x10^6$ cfu/ml in the sub soil for Total heterotrophic bacteria, $1.48\ x10^6$ cfu/ml and $1.56\ x10^6$ cfu/ml in the top soil and $1.45\ x10^6$ cfu/ml and $1.57\ x10^6$ cfu/ml in the sub soil for Total heterotrophic fungi, $1.17\ x10^6$ cfu/ml and $1.05\ x10^6$ cfu/ml in the top soil and $1.0\ x10^5$ cfu/ml and $1.09\ x10^5$ cfu/ml in the sub

soil for Hydrocarbon utilizing fungi and 4.75 $x10^5$ cfu/ml and 3.88 $x10^5$ cfu/ml in the top soil and 3.17 $x10^5$ cfu/ml and 2.66 $x10^6$ cfu/ml in the sub soil for Hydrocarbon utilizing bacteria.

Heavy Metals: The concentration of nickel in the dry season was 31.32 mg/kg and 24.07mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 73.51 mg/kg and 65.41mg/Kg for the top and sub soil respectively, cadmium concentration was 27.88 mg/kg and 32.16 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 8.29 mg/kg and 6.99 mg/Kg for the top and sub soil respectively, copper concentration was 22.31 mg/kg and 20.73 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 32.88 mg/kg and 29.73 mg/Kg for the top and sub soil respectively, iron concentration was 332.15 mg/kg and 335.11 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 465.43 mg/kg and 439.35 mg/Kg for the top and sub soil respectively, zinc concentration was 44.84 mg/kg and 41.17 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 65.88 mg/kg and 41.38 mg/Kg for the top and sub soil respectively, manganese concentration was 250.4 mg/kg and 260.2 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 357.6 mg/kg and 278.6 mg/Kg for the top and sub soil respectively, lead concentration was 31.92 mg/kg and 35.43 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 201.1 mg/kg and 203.9 mg/Kg for the top and sub soil respectively, chromium concentration was 114.45 mg/kg and 106.99 mg/Kg for the top and sub soil respectively and cobalt concentration was 23.52 mg/kg and 23.29 mg/Kg for the top and sub soil respectively. Cobalt and chromium was not detected in the wet season while Silver and vanadium were not detected in any of the sampled areas

Seasonal variations in heavy metals concentrations could be due to the slanty nature of the topography of the site which allows carriage of washed soil and other materials during rainfall across the site before disposal through the northernly corners of the site with chances of percolations along its flow.

Wildlife Study: The study area falls within the Central Business District of the Federal Capital territory, Abuja, where a lots of development projects have been undertaken. The implication of this is that wildlife habitats may have been destroyed and most of fauna gone into extinction. However, wildlife censored were non-game species with avian fauna dominating the vertebrate assemblages. The composition of the assemblages within the project location includes:

- Two (2) mammalian species;
- Sixteen (16) Avian species;
- One (1) reptilian species.

Vegetation Study: Four (4) transects identified and designated as VG1-VG4 and VGC1 – VGC2 (control stations) were surveyed using the Transect area method. Floristic composition was identified *in situ* and plant species that were doubtful were photographed and evaluated at the Herbarium. The main parameters evaluated include vegetation types and floral composition. Additional pathological studies were conducted by collecting data on the plant/crop health status by the identification of health conditions, fungi and bacterial disease of plants at the designated ecotype (Aigbokhan, 2016)**.**

Determination of species composition

Pathological investigations were carried out by traversing along all the established transects in the study area. This was aimed at determining as well as listing the pests and diseases of the plants in the study area. Disease severity for each plant was determined by the use of standard disease severity index expressed as infection indices similar to those of Alasoadura and Fajola (1970) and Emua (1980) (Table 6.16).

Vegetation Structure: The project area consists primarily of lowland fallowed vegetation ecotype dominated by Herbs, Sedges, Shrubs, Grasses and Vines with generally no climaxed vegetation ecotype in the urban center (Labour house, Central Business District, Abuja). A total of Forty -three (43) plant species were recorded along the transects surveyed and distributed among thirteen (13) plant families within the project area in the wet and dry seasons. The low-lying terrain and prolonged rainfalls during the wet season generally influenced the floral assemblages along the study transects (VG1. VG2, VG3 and VG4). The floristic composition of this lowland fallow ecotype was vertically stratified into two layers and comprised the nanophanerophytes predominantly the herbs and shrubs lifeforms (Plate 4.7 and 4.8). The assemblages around the control stations (VGC1 and VGC2), off the Shehu-Shagari Way, Central Business District (CBD) were significantly different as exfoliating shrubs dominated the life forms and sparse saplings. Plant habits in both climatic regimes were distributed in accordance to predominant growth forms. In order of percentage distribution and species number, the growth forms were as follows: Herbs >> Grasses>> Shrubs/Sedges >> Vines in the dry and wet season (Table 4.13). The total number of life forms censored in the project area and control stations were thirty-nine (39) species in the dry season and sixty-six in the wet season.

Nineteen (19) species representing 48.72% of the censored species were herbaceous plants in the dry season and twenty-eight (28) species, 42.42% in the wet season. Similarly, seven (7) species represented the Grasses (17.95%) and fifteen (15, 22.72%) in dry and wet seasons. The percentage composition and species numbers for sedges and shrubs compared favourably in the dry and wet seasons. Six (6) species each was censored for sedges and shrubs in the dry season comprising 15.38%. Sedges were represented by ten (10) species (15.15%) in the wet season and eight (8) species comprising 12.12% of the floristic composition. Furthermore, the Asteraceae dominated the

taxa classification comprising about 20.51 and 205.8% in both climatic regimes. Well represented species of the family Asteraceae predominantly herbaceous in life forms include: *Acanthospermum hispidum.*, *Adenostemma perrottetii*., *Aspilia africana*., *Aspilia helianthoides*., *Chromolaena odorata*., *Emilia praetermissa* and *Emilia sonchifolia*. The Poaceae followed closely with percentage distribution of 17.95 and 12.75% in the dry and wet seasons and were dominated by: *Acroceras zizaniodes*., *Andropogogon gayanus*., *Chrysopogon aciculatus., Cynodon dactylon., Eragrostis tremulla., Setaria barbata.,* and *Oplismenus burmannii*. Generally, the lifeforms and floristic composition recorded within the project area have also been censored in disturbed habitats and fallow lowlands within the Abuja Metropolis. Details of floristic composition of plant species censored in the dry and wet season is presented in Table 4.14.

Furthermore, the native plants comprised 59.52% of plant assemblages in the project location and were predominantly represented by *Abutilon mauritianum, Acanthospermum hispidum, Acroceras zizaniodes, Acrostichum aureum, Andropogogon gayanus, Bulbistylis pusilla, Aspilia helianthoides, Cyperus amabilis, Cynodon dactylon* and *Kyllinga erecta.* The exotic species followed closely with 38.10% introduced to the project sites by agents of pollinations and runoff during the peak of the wet season. *Waltheria indica, Oxalis corniculate, Emilia sonchifolia, Chromolaena odorata, Calopogonium mucunoides, Asclepias curassavica, Andrographis paniculate, Acanthospermum hispidum* and *Aeschynomene americana* recorded high exotic species number.

Phytochemistry: All the macronutrient elements analysed were below the internal concentrations of essential elements for higher plants with potentials for phytotoxicity or harm consumers (Kabata-Pendias, 2001).

Pathology: The evaluation of the health status of plants revealed the presence of fungal and bacterial infections on the aerial parts especially the leaves. The prevalent pathological conditions were leaf spots, leaf blight and leaf variegation.

Socio-Economic Study: Purposive sampling procedure was utilized to select individuals/group that were sampled for the survey. In depth interview session Focal Group Discussion (FGD) sessions Questionnaire administration, Participatory Rural Appraisal (PRA), Key Informant Interviews (KII) and walk through surveys were the primary data collection sources. Relevant published documents acted as secondary data collection sources. Collated data were analysed using descriptive statistics.

Sampling technique: A total of 500 questionnaires were administered to four routes within a spatial boundary of 2.5km of the project location. This represents a sample size of 9.8% of the total population size based on the 2006 census figures with annual growth rate of 3.2% (NPC, 2006). The routes/potential area of influence of the project activity include:

Access through undeveloped road (4th Street) between Federal Ministry of Finance building and Africa Re-Insurance Corporation property off Ralph Shodeinde street.

Ralph Shodeinde Junction along Sani Abacha way,

Labour road Junction along Sani Abacha way,

Ralph Shodeinde intersection along Ahmadu Bello way.

Furthermore, a non-proportional to size sampling was adopted with sample size not less than 50 along each route. In order to obtain qualitative information that may be difficult to get through the use of the questionnaire, Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were conducted in each area of influence of the project. A total of 4 FGDs and 2 KIIs were conducted along each route. The discussion groups consist of Adult males, adult females, young males and young females. Each discussion group had between 5-10 discussants. 2 Key Informants-1 adult male and 1 adult female were interviewed along each route. Table 6.17 and 6.18 shows the socioeconomics and health data needs captured by the data collected during the study.

Population Structure: Population structure according to Palmer and Gardner (1983) is characterised with reference to two main attributes: The age-sex distribution and demographic ratios (the sex and dependency ratios). Computations from the age-sex pyramids showed a predominant population of the working group (31-40 and 41-50 years old). These age group represented >80% of the population around the four designated locations (Access through undeveloped road (4th Street) between Federal Ministry of Finance building and Africa Re-Insurance Corporation property off Ralph Shodeinde street; Ralph Shodeinde Junction along Sani Abacha way; Labour road Junction along Sani Abacha way and Ralph Shodeinde intersection along Ahmadu Bello way) within a 2.5km of the project site censored.

The influx of population was domiciled around the labour house and Ralph Shodeinde street. This further lends credence to the high population of working group (31-40 and 41-50 years old) due to the location of Federal Ministry of Finance, State Government Liaison offices (Yobe Development House, Katsina State, Edo State, Plateau state, Imo State and Plateau state), Jaiz Bank, Korea Cultural Center and other Federal Government Parastatals.

Furthermore, the female population were the most dominant gender within the proposed project location with estimated 2:1 ratio. This data compared favourably with NPC national averages for age-sex distribution (NPC, 2011). The dominance of the female gender maybe attributed to increased gender-based advocacy conversations by Non-Governmental Organizations (NGOs), Government based agencies and the foremost need to support family finances.

The size of the population is such that, majority of people found in this community are neither residents nor indigenes, nevertheless our study indicated that the population varies, this is because there are more of commercial buildings and office complexes than residential, which implies that during the workdays the population is high, but by weekend or holidays the population is fewer. Therefore, the population of people who comes to engage in productive activities on a daily bases are put at 70% while the resident of the community is 30% of the entire population of the area. The population of Abuja Municipal Area Council is 776,298 according to the 2006 national Census with growth rate of 2.7 per annum.

Demographic characteristics of the Study Area: Abuja was planned as a capital where all Nigeria's ethnic groups, tribes and religions would come together in harmony. The population of AMAC includes the Afo, Fulani, Gwari, Hausa, Koro, Ganagana, Gwandara and Bassa ethnic groups. English is the official language. Other languages spoken in the study area include Hausa, Yoruba, Igbo and Fulani. Muslims make up 50 percent of the population, Christians 40 percent while the remainder adheres to indigenous beliefs.

Gender and Age Distribution: Percentage distribution shows 57.20% for male and 42.80% for their female counterpart. Age distribution shows that children of age <1 – 15 years constitute about 20% of the population mostly children who live and school in the study area. Those between 16 – 30 years constitute about 30%. Age 30 years and above constitute about 50% of the population. This distribution represents the age bracket of people who either work, school, live or carryout businesses in the study area.

Household Characteristics and Size

Occupation and Income: The data from respondents revealed the dominance of the civil service workforce comprising 49.6% of the total respondents, 40% of private businesses and 10.4% of small-scale businesses supporting these institutions. Government agencies/parastatals employ a significant percentage of respondents around the CCZA and this is ascribable to the Federal Ministry of Finance, Yobe Development House, Katsina State Government Liaison office, Edo State Government Liaison office, Plateau state Government Liaison office, Imo State Government Liaison office, Oyo State Liaison office and Plateau State Government Liaison office.

Information from respondents revealed the annual modal income profile was NGN 80,000 – NGN 89,000 comprising 26% of the total respondents. The high economic profile of the CCZA and dominance of businesses and government parastatals/agencies is a reflection of the earnings of paid workforce around the project area. Similarly, the Federal Government minimum wage benchmark corroborates with the income profile of respondents around the project area and preponderance of middle-class workforce. The low-income profile at the bottom of the income

pyramid within the minimum wage benchmark were generally attributed to small scale food vendors supporting businesses and governmental parastatals/agencies.

Educational Attainment: The gender distribution of educational attainment from the data analysed showed that the modal education category for male and female was ‘’Tertiary completed’’ comprising 44.6 and 50.7% respectively of the total respondents. Followed closely, is the ‘secondary completed’ totalling about 17.9% and 16.3% of the male and female respondents respectively. The educational attainment computation further lends credence to the high population of the female gender within the working group around the project location. The number of businesses, government offices and Banks around the labour house and Ralph Shodeinde street further corroborates this assertion. The least represented were those with no formal education and dominated the lowest section of the education pyramids within the proposed project location. This group dominated the small-scale businesses comprising local food, potable water and fabric vendors

Employment Status: The modal status revealed about 77.3% and 71.4% of male and female respondents were gainfully employed in business around the Labour house and private and government establishments around Ralph Shodeinde Street. A high female population was censored (n=280) and further lends credence to the age-sex distribution of the study area and the high business activity of the Central Cadastral Zone Area (CCZA). The construction phase of the AFREXIM Trade centre will further drive the employment status upwards with influx of skilled workers to the project site. However, the unemployment rate was at variance with the national average unemployment rate of 33.5% (NBS, 2020). This may be attributed to the high business activity around the project area.

Religion affiliations: The Muslim population dominated the religious groups within the study area with percentage composition of 54% of all respondents. Followed closely was the Christian denomination comprising 44% of the total population interviewed. The proximity of the Abuja National Mosque and worship centres within the premises of Government agencies/parastatals and the timing of the field survey (Friday) may be attributed to the high Muslim followership and sampling. The National Christian Centre (NCC), along Sani Abacha Way also supports high population of Christian gatherings on special scheduled events around the proposed project location. In-service Christian fellowships are also a common occurrence within business premises.

Social Amenities: These include transportation, water supply, electricity and telecommunication, in the project area.

Transportation Infrastructure: There are good road networks in AMAC, making transportation less difficult. The major means of transportation is by cars. Majority of the people own private cars, some individuals use public transport especially those coming into the community for business transaction.

People using private cars are put at 65% while 25% for people who take public transport system. Access to the project area is adorned with good city road network consisting of interconnected paved carriageways designed to carry buses, cars, articulate vehicles and accommodate pedestrian traffic. The road network facilitates easy connectivity to the Three Arms Zone, Federal Secretariat, Garki, Wuse, another adjoining parts of the city centre and suburban settlements within the Federal Capital Territory (FCT). The road systems also have monitoring system used to manage traffic such as intersection controls with traffic lights and Road Information Panels (DIPS) and Speed breakers. Road network with prevalent traffic exposure include:

- Ahmadu Bello Way/Ralph Shodeinde street;
- Ahmadu Bello Way/Independence Avenue;
- Independence Avenue/Sani Abacha Way and
- Sani Abacha Way/Ralph Shodeinde Street.

Details of road intersections and networks are detailed out in the Traffic Impact Assessment Report contained in the Traffic Impact Analysis in Appendix F

Water Supply: Major source of water in the study area is from FCT water board, boreholes and vendors. The percentage is summarized as follows;

- Water supply by individual boreholes 20%
- Water supply by FCT water board 70%
- Water supply by water vendors 10%

Energy infrastructure: The project area has a robust energy infrastructure managed by the Abuja Electricity Distribution Company (AEDC). The substations and distribution lines are connected to the National grid and supply businesses at the Labour house, Federal Ministry of Finance Headquarters, Yobe Development House, State liaison offices, Jiaz bank and other businesses around the Ralph Shodeinde street; Ahmadu Bello Way; Independence Avenue; Sani Abacha Way. Information from 70% of respondents interviewed suggests power provision is relatively stable and scheduled maintenance activities are conducted on AEDC infrastructure. The B33 Injection substation including transformers supports electricity management around the Central Cadastral Zone Area.

Communication: The means of communication in the study area are radio and television broadcasting, General System of Mobile Telephony, letters, personal contact and community development association, and traditional ruler-ship having meetings from time to time. Official communication between government and the led; that is, memo, letters and organizing meetings

Security and violent Crime: It was gathered, that the security of the place is guaranteed. The type of crime prevalent in the community are pick-pocketing and armed robbery. Police stations and police post are seen at strategic places to curb crime. Hence, Police anti-robbery squad and patrol teams, patrol day and night to ensure security of lives and properties.

Traffic Impact Assessment: Seven critical traffic hotspots were identified during the traffic assessment within 2.5km spatial boundary of the proposed project area. These hotspots provided clarity around envisaged volume of traffic through the project lifecycle. On the spot assessment showed high vehicular movements around:

- Ahmadu Bello way to the East of the project
- Independence Avenue to the North of the project
- Ralph Shodeinde Street to the South of the project
- Sani Abacha Way to the West of the project
- Labour Road to the East (current access to the site)
- Ralph Shodeinde intersection along Amadu Bello way
- Ralph Shodeinde Junction along Sani Abacha way

Traffic volume around some designated hotspots within the spatial area of the proposed project location is highlighted in Table 4.24 to Table 4.26. Detailed study outcome of assessments is presented in Appendix F.

Traffic Growth

Future Traffic Volume: Future traffic volume mainly increases on the peak hour time. Except this peak hour traffic volume remain same to the previous. Mainly morning peak hour intersection in traffic volume increases but in the morning peak hour intersection out traffic volume remains same as it is before. Alternate situation occurs at the afternoon peak hour time intersection out traffic volume increase but intersection in traffic volume remains same as it is before. Now gives the future increasing traffic volume morning intersection in and afternoon intersection out traffic volume.

From the tabular analysis, it can be seen that the future traffic volume cannot exceed the capacity of these four roads. Here, new volume is much low compared to this new volume's PCU which cannot exceed the road capacity's PCU, as the road capacity's PCU is so much high. So there is no impact on traffic if the proposed project commences operation.

Health Impact Assessment

Health Facilities: There are both public and private health hospitals in the community. Many people have access to medical facilities based on the level of their income. In the study area, AMAC has primary health care system in place at the area Council and in the various wards of the area council. There is the National Hospital and a host of other private hospitals in the area. The National Hospital Abuja is the closest tertiary facility to the proposed project location. The hospital is a 200 in-patient bed space hospital supporting family medicine, Obsteristics and Gynecology, Surgery, Oncology, Paediatrics and Dental health. The tertiary facility is open to the general public, and private patients for different health interventions.

Morbidity pattern: Data from respondents interviewed revealed the common cold, stress, malaria, typhoid and injuries were the leading causes of adult morbidity within the Central Cadastral Zone Area (CCZA). Fever is a major manifestation of malaria and other acute infections. Malaria contributes to high levels of malnutrition and mortality in young children and Adults. Malaria is more prevalent after the end of the rainy season (NDHS, 2018). Forty-four (44%) of adults within the age of 20 – 55 years old regularly had symptoms of these illnesses within a fortnight during the survey. Treatment was sought the same or next day for only 35% of the working population. Thirty percent of Adults with these common illnesses were taken to the National Hospital Abuja for treatment and while 70% were taken to a private sector chemist/patent medicine store (PMS) within the Labour house premises. The datasets obtained are generally consistent with National averages for the Federal Capital Territory Abuja (NDHS, 2018).

Mortality Pattern: Adult mortality indicators can be used to assess the health status of the population. Secondary data sources from hospital records identified 58% of Adult deaths per 1,000 population within the age of 30 to 60 years of age and dominated by the male population. Historical trends from records reveal since 2008, the probability of dying between exact ages 15 and 50 has improved among women, declining from 161 per 1,000 women in the 7 years before the 2008 NDHS to 117 per 1,000 women in the 7 years before 2018. Similarly, the probability among men decreased from 168 per 1,000 men in the 7 years before 2008 to 122 per 1,000 men in the 7 years before 2018 (NDHS, 2018). Common causes include but not limited to the following: Gastroenteritis, Car accidents, Respiratory illnesses and Cardiac related illnesses.

E.S 5 Associated and Potential Impact Assessment

The field survey determination of the associated and potential impacts of the AATC Abuja on the environment and Socio-Economic variables at Central Business District was carried out using Rau Ad-Hoc Method. The impacts of the proposed project are seen from the perspectives of effects related to vehicular traffic, air quality, noise level, visual landscape, socio-economics, construction waste management, water supply, runoff water, fauna and flora, and socio-economy.

The environmental impacts associated with the project have been identified by examining the ways in which the activities associated with the different components interact with the environment and its different components.

The potential and associated impact assessment covers all stages of the project, from site acquisition and preparation through construction operation to activities, decommissioning and closure.

Environmental Components and Impact Indicators

The components are those that the project activities are most likely to be impacted upon, while the indicators are the easily observable parameters that will indicate change/deviation, which could be used to monitor the various environmental components during the various phases of the project.

Impact Identification and Evaluation: The identification and evaluation of impacts associated with the project activities were based on a risk management process which involved in identification of project activities that may interact with the project environment, controls to reduce risk of impacts and monitoring the effectiveness of controls.

POSITIVE IMPACTS

The development of this project shall have a number of significant positive impacts both locally and nationally.

- Creation of Employment and Business opportunities
- Generation of Income and Source for Government Revenue
- Environmental opportunities

Construction phase

- Employment Creation
- Market for goods and services
- Population Increase
- Increase in Economic Activities and Revenue

Operational phase

- Increased Commercial Viability
- Creation of Employment Opportunities
- Increased Accommodation
- Increased Access to Goods, Services and Social Amenities
- Increased Economic Activities and Government Revenue

- Urban Development Stimulation
- Aesthetic Enhancements
- Improved Roads
- Population Increase
- Impetus to Improve Amenities and Services

Decommissioning phase

- Creation of Employment and Business Opportunities
- Income Generation
- Provision of Cheaper Building Materials

NEGATIVE IMPACTS

Construction phase

- Loss of Flora and Faunal Habitats
- Changes in Surface and Sub-Surface Hydrology
- Changes in soil characteristics
- Emission of Air pollutants
- Noise Generation
- Increased Pressure on Utilities
- Increased Heavy Traffic
- Population Influx
- Generation of Construction Waste

Operational phase

- Increased Pressure on Available Utilities
- Micro-Climate Modification
- Security Threats
- Socio-cultural Impacts
- Increased Air Pollution
- Increased Surface run-off
- Increased Traffic
- Generation of waste
- Generation of Noise

Decommissioning phase

- Generation of Noise
- Generation of Demolition Waste
- Increased Heavy Traffic
- Emission of Air Pollutants

E.S 6 MITIGATION MEASURES

The purpose of mitigation is to identify measures that safeguard the environment and the people affected by proposed project.

Figure 6.1 shows the hierarchy of action steps to mitigate impacts while Table 6.1 shows a summary of mitigation plans for associated impacts might occur from the construction and operation of the AATC

Mitigation Measures for Traffic Impact

During Construction Phase: The significant traffic impact of the proposed development will occur during the construction phase. This is due to the trip generation of the expected 350 construction workers on site.

The contractor will be required to prepare a construction traffic management plan that will specify haulage routes to and from the site, keeping heavy goods vehicles (HGV) traffic to designated suitable roads in the area.

During Operational Phase: The impact of the traffic generated by the operational phase on the surrounding road network will not be significant and no mitigation measures are required. Nevertheless, AFREXIMBANK plans to implement a mobility management plan for the site with the focus of promoting more sustainable modes of transportation, other than the car, amongst its employees. Such a Plan would entail the following:

- Review of the existing and future transportation framework within the vicinity of the development;
- Review of the existing travel patterns of staff that will be employed at AFREXIMBANK;
- Development of a sustainable travel strategy which may include the promotion of public transport, establishment of a car share scheme, ensure footpaths are safe and well lit, and the appointment of a mobility management coordinator amongst others; and
- Setting of realistic mode share targets based on the findings of the previous steps outlined above

E.S 7 ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan (EMP) has been developed to assist the proponent in mitigating and managing environmental impacts associated with the life cycle of the project. The EMP has been developed to provide a basis for an Environmental Management System (EMS; ISO 14001 principles) for the project. Table 7.1 forms the core of this EMP for the construction, operational and decommissioning phases of the proposed AATC respectively. The Table generally outlines the potential safety, health and environmental risks associated with the project and the necessary mitigation measures as well as the persons responsible for their implementation. The EMP will be used as checklist in future environmental audits.

Monitoring and Auditing Plans

Environmental Monitoring Plans: The proponent shall monitor the proposed development from pre-construction all through operation stages to keep track of the entire project development life cycle. The monitoring plans for the project including the environmental components, parameters and frequency of monitoring as well as responsibilities are presented in Table 7.1

Environmental Auditing Plans: AFREXIM Bank shall set up a QA/QC function to monitor through regular auditing the quality management system of the project to ensure compliance with the project design concepts. This audit shall check the prediction of the EIA and assess the general performance of the project to ensure that environmental standards are maintained and that the facility policies and environmental management guidelines are strictly maintained.

Remediation plans after Decommissioning/Closure: The proposed project initiative is not expected to be entirely decommissioned. This is in consideration that human activities will continue to require this kind of project especially within FCT. In event of unlikely need to decommission the project, a well-articulated plan shall be developed in consultation with all relevant regulators and institutions to ensure that the site is restored and improved if possible, beyond its current level

E.S 8 DECOMMISSIONING AND CLOSURE

This involves activities that result in the stabilization and restoration of unneeded site to a more natural state. For this project, AFREXIM Bank will ‘return’ the project site to its initial and unblemished natural state, through rehabilitation and enhancement, as prescribed by the environmental statutes and in recognition of multi-stakeholders’ decision.

CONSULTATION: The project decommissioning and abandonment plan will include consultation with various stakeholders including employees from various departments. The decommissioning team will include competent personnel from various departments as well as the regulatory authorities.

REPORTING: As required by regulations, a post-decommissioning report will be prepared and submitted to the FMEnv.

E.S 9 CONCLUSION

This EIA study has established that the proposed development project by AFREXIM Bank will contribute significantly to the improvement of living standard and by extension spur economic development. This will be achieved through the prior discussed positive impacts namely; attraction of foreign investment, increasing foreign exchange inflow, Increasing Foreign Direct Investment, growth of the economy, boosting of the informal sector during the construction phase, provision of market for supply of building materials, employment generation and increase in government revenue. However, the EIA study has established that the proposed project will also come along with some negative impacts which include pressure on the existing traffic and utilities, noise pollution, dust emissions, solid waste generation, increased water demand, increased energy consumption, generation of exhaust emissions, workers accidents and hazards during construction, possible exposure of workers to diseases, possible attraction of terrorist, increased storm water among others can however be sufficiently mitigated.

The proponent of the proposed project shall be committed to putting in place several measures to mitigate the negative environmental, safety, health and social impacts associated with the life cycle of the project. It is recommended that in addition to this commitment, the proponent shall focus on implementing the measures outlined in the EMP as well as adhering to all relevant national and international environmental, health and safety standards, policies and regulations that govern establishment and operation of such projects. It is expected that the positive impacts that emanate from such activities shall be maximized as much as possible as exhaustively outlined within the report. These measures will go a long way in ensuring the best possible environmental compliance and performance standards.

It is our recommendation that the project be allowed to go on provided the mitigation measures outlined in the report are adhered to, Environmental Management Plan (EMP) is implemented and the developer adhere to the conditions of approval of the project.

Acknowledgements

The AFREXIM Bank Trade Center Project is a development in which many people and organizations contributed and participated. As such we are thankful to the proponent of the project that we as an Environmental and Social Impact Assessment consultants have been given the task and responsibility to prepare this important EIA report.

Throughout the preparation of this EIA reports there has been ample interaction with the Federal Ministry of Environment (FMEnv). We have very much appreciated this and were very fortunate to receive constructive comments that have been used for the benefit of the EIA report.

During the various stakeholder and public consultation events as well as during the various consultations with local parties, businesses and communities we also received many contributions and remarks and suggestions. We would like to express our sincere appreciation for all this that also has been used for the benefit of the AATC project.

Last but not least, thanks to our partners and project consultants as well as survey experts who have made dedicated and professional contributions to this report. We all trust that this EIA report contributes to a further sustainable development of the Trade Center for the benefit of Abuja and Nigeria and its people.

CHAPTER ONE

1.0 BACKGROUND INFORMATION

This is the draft report of Environmental Impact Assessment (EIA) for the proposed AFREXIMBANK–Africa Trade Centre (AATC), Abuja Municipal Area Council, Federal Capital Territory Abuja. The approach to this EIA was structured such as to cover the requirements under the EIA Act CAP E12, LFN 2004, the EIA Regulations as stipulated under the Federal Republic of Nigeria official Gazette No. 73, Vol.79, and the World Bank Safeguard Policies.

1.1 The Proponent

African Export-Import Bank (AFREXIMBANK) is headquartered in Cairo, the capital of the Arab Republic of Egypt, a pan-African, multilateral financial institution which was established in 1993 by Governments, African private and institutional investors, non-African institutions and private investors for financing, promoting and expanding intra-African and extra-African trade , commenced operations on 30 September 1994, following the signature of a Headquarters Agreement with the host Government in August 1994.

The Bank has regional branch offices in Harare, Abuja and Abidjan.

The Bank currently has four classes of shareholders, namely:

i. Class “A”, comprising African governments and/or their central banks, the African Development Bank,

African continental, regional and sub-regional financial institutions and economic organizations;

ii. Class “B”, consisting of African national financial institutions and African private investors; and

iii. Class “C”, comprising international financial institutions and economic organizations, non-African financial institutions and non-African private investors.

iv. Class “D” shares, a tier approved in December 2012, are fully paid par value shares that can be held by any investor.

In execution of its mandate, AFREXIMBANK uses three broad instruments of intervention namely credit (trade and project finance), risk bearing services and advisory services.

In 2017, the Bank approved its 5th Strategic Plan (2017 – 2021) which places emphasis on the following:

i. promoting intra-African trade;

ii. Facilitating industrialization and export development in Africa;

iii. Strengthen Trade Finance Leadership; and

iv. Improve financial soundness and performance

Considering the low rate of African trade in comparison to trade in Europe, Asia and North America, AFREXIMBANK has embarked on a strategic plan to promote intra-African trade and the

diversification of African economies through the establishment of trade facilitation hubs – the AFREXIMBANK–Africa Trade Centre (AATC).

The bank is now considering transforming its existing and future buildings into business complexes and is investigating developing a mixed-use Trade Centre in Abuja. The aim is to develop a "One-Stop-Shop" for trade services with the objective of:

- Bridging the gap in trade and market information in Africa, especially with regards to intra African trade
- Providing an integrated one stop-ship for trade services, trade finance and advisory services to the business community
- Providing a range of iconic business facilities to support the effective provision of key trade services offered by the AATC
- Increasing intra-African trade, catalysing value addition and export manufacturing and contributing towards positive economic transformation of the African continent

(Source: AFREXIMBANK Africa Trade Centre, A concept paper, November 2017)

AFREXIMBANK identified a site located on a parcel of land in Abuja, Nigeria. It can be found on the southern portion of the intersection of Independence Avenue and Sani Abacha Way. The proposed site is also bordered by the National Ecumenical Centre (NEC).

1.2 Purpose and Contents of this report

The purpose of this Environmental Impact Assessment (EIA) report is to identify the major environmental and social impacts associated with the project development of AFREXIMBANK–Africa Trade Centre (AATC) as well as identifying mitigation measures to reduce or avoid anticipated impacts.

1.3 Project Location

The proposed site is located on a parcel of land in Abuja, Nigeria. It can be found on the southern portion on the intersection of Independence Avenue and Sani Abacha Way. The proposed site is also bordered by the National Ecumenical Centre. The site is measured at 5,856 square meters and is in the Central Business District (CBD) (Plate 1.3), Abuja within the geographical coordinates of latitude 9.05422 and longitude 7.49719 sitting on an elevation of approximately 497metres above sea level and surrounded by a 287meter perimeter fencing guarded by security guards attached to the company. The site facing the northwest direction is bordered to the west by the Labour House and to the east, compound belonging to the Ministry of finance, while to the south it is flanked by a property owned by African Renaissance (Africa-Re) and to the north, the Independence avenue.

The site had signs of previous construction work having taken place there, the remnant gravel on the site is been washed in the downwards sloppy northerly direction of the site with every rainfall.

Plate 1. 1: Administrative Map of Nigeria indicating Abuja the Proposed Project State

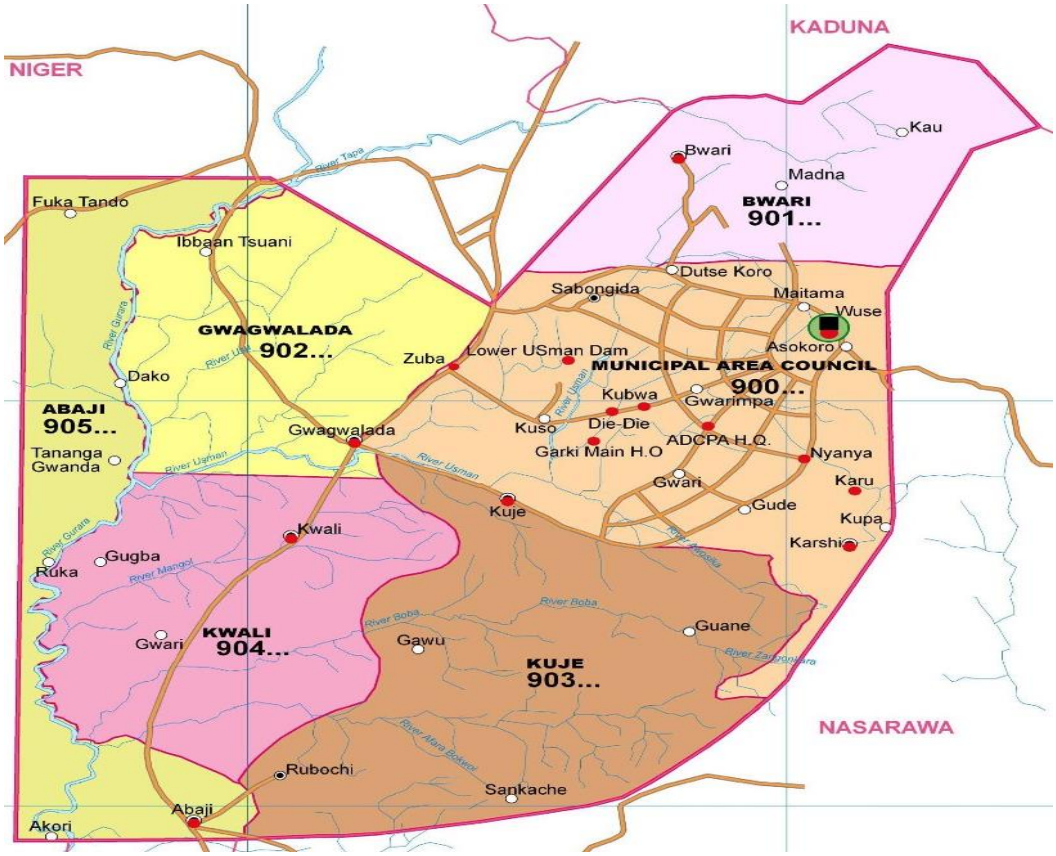


Plate 1. 2: Administrative Map of Abuja Indicating AMAC, the Area Council Hosting the Project

Plate 1. 3: Location Map

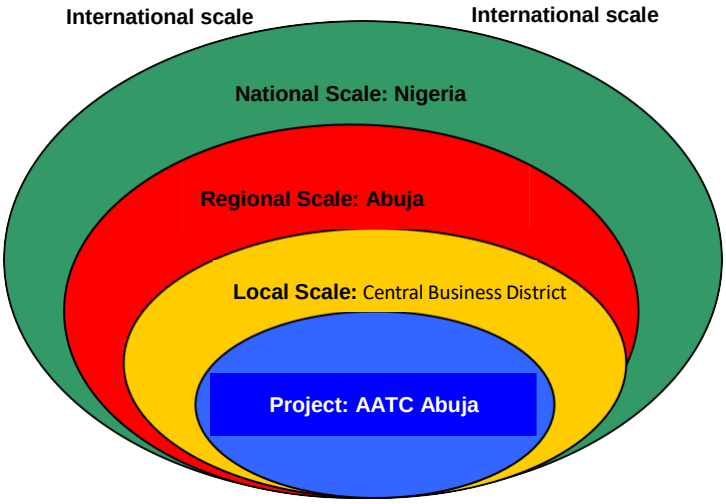


Figure 1. 1: Schematic study areas under consideration

The main advantages of the site are:

- The site has good visibility from Indep33endence Avenue and parts of Sani Abacha Way;
- The site has a gentle slope towards north;
- The development puts the land to productive economics use; and
- The central business district location of the development affords the site access or potential access to pre-planned municipal infrastructure like power, water, drainage and accessibility.

1.4 Scope of the project

It is proposed that the development will accommodate the following key facilities

1. AFREXIMBANK Offices
2. Contingency Offices
3. Tenant Offices (long term corporate rental)
4. Trade Centre Offices
5. Conference Hall/ Exhibition
6. Seminar and Meeting Rooms
7. SME Business Innovation/ Incubation Hub (including Knowledge Centre & Library)
8. Hotel (120 keys) including associated public areas, restaurants, light retail & gym
9. Car Parking

	Facility	Bulk Area (sqm)
1	AFREXIMBANK Offices	3,000
2	Contigency Offices	1,500
3	Tenant Offices(long term corporate rental)	3,000
4	Trade Centre Offices	475
5	Conference Hall/ Exhibition	2,000
6	Seminar and Meeting Rooms	300
7	SME Business Innovation / Incubation Hub including Knowledge Centre & Library	300
8	Hotel (120 keys) including associated public areas, restaurants, light retail & gym	5,500
9	Car Parking	

1.5 EIA Objectives

The objectives of the EIA for the project are:

- to provide information and evidence needed for developing an Environmental Impact Statement (EIS) for the proposed project in its entirety;
- To establish the baseline environmental, identify any sensitive components of the environment and social setting of the project site and its surroundings.
- To identify adverse environmental problems that may be encountered in the development of the proposed project which may cause negative environmental, social, health and economic effect on the immediate environment.
- To incorporate mitigation measures on environmental management programme of the proposed project development process.
- To resolve conflict that may occur between social, economic, visual, ecological and engineering requirements during all stages of project development.
- Assist project design and planning by identifying and quantifying aspects of construction,

operation and decommissioning which may cause adverse environmental, social, health and economic effects and recommend measures to avoid and mitigate adverse effects and enhance beneficial impacts.

- To identify the best practicable environmental options that requires that the chosen option should result in the least environmental damage
- To develop an Environmental Management Plan (EMP) for all phases of the project including compliance, monitoring, auditing, and contingency planning.
- To meet the FMEnv requirements on EIA procedure for approval/certification before project commencement and implementation.

1.6 Benefits of the EIA

The EIA is a tool for generating information and assessing developmental activities for potential environmental risk that may result from such activities. The proponent in her mandate to undertake this project when approved is committed to environmental protection, resource conservation, poverty alleviation through employment generation and people's involvement in infrastructural and services provision within FCT. The EIA will boost confidence of the communities within the project area; and its implementation will engender accrued benefits to AFREXIM Bank and the government, in the following ways:

- Integration of environmental consideration in the development plan, construction and use; of infrastructural and engineering facilities within the project area.
- The proponent will be equipped with necessary information that will guide planning, execution and utilization of the project;
- Integration of concerns of all stakeholders through consultation necessary for effective take off, operation, maintenance and decommissioning of the project and
- Engagement of a continuous assessment and environmental monitoring to enhance performance of project implementation.
- Fulfill regulatory requirements necessary to secure permit(s) from regulatory authorities before the commencement of the Development Project.

1.7 EIA Methodology

The method adopted in conducting the EIA for the AFREXIMBANK–Africa Trade Centre (AATC), project is illustrated in the flowchart presented in Figure 1.2

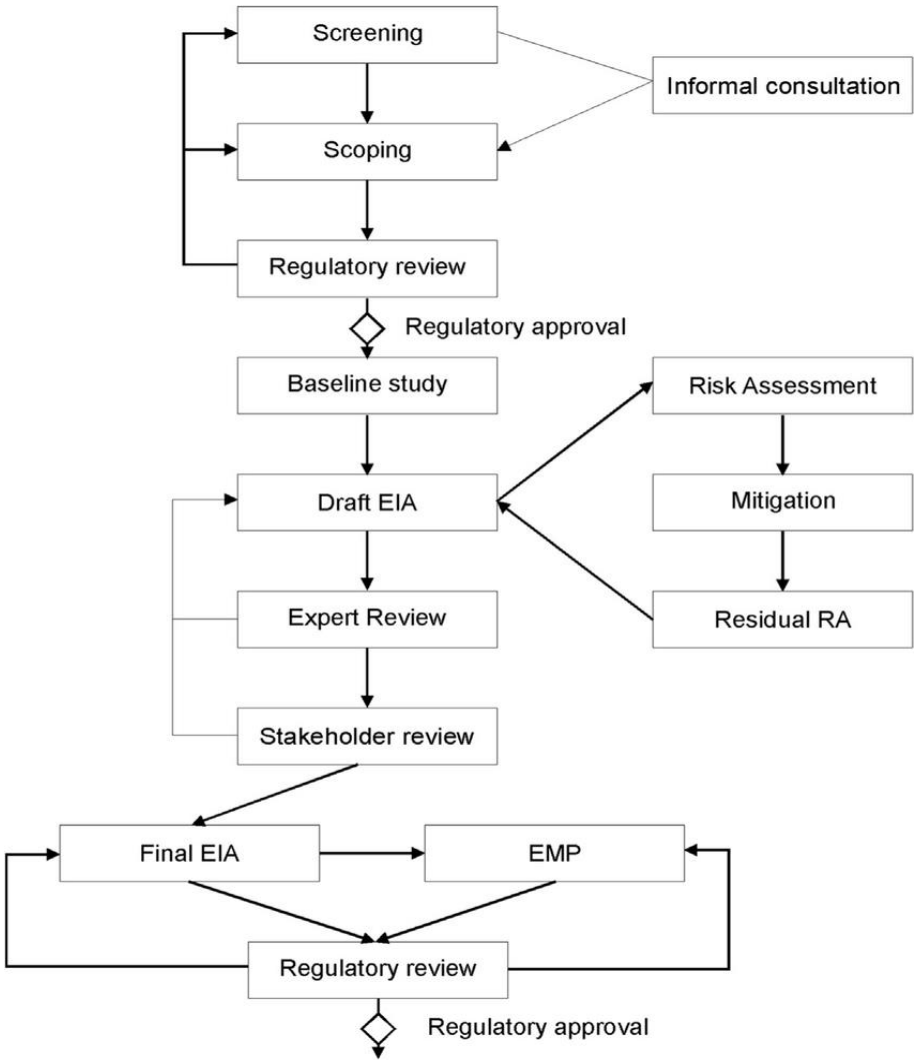


Figure 1. 2: EIA Implementation Flowchart

1.7.1 Desktop Research

The geography and available environmental and socio-economic information on the proposed project location were initially gathered from maps, charts, articles, previous study reports on the area, photographs, textbooks and similar resources. The information generated enabled definition of limits of the area to be surveyed and assessed. A data gap analysis was carried out to identify areas where additional information was required and the results used in planning the execution of field sampling/measurement aspects of the EIA project.

1.7.2 Field Data Collection

The information gathered from the desktop literature study was used in categorizing the measurable parameters in the area and their respective sampling requirements with respect to obtaining supplemental qualitative and quantitative data from the project area. During the fieldwork, additional site-specific ecological and socio-economic data were obtained to complement information obtained from the desktop study. The IESL team, led by Adebanjo Anthony, mobilized to field for the sampling exercise on the 13th February 2020 for the dry season and 26th June 2020 for the wet season, safety briefings was conducted by Dr. Adesola Ojesanmi and the team sampled with the FMEnv

representatives in persons of Mr. Oyebode Taofeek and Ms. Iyo Georgina present as witnesses. The *in-situ* parameters were measured on site, water samples were sub-sampled for physico-chemistry, THC, BOD/COD, heavy metals and microbiology, and thereafter they were fixed and stored in a cooler with ice. The soil samples were also sub-sampled for physico-chemistry, THC, heavy metals and microbiology and stored in the cooler with ice. All samples collected were properly preserved, labelled and transported to the laboratory for further analysis.

1.7.3 Consultation with Stakeholders and Experts

Consultation was carried out to solicit stakeholders' views on the proposed actions. This involved engaging the stakeholders in a dialogue characterized by two-way flow of information that enabled the potentially affected population to contribute information that might influence the decision-making process in project design, mitigation, monitoring and management plans, as well as the analysis of alternatives to be implemented. Consultation was also conducted with Nigerian authorities (FMENV).

1.7.4 Impact Identification and Evaluation

The environmental aspects and impacts of the proposed project that may interact positively or negatively with the environment during the construction, operation and decommissioning phases were identified at this stage of the assessment. An internationally accepted objective approach was adopted in evaluating the potential and associated impacts of the project on the environment.

1.7.5 Impact Mitigation

Mitigation measures designed to prevent, reduce or control the adverse impacts of the proposed project activities were formulated using professional judgement based on previous project experiences, proven scientific methods and sound engineering practices. Other resource materials consulted include the FMENV EIA Sectoral Guidelines, the World Bank Environmental Source Book, past reports on the area and various regulatory publications of FMEnv. Similarly, enhancement measures were formulated to ensure that beneficial impacts of the project are realized.

1.8 Policy, Legal and Administrative Framework

There are a number of relevant national and international environmental policies and regulations that are applicable to this project are hereunder discussed.

- Environmental Impact Assessment (EIA) Act *Cap E12, LFN 2004*
- National Environmental Standards And Regulation Enforcement Agency (NESREA) Act 2007
- AEPB Act of 1997
- Land Use Act
- Development Control guidelines

- Abuja Master Plan of 1976

1.8.1 Nigeria Administration

In Nigeria, there are several National laws, regulations and standards, which seek to protect the natural environment and assure sustainable development in the country. A number of these regulatory instruments were developed following the Koko toxic waste episode of 1987, which led to the promulgation of the Harmful Waste Act No. 42 of 1988 and the establishment of the Federal Environmental Protection Agency (FEPA). Laws establishing some government agencies also contain provisions to ensure environmental protection as development progresses

The constitution of the Federal Republic of Nigeria (1999), as the national legal order, recognizes the importance of improving and protecting the environment and makes provision for it. Relevant Chapters are:

• Chapter 20 makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria.
• Chapter 12 establishes, though impliedly, that international treaties (including environmental treaties) ratified by the National Assembly should be implemented as law in Nigeria.
• Chapter 33 and 34 which guarantee fundamental human rights to life and human dignity respectively, have also being argued to be linked to the need for a healthy and safe environment to give these rights effect.
In Nigeria, there are several legislative and regulatory requirements controlling infrastructural projects (i.e. urban development, utilities, energy, recreation etc.). These regulations include local laws as well as some international treaties, acts and conventions.

In this Chapter, overviews of the laws that relate to the infrastructural projects are presented below. Local regulations for infrastructural projects fall under the jurisdiction of two main government agencies: The Federal Ministry of Environment (FMEnv), and State Environment laws.

These following regulations are of relevance:

• Federal Environmental Protection Agency (FEPA), (now Federal Ministry of Environment - FMEnv) Environmental Guidelines and Standards, including the EIA Act No. 86 of 1992;

1.8.2 Federal Ministry of Environment

The discovery of six ship loads of toxic waste, of Italian origin in Koko, Delta State in 1988, exposed the need for stringent environmental laws and its effective enforcement with monitoring mechanism put in place. The Federal Government promulgated the Harmful Wastes Criminal Provision Decree 42 of 1988, which made it a criminal offence to import or trade in toxic waste. The Federal Environmental Protection Agency (FEPA) was created by Decree 58 of 1988 as a parastatal of the Ministry of Works and Housing. The agency authority was strengthened through Decree 59 of 1992

and October 12th, 1999 saw the creation of the Federal Ministry of Environment (FMEnv). The Federal Ministry of Environment is charged with the overall responsibility of protecting the Nigerian environment including biodiversity, conservation and sustainable development of natural resources. The ministry has a mandate to co-ordinate the environmental protection and conservation of natural resources for sustainable development in Nigeria. The specific responsibilities of the ministry include:

- Monitor and enforce environmental protection measures;
- Enforce international laws, conventions, protocols and treaties on the environment;
- Prescribe standards and make regulations on air quality, water quality, pollution and effluent limitations, the atmosphere and ozone layer protection, control of toxic and hazardous substances; and
- Promote cooperation with similar bodies in other countries and international agencies connected with environmental protection.
- Pursuant to the FEPA Act 58 of 1988, a number of other environmental regulations now exist.

FMEnv instituted a number of Regulations, Guidelines and Standards as summarized below;

The National Environmental Protection (Effluent Limitation) Regulation S 1.8 of August 1991

- Every industry should install anti-pollution equipment for the treatment of effluent discharge.
- Effluent shall be treated and monitored on monthly basis.

1.8.3 Other Ministries Departments and Agencies (MDAs)

A number of other government Ministries Departments and Agencies have enabling laws, which support the objectives of this ESMF. Some of these laws also seek to eliminate or minimize environmental and social impacts of activities associated with their various functions. The key MDAs are discussed.

1.8.3.1 Federal Ministry of Industry, Trade and Investment

The ministry plays a decisive role in the diversification of the resource base of the economy by promoting trade and investment with special emphasis on increased production and export of non-oil and gas products that will lead to wealth and job creation, poverty reduction, supervise the FEC Trade Zones and ensure enhanced service deliver on a manner that will aid growth of the Nigerian economy.

National Urban Development Policy (NUDP National Urban Development Policy (NUDP) is to promote a dynamic system of urban settlements, which fosters sustainable economic growth,

promotes efficient urban and regional planning and development, as well as ensures improved standard of living and well-being of Nigerians.

1.8.3.2 Federal Ministry of Agriculture and Rural Development

The Federal Ministry of Agriculture and Rural Development ensures that the citizenry are provided with credible and timely information on government activities, programs and initiatives; while creating an enabling technological environment for socio-economic development of the nation.

Water Resources Act 1993, No.101: This act promotes the optimum planning, development and use of Nigeria's water resources and other matters connected therewith. The right to the use and control of all surface and groundwater and of any watercourse affecting more than one State as described in the Schedule to this Act, together with the bed and banks thereof, are by virtue of this Act and without further assurance vested in the Government of the Federation State Environmental

Quarries Act 350 Laws of Federation of Nigeria of 1990: The act provides for and regulates quarrying activities in Nigeria. It prohibits unauthorized quarrying activities for industrial use and diversion of watercourse or impounding of water for that purpose. The Act gives the Minister for Mines and Power the power to make regulations for prevention of pollution of natural water supply.

The Land Use Act: Nigeria's Land Use Act of 1978 (modified in 1990) remains the primary legal means to acquire land in the country. The Act vests all land comprised in the territory of each state in the Federation in the trust of Governor of the state and requires that such land shall be held in trust and administered for the use and common benefit of all Nigerians in accordance with the provisions of this Act.

According to the Act, administration of land area is divided into urban land which will be directly under the control and management of the Governor of each State; and non-urban land, which will be under the control and management of the Local Government. State Governors are given the right to grant statutory rights of occupancy to any person or any purpose; and the Local Government will have the right to grant customary rights of occupancy to any person or organization for agricultural, residential and other purposes.

The Labour Act of 1990: The Labour Act of 1990 contains general provisions on the protection of wages, contracts of employment and terms and conditions of employment for workers in Nigeria. The Act also gives some guidelines for recruiters and recruiting in general including recruiting of non-Nigerians to work in Nigeria. The Special Classes of Worker and Miscellaneous Special Provisions section deals with children and young adults between the ages of twelve and sixteen, women, domestic service, labour health and forced labour. Nigeria is also a signatory to a number of international labour related treaties and conventions. These are covered in Sections 3.4 and 3.5.

1.8.4 State Policy/ Legislation

Amended Decree No. 59 of 1992, which established FEPA, also issued a federal directive to the states to establish State Environmental Protection Authorities or Agencies

The functions of State Environmental Protection Authorities include:

- Protection of air, water, land, forest and wildlife within the states;
- Preservation, conservation and restoration to pre-impact status of all ecological processes essential to the preservation of biological diversity;
- Enforcement of all environmental legislations and policies;
- Coordination and supervision of environmental assessment studies;
- Minimization of impacts of physical development on the ecosystem;
- Pollution control and environmental health in the states
- Co-operation with FMEnv and other agencies to achieve effective prevention of abatement of trans-boundary movement of waste.

1.8.4.1 Abuja Environmental Protection Board (AEPB)

AEPB was established under AEPB Decree No. 10 of 1997 and serves as the regulatory authority charged with the responsibility for the protection and management of the environment. The following are the specific functions but are not limited to:

- Minimizing the impacts of physical development of the ecosystem
- Preserving, conserving and restoration to pre impact status of all ecological processes essential for the preservation of biological diversity.
- Enforcement of all environmental legislations and abatement of all forms of environmental degradation and nuisance.
- Protection and improvement in air, water, land, forest, and wildlife in the ecology of the federal capital territory.
- Municipal liquid and solid waste collection and disposal/sanitation management services including connection of plot to the central sewer line.
- Pollution control and environmental health fumigation and vector control services.

1.8.4.2 Nigeria Export Processing Zones Act (CAP N107 LFN 2004)

The institutional framework that governs the establishment of WTC falls under the jurisdiction of Nigeria Export Processing Zones Authority.

"*In exercise of the power conferred upon it by section 27 of the Nigeria Export Processing Zones Act, CAP N107 LFN 2004 and of all other power enabling it in that behalf, Nigeria Export Processing Zones Authority with the approval of the Honorable Minister of Trade and Investments*".

The objectives of these regulations will apply to the AFREXIMBANK–Africa Trade Centre (AATC)

- Complement and enhance the provisions of the Nigeria Export Processing Zones Act, 2004
- Provide details of regulatory and supervisory requirements necessary to promote efficient and profitable operations in Nigeria's Free Trade Zones
- Facilitate the attainment of goals for which Free Trade Zones are established in Nigeria.
- These regulations shall take precedence over the Investment Procedures, Regulations and Operational Guidelines for free zones in Nigeria, 2004
- The Authority (Nigeria Export Processing Zone Authority) has delegated Abuja World Trade Centre management the responsibility to develop, manage, operate and administer the area of the zone.

1.8.5 The Core Labour Standards

Although other labour standards exist, four labour standards are internationally accepted as the "core" labor standards (CLS).

- Effective Abolition of Child Labor
- Elimination of Discrimination in Employment and Occupation
- Elimination of All Forms of Forced or Compulsory Labor
- Freedom of Association and the Effective Recognition of the Right to Collective Bargaining

The standards are a set of internationally recognized basic rights and principles at work. There is a global recognition that the CLS are generally applicable to all countries including Nigeria. They do not establish a particular level of working conditions, wages, or health and safety standards to be applied internationally nor do they seek to change the comparative advantage of any country.

They are basic rights that have been repeatedly articulated in international human rights instruments and declarations, such as the Universal Declaration of Human Rights in 1948 and the Convention on the Rights of the Child, 1989.

Adequacy of Environmental Legislation

Sections 3.1 to 3.5 have provided an overview of existing laws, regulations and standards available in Nigeria. International laws that are relevant to the PPP were also highlighted. As is evident, there is no dearth of legislative instruments to assure sustainable development in Nigeria. Indeed, some sector operators believe they are over-regulated. This is a position espoused by the oil and gas operators whose activities seem to attract interest of several regulators. The challenge of enforcing environmental regulations in Nigeria is therefore not so much the adequacy of environmental legislation but a number of other factors including conflict in roles and a general lack of

environmental governance. According to Adegoroye (1994), factors contributing to the poor enforcement of environmental laws in Nigeria include:

- Influential individuals and groups;
- Industries with environmentally unacceptable technology;
- Role conflicts among government MDAs;
- Political instability - leading to the scrapping of the enforcement arm of FEPA. If allowed to function properly, the establishment of NESREA should however address this problem
- Need for capacity building

1.8.6 Applicable Nigerian Laws

- Federal Capital Territory Creation Act, Decree No.6 of 1976
- Federal Capital Territory's (Establishment of functionaries and Departments) and the Federal Capital Territory's (Dissolution) order No. 1 of 2004
- The Abuja Environmental Protection Board Act No. 10 of 1997
- Environmental Impact Assessment Act CAP E12, LFN 2004.
- Harmful Wastes (Special Criminal Provisions etc.) Act No.42 of 1988
- Solid Waste Control/Environmental Monitoring, (AEPB Regulations 2005)
- The Endangered Species (Control of Trade and Traffic) Act in 1985
- Exclusive Economic Zone Act No.42 of 1998
- Territorial Waters Act No.1 of 1998
- Land Use Act (LUA) Cap.202, 1990
- Exchange Control Repeal Act 1995
- Nigerian Enterprises Promotion Repeal Act 1995
- Nigerian Investment Promotion Commission (NIPC) Act No. 16 of 1995, now Cap. N117 LFN 2004)
- Foreign Exchange (Miscellaneous & Monitoring Provisions) Act (No. 16 of 1995, now Cap. F34, LFN 2004

1.8.6.1 National Environmental Standards and Regulation Enforcement Agency (NESREA) Act 2007

- Section 7 provides authority to ensure compliance with environmental laws, local and international, on environmental sanitation and pollution prevention and control through monitory and regulatory measures.
- Section 8 (1)(K) empowers the Agency to make and review regulations on air and water quality, effluent limitations, control of harmful substances and other forms of environmental pollution and sanitation.
- Section 27 prohibits, without lawful authority, the discharge of hazardous substances into the environment. This offence is punishable under this section, with a fine not exceeding,

N1, 000,000 (One Million Naira) and an imprisonment term of 5 years. In the case of a company, there is an additional fine of N50, 000, for every day the offence persists.

Regulations (under NESREA) - National Effluent Limitation regulations

- Section 1 (1) requires industry facilities to have anti-pollution equipment for the treatment of effluent.
- Section 3 (2) requires a submission to the agency of a composition of the industry's treated effluents.
- National Environment Protection (Pollution Abatement in Industries and Facilities producing Waste) Regulations (1991).
- Section 1 Prohibits the release of hazardous substances into the air, land or water of Nigeria beyond approved limits set by the Agency.
- Section 4 and 5 requires industries to report a discharge if it occurs and to submit a comprehensive list of chemicals used for production to the Agency.

1.8.6.2 Federal Solid and Hazardous Waste Management Regulations (1991)

- Section 1 makes it an obligation for industries to identify solid hazardous wastes which are dangerous to public health and the environment and to research into the possibility of their recycling.
- Section 20 makes notification of any discharge to the Agency mandatory.
- Section 108 stipulates penalties for contravening any regulation.

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

Sections relevant to environmental emergency prevention under the EIA include:-

- Section 2 (1) requires an assessment of public or private projects likely to have a significant (negative) impact on the environment.
- Section 2 (4) requires an application in writing to the Agency before embarking on projects for their environmental assessment to determine approval.
- Section 13 establishes cases where an EIA is required and
- Section 60 creates a legal liability for contravention of any provision.

1.8.6.4 The Nigerian Urban and Regional Planning Act Cap N138, LFN 2004

- Section 30 (3) requires a building plan to be drawn by a registered architect or town planner.
- Section 39 (7) establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.
- Section 59 makes it an offence to disobey a stop-work order. The punishment under this section, is a fine not exceeding N10, 000 (Ten thousand naira) and in the case of a company, a fine not exceeding N50, 000.

- Section 72 provides for the preservation and planting of trees for environmental conservation.

1.8.6.5 Land Use Act, Cap 202, LFN 2004

The Land Use Act places the ownership, management and control of land in each state of the federation in the Governor. Land is therefore allocated with his authority for commercial, agricultural and other purposes.

1.8.6.6 Harmful Waste (Special Criminal Provisions) Act, Cap H1, LFN 2004

The Harmful Waste Act prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

- Section 6 provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.
- Section 7 makes provision for the punishment accordingly, of any conniving, consenting or negligent officer where the offence is committed by a company.
- Section 12 defines the civil liability of any offender. He would be liable to persons who have suffered injury as a result of his offending act.

1.8.6.7 The Endangered Species Act, Cap E9, LFN 2004

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

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

1.8.6.8 Exclusive Economic Zone Act, Cap E11, LFN 2004

The Exclusive Economic Zone Act makes it illegal to explore or exploit natural resources within the Exclusive zone without lawful authority. The Federal Government regulates the activities of the Exclusive Zone.

1.8.6.9 Criminal Code

The Criminal Code contains provisions for the prevention of public health hazards and for environmental protection. Hence:

- **Sections 245-248** deal with offences ranging from water fouling, to the use of noxious substances.

1.8.6.10 Waste Management and hazardous Waste Regulations of 1991

- Regulates the collection, treatment and disposal of solid and hazardous wastes from municipal and industrial sources.

1.8.6.11 Guidelines and Standards for Environmental Pollution Control in Nigeria 1991

- Directs industries to improve the quality of the environment.
- Serves more or less as recommended standards of environmentally good behavior for industries.

The Federal Government of Nigeria also passed into law the **Environmental Impact Assessment (EIA) Act No 86 of 1992,** which is summarized below,

- Requires the government, its agency and private enterprises to carry out EIA study of a proposed project,
- The study also covers for proposed expansion of existing project or facility/ industry.

1.8.7 Nigeria Environmental Policy

In November 1989, the present Nigeria Environmental Policy was launched to guide environmental activities in Nigeria. The main objective of the policy is to achieve sustainable development which can be achieved by;

- Securing for all Nigerians a quality of Environment adequate for their health and wellbeing;
- Conserving and using the natural resources for the benefit of the present and future generations;
- Restoring, maintaining and enhancing the ecosystem and ecological process essential for the preservation of biological diversity;
- Raising public awareness and promoting understanding of the essential linkages between environment and development;
- Co-operation with other countries and international organizations and agencies to achieve the above specific goals, and prevent transboundary environmental pollution.

1.8.7.1 National Environmental Standards and Regulation Enforcement Agency (NESREA)

The basis of environmental policy in Nigeria is contained in the 1999 Constitution of the Federal Republic of Nigeria. Section 20 of the Constitution empowers the state to protect and improve the environment; and safeguard the water, air and land, forest and wildlife of Nigeria. Hitherto, various laws and regulations have been enacted to safeguard the Nigerian environment. These include:

- National Environmental Protection (Effluent Limitation) Regulations;
- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations; and

- National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations.
    - National Environmental Health Practice Regulations 2007; and
    - Nigerian Radioactive Waste Management Regulations 2006.
- Environmental Impact Assessment Act of 1992 (EIA Act).
- Harmful Wastes (Special Criminal Provisions etc.) Act of 1988 (Harmful Wastes Act).
- The National Environmental Standards and Regulations Agency 2007 (NESREA Act).

The NESREA Act was enacted on the 31st July, 2007 to provide for the establishment of the National Environmental Standards and Regulations Agency (NESREA). This Act repealed the Federal Environmental Protection Agency Act (the FEPA Act) pursuant to which the FEPA which was formerly charged with the protection and development of the environment in Nigeria was established. However all regulations, authorizations and directions made pursuant to the FEPA act and which were in force at the commencement of the NESREA Act shall continue to be in force and have effect as if made by the NESREA Act. The NESREA Act applies to the regulation and the protection and development of the environment in Nigeria with the exception of the oil and gas sector.

The NESREA is responsible for the protection and development of environmental standards, regulations, rules, laws, policies and guidelines within Nigeria. The NESREA's functions do not however include enforcement of environmental standards, regulations, policies and guidelines in the oil and gas sector of Nigeria. The NESREA Act give authorized officers of the NESREA powers to:

- Enter and search any land, building, vehicle, tent, vessel, floating craft or any inland water; for the purpose of conducting inspection, searching and taking samples for analysis which are reasonably believed to be carrying out activities or storing goods which contravene environmental standards or legislation
- Seize or detain for such a period as may be necessary articles which are reasonably believed to contravene provisions of the legislation or any of its regulations; and
- Obtain an order of a court to suspend activities, seal and close down premises including land, vehicle, tent, vessel, floating craft or any inland water and other structure.

Functions of NESREA Act

- Under the NESREA Act, the Minister charged with the responsibility of the environment is empowered by regulations to prescribe any specific removal methods and reporting obligations on the owners or operators of vessels discharging harmful substances and waste into the environment.

- Public authorities are statutorily required to inform the public of Environment-related issues. The NESREA Act requires NESREA to enforce compliance with environmental regulations, to create public awareness, provide environmental education on sustainable environmental management and to publish data resulting from the performance of its functions.
- The NESREA Act provides that a person who breaches the provisions of the Act commits an offence and shall on conviction be liable to a fine, or imprisonment, or both.
- The NESREA Act also provides that where there has been a discharge of any hazardous substance in violation of environmental laws/permits, the person responsible for the discharge will bear the liability of the costs of removal and clean up.
- In executing its functions, the NESREA is required to conduct environmental audits and establish a data bank on regulatory and enforcement standards.

1.8.7.2 Statutory Regulations Guiding Solid Waste Management in Nigeria

- **The National Environmental Standards And Regulations Enforcement Agency Act 2007 (NESREA Act)**

After the repealing of the Federal Environmental Protection Act of 1988, the NESREA Act, 2007 became the major statutory regulation or instrument guiding environmental matters in Nigeria. It specially makes provision for solid waste management and its administration and prescribes sanction for offences or acts which run contrary to proper and adequate waste disposal procedures and practices.

- **Environmental Impact Assessment Act of 1992**

The purpose of the EIA Act is to among other things establish before a decision taken by any person, authority corporate body or unincorporated body including the Government of the Federation, State or Local Government intending to undertake or authorise the undertaking of any activity that may likely or to a significant extent affect the environment. Such activities include the disposal of solid waste in the environment.

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

This regulation that was promulgated in 2009 among other things makes adequate provisions for waste control and environmental sanitation including punishments in cases of malfeasances.

- **The Harmful Waste (Special Criminal Provisions, etc) Act**

The Decree prohibits the Carrying, depositing and dumping of harmful waste on any land, territorial Waters, contagious zone, Exclusive Economic Zone of Nigeria or its inland Water ways and prescribes severe penalties for any person found guilty of any Crime relating thereto.

- **The NEP (Pollution Abatement in Industries and Facilities Generating Waste) Regulations**

Restrictions are imposed hereunder on the release of toxic substances and requirement of Stipulated Monitoring of pollution to ensure permissible limits are not exceeded; Unusual and accidental discharges; Contingency plans; Generator's liabilities; Strategies of waste reduction and safety for workers.

- **The Management of Solid and Hazardous Wastes Regulations**

These regulate the collection, treatment and disposal of solid and hazardous waste for municipal and industrial sources and give the comprehensive list of chemicals and chemical waste by toxicity categories.

- **The National Effluents Limitations Regulation**

This instrument makes it mandatory that industrial facilities install anti-pollution equipment, make provision for further effluent treatment, prescribe maximum limit of effluent parameters allowed for discharge, and spell out penalties for contravention.

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

This was launched on March 12th 1991 and represents the basic instrument for monitoring and controlling industrial and urban pollution.

1.8.8 International Environmental Legislation

Nigeria is signatory to several international treaties and conventions. These include those on climate, waste, oil and chemical pollution and others. These conventions and their years of adoption are shown in **Table 1.1**.

Consequence/s: These are triggered with respect to import-export of commodities and resources.

Table 1. 1: Summary of Key International Environmental Agreements

Treaty, Convention, Regulation	Year Adopted
Desertification Convention	1997
International Convention on Oil Pollution Preparedness, Response, and Cooperation	1995
Framework Convention on Climate Change	1994
United Nations (UN) Convention on Biological Diversity	1994
International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (IOPC FUND)	1992
UN Framework Convention on Climate Change	1992
International Oil Pollution Compensation Fund (IOPC Fund)	1992
International Convention on Oil Pollution Preparedness, Response and Cooperation	1990

Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel Convention)	1990
Basel Convention on the Control of Trans Boundary Movements of Hazardous Wastes and their Disposal	1989
Protocol on Substances that deplete the Ozone Layer (Montreal Protocol)	1989
Convention for the Protection of the Ozone Layer (Vienna Convention)	1989
Convention on the Conservation of Migratory Species (CMS)	1987
Vienna Convention on the Law of Treaties	1980
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1974
African Convention on Conservation of Nature and Natural Resources	1968

Source: UNEP 1990

Labour Laws: The Labour Act of 1990 contains general provisions on the protection of wages, contracts of employment and terms and conditions of employment for workers in Nigeria (*see* ***Table 1.2***).

Table 1. 2: List of International Labour Laws Ratified By Nigeria

Regulation	Year Adopted
Worst Forms of Child Labour Convention, 1999 (No. 182)	2002
Discrimination (Employment and Occupation) Convention, 1958 (No. 111)	2002
Tripartite Consultation (International Labour Standards) Convention, 1976 (No. 144)	1994
Occupational Safety and Health Convention, 1981 (No. 155)	1994
Minimum Age (Underground Work) Convention, 1965 (No. 123)	1974
Equal Remuneration Convention, 1951 (No. 100)	1974
Final Articles Revision Convention, 1961 (No. 116)	1962
Abolition of Penal Sanctions (Indigenous Workers) Convention, 1955 (No. 104)	1962
Right of Association (Agriculture) Convention, 1921 (No. 11)	1961
Minimum Wage-Fixing Machinery Convention, 1928 (No. 26)	1961
Employment Service Convention, 1948 (No. 88)	1961
Equality of Treatment (Accident Compensation) Convention, 1925 (No. 19)	1960
Forced Labour Convention, 1930 (No. 29)	1960
Recruiting of Indigenous Workers Convention, 1936 (No. 50)	1960
Contracts of Employment (Indigenous Workers) Convention, 1939 (No. 64)	1960
Penal Sanctions (Indigenous Workers) Convention, 1939 (No. 65)	1960
Labour Inspection Convention, 1947 (No. 81), *Excluding Part II*	1960
Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87)	1960

Labour Clauses (Public Contracts) Convention, 1949 (No. 94)	1960
Protection of Wages Convention, 1949 (No. 95)	1960
Migration for Employment Convention (Revised), 1949 (No. 97) *Has excluded the provisions of Annexes I to III*	1960
Right to Organise and Collective Bargaining Convention, 1949 (No. 98)	1960
Abolition of Forced Labour Convention, 1957 (No. 105)	1960

Source: ILO 2000

Other triggered World Bank/IFC policies are also applicable, including:

- World Bank Safeguard Policies;
- OP/BP 4.01 – Environmental Assessment;
- OP/BP 4.04 – Natural Habitats;
- OP 4.36 – Forests; and
- OP 4.11 – Physical Cultural Resources.

1.8.9 International Finance Corporation (IFC) requirements

The EIA will be consistent with the International Finance Corporation (IFC) requirements. While developing the EIA, the following Policies, Standards and Guidelines will be adhered to:

- IFC's Policy and Performance Standards (PS) on Environmental Sustainability (January 2012).
- The World Bank Group Environmental, Health, and Safety Guidelines, known as the 'EHS Guidelines' (2012) (see **Table 1.3**).

Table 1. 3: EHS Guidelines

Project component	Applicable EHS Guideline
All components	General EHS Guidelines
	EHS Guidelines for Water and Sanitation
	EHS Guideline for Waste Management
Construction activities	EHS Guidelines for Construction Material Extraction

In addition, the following IFC's Good Practice Documents will be consulted during the EIA process:

- IFC Good Practice Note "Addressing the Social Dimension of Private Sector Projects" (December 2003);
- IFC "Investing in People: Sustaining communities through improved business practices – A community development resource guide for companies" (January 2001).

In case IFC standards and guidelines do not address some specific environmental or social aspects associated with the proposed AFREXIMBANK–Africa Trade Centre (AATC), Abuja, other applicable international (e.g. World Health Organization, IUCN, etc.) standards will be considered.

Since, the IFC or other financiers have not yet been involved in the project, no *'IFC Environmental and Social Category'* has been officially assigned to the project. Nevertheless, given the current level of knowledge, it is likely that the Project would be classified as a Category B project, which means a "project *activities with potential limited adverse environmental or social risks and/or impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures"*. This classification requires that the construction of the AFREXIMBANK–Africa Trade Centre (AATC), is to be the subject of a detailed EIA. Such an EIA (using IFC standards) is a prerequisite for financiers subscribing the Equator Principles (i.e. those financiers who have pledged to follow the IFC's environmental and social standards).

1.9 EIA Report Structure

The main body of the report is presented in 9 (Nine) chapters.

Executive Summary		
Chapter One	-	Introduction
Chapter Two	-	Project Justification
Chapter Three	-	Project and Process Description / Environmental Design
Chapter Four	-	Description of Project Environment
Chapter Five	-	Associated and Potential Environmental Impacts
Chapter Six	-	Mitigation Measures
Chapter Seven	-	Environmental Management Plan
Chapter Eight	-	Decommissioning and Closure
Chapter Nine	-	Conclusion
Appendix		
References		

CHAPTER TWO

2.0 PROJECT JUSTIFICATION

2.1 Need for the Project

In execution of its mandate, AFREXIMBANK uses three broad instruments of intervention namely credit (trade and project finance), risk bearing services and advisory services.

In 2017, the Bank approved its 5th Strategic Plan (2017 – 2021) which places emphasis on the following:

i. promoting intra-African trade;

ii. facilitating industrialization and export development in Africa;

iii. strengthen Trade Finance Leadership; and

iv. improve Financial Soundness and Performance

In line with this strategic plan, the Bank has set out to transform its existing and future buildings into business complexes, which will be branded “AFREXIMBank – Africa Trade Centres”, to provide an integrated one-stop shop for trade services. These are envisaged to be iconic business complexes that will provide a suite of integrated trade services and trade finance. These trade centers are expected to enhance the Bank’s brand equity and play a vital role bridging the intra-African trade information gap on the continent. Additionally, and in order to gain scale, the Bank will consider supporting existing and new TCs in various African cities.

2.2 Objectives for the Project

Broad Objective

To establish an iconic business complex to provide an integrated one-stop shop for trade services and business facilities. The trade services would be provided by way of possible joint ventures/partnerships through co-branding and co-servicing with relevant partners.

Specific Objectives

- To bridge the gap in trade and market information in Africa, especially with regard to intra-African trade;
- To provide an integrated one stop-shop for trade services, trade finance and advisory services to the business community;
- To provide a range of iconic business facilities to support the effective provision of key trade services offered;
- To increase intra-African trade, catalyse value addition and export manufacturing and contribute towards positive economic transformation of the African continent.

2.3 Envisaged Sustainability

This project shall be undertaken according to best industry practice, including standard and time-tested design, standard construction methods, standard operational procedures and fully trained and qualified personnel to man the project. The project shall also incorporate an enhancement and preservation of the existing environment. The sustainability of this project is based on the following specific considerations:

2.3.1 Technical Sustainability

The proponent has set up a highly technical multi-disciplinary project team which includes civil engineer, electrical engineer, mechanical engineer, geologist amongst others to prepare the engineering design of the project construction in an environmentally friendly manner. Equipment and machineries put in place by the proponent for this project are those whose operation will not have adverse effect on the environment in terms noxious gases emission, noise and vibration. Installation of any equipment will be undertaken with a firm understanding of the implications of its impact on process mass balance, electrical capacity and other process services.

2.3.2 Technological Sustainability

The project will be constructed using modern, locally and internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements. Equipment and systems that save resources including energy and use of solar systems, water conservation will be given first priority without compromising on cost or availability factors. Asphalt mixers, crushers and other construction equipment and machineries will be incorporated with pollution control devices like dust arrestors/precipitators, emission control, noise abatement devices and desulfurization devices. The equipment and vehicles will have highest levels of combustion efficiency, capability to use cleaner fuels like bio-diesel and will have enhanced safety features.

2.3.3 Economic Sustainability

This project will be sustained economically by way of improving trade relations between Nigeria and the rest of the world; bringing in foreign investments into the country usage, and expanding local markets and trades in Abuja which in turn will increase foreign exchange inflow as well as generate revenue for the government. A move towards a solution-based business model will be undertaken, whereby a new perception of value is established, that will enhance material gain, eliminating the concept of waste as part of the production cycle.

2.3.4 Social Sustainability

The project will be undertaken in a socially sustainable manner since it has a lot to do with the public and the local community around the project area. The immediate community bordering the project is well disposed to the project and is willing to support the implementation of the project to its logical conclusion. Consultation so far carried out at the planning stage, showed that the people are happy with the project.

2.3.5 Environmental Sustainability

This project would have some potential negative impacts on the environment. It is the policy of the project proponent to conduct EIAs for her projects in accordance with the national laws. The EIA will identify all potential impacts associated with the proposed project and proffer appropriate mitigation/ameliorative measures that will ensure that all the impacts are minimized or completely avoided. However incorporating the findings and recommendation of this EIA, and implementing an effective Environmental Management Plan, at the planning, design, construction, operation and abandonment/decommissioning stages of the proposed project, will ensure its environmental sustainability.

2.4 Project Development Options

2.4.1 No project option

The “no-project option” implies that the construction of the proposed AFREXIM Bank–Africa Trade Centre **(AATC)** Abuja will not be. This option is considered if there is economic, technical or human capacity deficiencies or that the proponents are unwilling to commence the project or that the regulatory authorities are unwilling to approve the project; thus leading to a “no project option” . This option will translate to non-beneficiary by the FCT in particular and the nation as a whole. This will also mean that the socio-economic impact seen as positive on Abuja and the nation will not be achieved. This is not good for socio-economy, population growth, poverty alleviation, health, expansion and development of the nation. This option was not considered, therefore, the need for the project.

2.4.2 Delayed project option

This option implies that the execution of this project will be delayed until a much later date. Such option is usually taken when conditions are unfavourable for project implementation, such as in a situation where there is war, or host community is deeply resentful of the project. Also, if the economics of the project are unacceptable or unattractive at the time, then a delay may be feasible. But none of these conditions are applicable. In fact, on the contrary, both the economics and the political environment are most favourably disposed towards the project. Therefore, the

implication of delaying the project will include the fact that all contractors, workers and equipment that have been mobilized for this project, and procurement, will have to be demobilized. Also, because of the inflationary trends in Nigeria, such a delay may result in unanticipated increase in project costs, leading to a decrease in final profit accruable from the project. These, and other related problems make it impossible to adopt the delayed project option.

2.5 Alternative Site/Location option

The proposed site is located on a parcel of land in Abuja, Nigeria. It can be found on the southern portion on the intersection of Independence Avenue and Sani Abacha Way. The proposed site is also bordered by the National Ecumenical Centre. The site is measured at 5,856 square metres and is in the Central Business District (CBD). The certificate of occupancy, survey map and development control parameters are attached to this report (see **Appendix A, B** and **C**). The specialist consultant commenced with doing site investigations with regards to the suitability of the location, sustainability factors for similar trade centres, adequacy of the site and site services, and evaluating the environment and safety and health issues, as well as investigating local authority restrictions. The site was carefully selected to meet the criteria for selection of an appropriate site for project of this magnitude which include; minimum possible infringement, availability of adequate space, avoidance of historic sites and environmental sensitive areas. The project site has been surveyed and all necessary site details, site layout drawings, site plan and approvals from the Federal Capital Development Authority have been processed. Thus, alternative site/location is not considered.

2.6 Alternative Technology Option

There are various technologies and equipment vendor available in the construction industry. The proponent shall adopt the technology and equipment produced by a technical company with integrity. For consistency with the technological make-up of the existing equipment and tools, there is no need for consideration of an alternative technology for the proposed project. In effect, the option to go ahead with the proposed project, using the time-tested, efficient, cost-effective and environment friendly technology and equipment produced by a technical company with integrity is considered the most economically, technically and environmentally sustainable and feasible alternative for the project.

2.7 Analysis of Alternative Construction Materials and Technology

The proposed project will be constructed using modern, locally and internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements.

Equipment that saves energy and water will be given first priority without compromising on cost or availability factors. The concrete pillars and walls will be made using locally sourced stones, cement, sand (washed and clean), metal bars and fittings that meet the Nigeria Building code requirements. Beautiful and durable reinforced concrete roofs shall be used because they are good in heat insulation with minimal Iron/Aluminum sheet roofs. This will ensure that the rainwater harvested will be utilized in other areas such as watering the flower gardens. Heavy use of timber during construction is discouraged because of destruction of forests. However, the construction methods and technologies to be used for this project will require very little timber.

2.8 Domestic waste water management alternatives

The available project technologies for domestic waste management alternatives are discussed below:

2.8.1 Alternative One - Use of septic tanks

This involves the construction of underground concrete-made tanks to store the sludge with soak pits. It is expensive to construct and regular empting in large discharge points like the large scale office building project proposed. Given the kind of liquid waste emanating from the proposed project this option is not preferred since it will be uneconomical.

2.8.2 Alternative Two - Connection to the sewer line system

Connection to the central sewer line option is a viable option since the Central Business District (CBD) of FCT Abuja is served by existing sewer line.

2.8.3 Alternative three: Use of Bio-digester

Bio digester is an on-site sanitation unit that utilizes anaerobic technology for the disposal of toilet (black) wastewater as well as of kitchen and bathroom (grey) water, in a closed system. This is an incredibly ethical sanitation technology which treats wastewater in an environmentally friendly manner, facilitating its use for irrigation or its return to water bodies without polluting them. The process also generates organic fertilizer and biogas (a form of fuel) by allowing naturally occurring bacteria to break down solid waste. From the analysis and economic as well as environmental; considerations use of bio digester system is a viable option for the proponent to adopt in order to supplement connection to the sewer system.

2.9 Solid waste management alternatives

A lot of solid wastes will be generated from the proposed project especially during its operation. An integrated solid waste management system is recommendable. First, the proponent will give

priority to Reduction at Source of the waste materials. This option will demand solid waste management awareness among the staff the proposed AFREXIM Bank–Africa Trade Centre **(AATC)** Abuja. Notices for proper waste management/handling shall be posted at strategic places for the sake of visitors. Secondly, Recycling and Reuse of the waste will be the second alternative in priority. This will call for a source separation programme to be put in place. The recyclables will be sold to waste buyers within Abuja.

Summary

In effect, the option to go ahead with the proposed AFREXIM Bank–Africa Trade Centre **(AATC)** Abuja, using the time-tested, efficient, cost-effective and environment friendly technology and equipment produced by a technical company with integrity is considered the most economically, technically and environmentally sustainable and feasible alternative for the project.

CHAPTER THREE

3.0 Project and Process Description / Environmental Design

A Global/pan-Africa Design concept is being developed as part of the Abuja AATC. The design will incorporate the Bank's vision of a landmark, mixed-use, modern, futuristic and iconic one-stop shop Complex which possesses a broad intra-African-Trade, character and appeal. The concept will be scalable and adaptable to the Bank's proposed site while maintaining the core character, appeal, look and feel as we adapt to local constraints such as land size, shape, regulatory provisions or any other restrictions. The Bank has set out to transform its existing and future buildings into business complexes, which will be branded "AFREXIM Bank – Africa Trade Centre", to provide an integrated one-stop shop for trade services. These are envisaged to be iconic business complexes that will provide a suite of integrated trade services and trade finance. These trade centers are expected to enhance the Bank's brand equity and play a vital role bridging the intra-African trade information gap on the continent. There are a range of facilities that will be housed under the Trade Centre and these include all or part of the following:

i. Office tower with corporate offices for Bank and Tenant offices
ii. Exhibition facilities and convention/conference centres
iii. Seminar / Meeting Rooms / Auditorium
iv. Medium-sized hotels (up to 200 rooms) and restaurants/food court
v. High end apartments and residence for the Regional Chief Operations Officer
vi. Trade information and knowledge centre with electronic and physical library
vii. Parking space
viii. Business centre
ix. Contingency and or temporary executive office space
x. A small business innovation and incubation hub
xi. Trade Information and knowledge centre/library
xii. Other facilities.

This section focuses on the technical viability with regards to the existing services and environmental sensitivities.

3.1 Proposed Abuja Technical Plan Design/Concepts

AFREXIMBANK notes that branding the AATC is an opportunity to make their mandate more visible while also making Africa's opportunities more tangible to the local, regional & international business communities. This branding is viewed as more than branding a building; it is about branding Africa and driving positive perceptions of the continent to attract investments and

committed collaborative action. There is an opportunity to represent the history and future of African trade as well as draw inspiration from appropriate ancient African architectural legacies to develop an iconic AATC building that will become a recognizable signature for the AATC brand and buildings to be completed across Africa.

An AATC building or complex of buildings should therefore:

- Look & feel like a modern marvel;
- Drive collaborative development;
- Help at interconnecting Africa; and
- Have a legacy for future generations.

Not only will the building have an iconic and recognizable signature, but it should be intelligent buildings that use state of the art technology, green building technologies and principles to ensure an efficient, pleasurable, safe and secure working and trading environment. The AATC concept proposed for Abuja has been adapted from the Global concepts and the concept chosen has been scaled to fit the Abuja site.

Plate 3. 1: Proposed Heterogeneous Building

The Abuja AATC is located on a significantly smaller site footprint. This AATC essentially provides the core functions with a small hotel. As there is no retail offering the conference hall

and associated meeting rooms are located on the ground floor with a direct link to the arrival piazza and atrium. Trade centre offices and SME incubation hubs are located on the mezzanine level with offices and accommodation above. The long terms rental offices and apartments are located in the towers which have good visibility from both Independence Avenue highway and the access road. There is a small portion of on grade parking in front of the building for the VIPs. Possible delivery access could be taken from the street on the western side of the site should this be possible in future. This concept has been selected as the preferred Global Concept.

3.1.1 Site-Adapted Concept Design

Site Layout & Articulation

Two access points to the site are proposed comprising a main entrance from 4th Street parallel to the NE boundary and a service access from Labour Road at the SW corner of the site. 4th Street is presently an undeveloped road taking off from Ralph Shodeinde Street and terminating at the North boundary of the site. Labour Road is a paved road taking off from Sani Abacha Way and terminating in a blind alley at the SW corner of the site. Security Booths and gates are provided at each of the site access points. At grade level, the site is zoned into 3 main areas as follows:

- The Forecourt comprising the internal driveways. Arrivals/drop and off area and short term parking for cars and buses all accessed through the main entrance gate on 4th Street.
- The mid-section in which the building mass is situated
- The Backyard comprising the M&E services plant area and the delivery yard that provides a loading bay for deliveries to the Hotel and service access for large items to the Exhibition Hall. The backyard is accessed via the Service gate on Labour Road.

There is provision for limited landscaping on the fringes of the site largely along the NE and SW boundaries.

Building massing

The development massing consists of two mid-rise tower blocks of the same height set atop a two storey podium block. The podium block houses the Visitors· Management Centre, the Hotel Reception and a multi-functional Hall on the ground floor and the Hotel public facilities on the first floor. Above the podium block, the two tower blocks are connected on every floor via a glass bridge across a 10-storey Atrium. The roofs of the tower blocks provide open-air terraces to accommodate some M&E plant (Ventilation and Air-Conditioning Chillers, Air Handling Units) and solar panels.

The podium block sits on two levels of basement housing car parking decks and some M&E service spaces. Each tower has its own independent lift core in which the service facilities are consolidated. The towers have good visibility from Independence Avenue (North of the site) and from Ralph Shodeinde street (South of the site)

Internal configuration

Common areas

At ground floor level in the podium block, the towers have a common public space - a double height Concourse. Visitors arrive at the Concourse via the sheltered arrivals drop-off at street level or via a pair of dedicated Shuttle Lifts conveying people from the Basement car park. A large pyramidal skylight over the Concourse will provide a generous flood of natural daylight within this double height space.

The Concourse directly feeds the Visitors· Management Centre and the Hotel Reception Lobby. The Visitors· Management Centre will enhance the screening and processing of Visitors before admission into the building. It contains a reception, waiting Area, meeting rooms and washroom facilities.

A second layer of public space at ground floor level - a 10-storey Atrium - accessed through the front entrance doors gives controlled access (by means of security Turnstiles) to the Office tower and the Conference/Exhibition Hall. The Atrium is laid out as a light-filled space having visual connectivity with the bank of scenic Lifts on two of its sides and volumetric continuity with seminar rooms and the Hotel Lounge Bar on the first and second floors respectively. The flow of people in the Atrium coupled with the visible activities on the upper floors and the visible motion of lift cars conveying people up and down the two towers will foster a vibrant and animated ambience within the atrium. This dynamic environment will further enrich the perception and experience of this communal space as the social heart of the development.

A mezzanine level in the podium block houses seminar rooms, trade centre offices and SME incubation hub. Suites are provided on the ground floor and on the mezzanine floor respectively for Security office and facilities Management front office and BMS (Building Management System).

Hotel tower

The **first floor** of the podium block contains the Hotel's public facilities - Lounge Bar and Dining area both of which open onto a landscaped swimming pool deck creating opportunity for

ALFRESCO dining and outdoor lounging. A skylight over the Lounge will flood the Bar area with filtered natural lighting. The kitchen, banquette hall and a Gym/wellness Centre are also located on the first floor.

The **eight upper floors** above the podium block in the Hotel tower houses 120 guest rooms featuring 3 room types -16 Suites, 8 Deluxe rooms and 96 Standard rooms. The external facade comprising concrete, glass and aluminum features horizontal aluminum louvres as sun shading devices creating a dynamic interplay of light and shadows and help in preventing reflective glares.

The **Hotel tower facade** overlooking the portion of the office tower to the south of the service core has distinctive cantilevered triangular bays along the floor plate to open up views to the outside without compromising privacy in the guest rooms.

Office tower

Open plan office accommodation offering a flexible workplace environment is laid out on 8 storeys in 2 wings on either side of a dedicated lift core housing the washrooms and the service spaces. The core is connected to the Hotel Core on every floor via a link bridge across the 10-storey Atrium.

The overall width of approximately 14meters for the floor-plate will facilitate good light penetration into the floor-plate and exterior views for all occupants of the office space.

3.2 Structural Engineering

The proposed development consists of two detached identical buildings. a 13-storey and 11-Storey building structures which are wholly attached at the basement & ground floor levels and comparatively connected on the 1st. 2nd. & 3rd floor levels respectively. They are further linked via a 5.31m wide link bridge on the 4th - 8th floors Level. The basement consists of two underground parking floor levels which accommodates adequate parking, on the 1st & 2nd Levels respectively. While the other floor usage consists of:

- Office Areas including AFREXIMBank Office Spaces. (7453 sqm) Hotel Spaces. (9433 sqm)
- Shared Office Lobbies. (690 sqm)
- Conference Spaces. (1381 sqm)
- Seminar Spaces. (462 sqm)
- SME. Incubation. Knowledge Centre & Library, (222 sqm) Total Gross Building Area (19640 sqm)

3.2.1 Applicable Regulations

The Nigerian Building Code recognizes and permits designs to be carried out on the generally accepted and more onerous international standards particularly the following British Standards among several others:

- BS 8110 The Structural Use of Concrete : Parts l & 2 (1997) Code of practice for design and construction
- BS 8500:2002 Concrete Complimentary British Standard to BS EN 206-1 Part 1: Method of specifying Guidance for the specifier.
- BS EN 197-1:2000 - Specification for Portland cement. (Replaced BS12:1996)
- BS 4449:2005+A2:2009 - Steel for the reinforcement of concrete, weld-able reinforcing steel Bar. coil and de-coiled product specification+ Amendment 2 2009 Specification for Carbon steel bars for the Reinforcement of concrete
- BS 5950 -1:2000 - The Structural use of Steelwork in Buildings.
- BS 6399 : Part l (1996) - Loading for Buildings
- BS 5930 : 1999 + A2 : 2010 - Code of Practice for Site Investigations
- BS EN 1997-1:2004 -Code of Practice for Foundations
- BS 4987 & 7263 -Roads and Pavements Design
- BS EN 12056-3:2000 - Code of Practice for Drainage of Roofs and Paved
- BS 6031:2009 - Code of Practice for Earthworks
- BS 1377:1990 - Methods of Tests for Soils for Civil Engineering
- Other relevant Nigerian Local Authority Building Regulations, or equivalent EN-BS codes where these are not inferior to generally acceptable engineering practices

The selection of an appropriate structural system to be used for the floor plates will depend on the final details of the proposed building and preferred column positions and spans required. Typically, flat slabs, or a derivative of a flat slab arrangement, would be preferred – not only does it provide the building with clean structural lines, the system facilitates ease and speed of construction, as well as simplified management of building services, as opposed to normal beam and slab systems.

Consideration will be given to:

- Conventional reinforced concrete flat slabs as well as post-tensioned slabs, in order to provide a structural system that is both economical, easy to construct and satisfies

the basic architectural requirements;

- Columns will be positioned and sized based on loading and floor span requirements and will take into account lateral stability requirements provided by lift shafts and shear walls. Joints will be provided at selected positions to ensure that building thermal and shrinkage movement can be accommodated within the structural system;
- Special consideration will need to be given to the sizing and design of the flying wing supported on an inclined column as indicated above, to allow for the floor plates to cantilever off the central support; and
- The structure will be modelled and designed using Revit which will provide full BIM based collaboration with the architect and the other engineering disciplines.

Site Geology

The geology at the proposed development is comprised of migmatite. The mineralogical composition is up to 70% quartz hence sandy soils are expected to have developed from the migmatite. A geotechnical investigation was carried out at a location about 1.5km away comprising boreholes and Cone Penetration Testing (CPT). As it is on the same geology, it can be safely assumed that the encountered ground and derived geotechnical properties should be similar to the site of the proposed development. The ground was found to be comprised of sands, sandy gravels, sandy clays and gravelly clays, with bedrock in excess of 5m deep. Until a detailed geotechnical investigation of the site is undertaken it will not be possible to establish any definitive founding guidelines for the structures proposed for the site.

The proposed concept design indicates a large cantilevered wing supported in an inclined column which will results in very high loadings. These areas may require special foundation treatment to ensure that the loads can be carried safely without any significant defection. This may require deep foundation to enable founding to take place at the level of the un-weathered rock. For secondary single- and double-storey structures, which would be ideally founded on spread footings, it may be necessary to either provide an engineered raft to counteract poor soil conditions or alternatively a concrete raft founding solution could be considered. Where deeper structures which may incorporate basements are proposed it may be possible to found within the un-weathered or slightly weathered rock zone at depth. The jointing of the structures and especially brick wall jointing details will be reviewed depending on the final founding solution and the risk associated with possible differential movement. The following risks to the project have been potentially identified and are detailed in the risk register:

- It is anticipated that the project will comprise a multi-storey building with a deep basement with the assumption that the building can be founded on good quality partially weathered or sound rock at relatively shallow depth;
- Height considerations to be considered; and
- Delay in municipal approvals

STRUCTURAL MATERIALS

The building shall be constructed of reinforced concrete generally, with likelihood of using some elements of structural steel and glass as necessary and/or for effect. The following material types and strengths will be considered in the preliminary designs:

Concrete

- Concrete is proposed to be Grade 25-30N/mm2 for the structural elements with grade 30-40 N/mm2 being proposed for the foundation, columns and walls.
- Cement will be Ordinary Portland Cement conforming to BS 12 specifications.

Reinforcement Bars

- Reinforcing Steel will be High Yield Deformed Bars Type 2 with design strength of 410N/mm2 conforming to BS 4449 specifications.

Structural Steel

All structural steel will be grade 43 in compliance with BS 5950. This shall be painted with anti-corrosive paint consisting of:

- Zinc rich epoxy primer
- Supreme H/B M.1.0. coating
- Supreme 2pk acrylic finish

However, where it is required to protect the steel element against fire and approved intumescent paint-build up with its compatible primer & top seal finish is suggested.

Structural elements

Cast-in-place reinforced concrete is selected as the primary construction material for this project. One of the primary reasons is due to its ideal mass and stiffness characteristics which aid in the reduction of the wind impact on the Towers.

The proposed lateral load resisting system for the Towers consists of a combination of core walls and a moment-resisting perimeter exterior frame connected by the two-way spanning reinforced concrete floor flat slabs at each level acting as rigid diaphragms. This system maximizes the effective structural 'footprint' of the Tower by utilizing a significant amount of the vertical reinforced concrete weight for lateral load resistance.

Shafts and shear walls

Lift shaft and shear walls in this building will be concrete from basement floor level up to roof level. Doorway walls will be constructed in block-work with lintels over doorways.

Finish to concrete walls will be specified normal smooth concrete struck off the shutter and rubbed down. Architectural finishes will be applied to this surface.

Lift shaft pits will be cast with crystalline waterproofing admixture and will have gravity drainage outlets to drain the sump in emergency situations.

Concrete grade 30-40 N/mm2 will be used in the design of the walls from foundation to roof levels.

Columns

The column sizes in the structure will typically be 500 x 1200mm from the basement to be reduced both in width and length as the structure progresses towards the roof level. The concrete grades will range from 30 N/mm2 to 40 N/mm2.

Column finish will be specified normal smooth concrete struck off shutter and rubbed down. Architectural finishes/paint will be applied to the surface. Edge roundings are applicable to parking columns. Plaster finishes and corner chamfers as per the architectural requirements.

Slabs

The floor slabs will typically be 300mm thick conventionally reinforced cast in-situ concrete Flat Slab of grade 25-30 N/mm2.

The roof slab of the office building will be a 300mm thick conventionally reinforced slab. Minimal slab thickenings of down-stand beams will be required to limit deflection especially along long spans.

Deflection limitations will be within BS 8110 requirements that being a long term maximum of span/250 total post un-propping and span/500 post installation of brittle finishes. These deflection requirements are in line with British/European Standards.

Added benefits of the flat soffit floor slab are:

1. **Flexibility**

- Allows Architect to introduce partition walls anywhere required
- Allows owner to change the size of room layout
- Allows choice of omitting false ceiling and finish soffit of slab with skim coating

2. **Savings in Building Foundation Loads**

- A constituent part of the floor flat slab can also be ribbed if with polystyrene insulation block (which is very lightweight) is readily available
- Approximately saves 20% in vertical loads

- Reduce foundation loads and the cost of the foundation construction

3. **Shorter Construction Time**

- Flat plate design will facilitate the use of big table formwork to increase productivity
- Simplified table formwork needed

4. **Ease of Installing M&E Services**

- All M & E services can be mounted directly on the underside of the slab instead of bending them to avoid the beams
- Avoids hacking through beams

5. **Prefabricated Welded Mesh**

- Prefabricated welded mesh in standard sizes minimizes installation time and better quality control.
- Constructability Improved
- Allows standardized structural members and prefabricated sections to be integrated into the design for ease of construction
- This process will make the structure more buildable, reduce the number of site workers and increase the productivity at site
- More tendencies to achieve a higher constructability score

Floor ramps

This involves creating access ramps at designated locations indicated on the architectural drawings for the parking floors of the development which is used for the vertical vehicular movement into the car parking spaces provided to meet planning regulation.

Structural steel

All structural steel will be of grade 43 in compliance with BS 5950 and shall be painted with anti-corrosive paint consisting of:

- Zinc rich epoxy primer
- Supreme H/B M.1.O coating
- Supreme 2pk acrylic finish
- Similar approved paint specifications.

The cladded facade will be braced and supported by a structural steel frame connected back to the concrete structure. The density of the steel frame will be designed once architectural details of the facade is available. This facade will function as the weather line for these two sides of the building and will be designed by the Facade Consultant.

Foundations

The sub-soil investigation for this project is important and was therefore given top priority and was commissioned by the project architects and ourselves in order to be able to determine the most appropriate foundation solution. However, the general experience of the underlying soils below the neighborhood of the site location suggests that the foundation is most likely to be on a raft slab with uniform thickness given the stiff to very stiff reddish brown and grey, lateritic silty / sandy clay typical of the area.

In the interim and only for the purposes of assisting with the development of a project cost budget, a preliminary assumption 600-800mm thick raft slab over the entire building footprint is expected to be used, or as an alternative, approximately 300mm thick raft slab incorporating slab thickenings/down-stand beams along column grids. Whichever option proves to be more effective during later design development will be adopted. These will be confirmed after detailed sub-soil investigation. It is pertinent to note that this is based on professionally guided assumptions and therefore subject to review and further confirmation.

The raft slab solution is advised due to its ability to uniformly distribute loads on to the subgrade without uneven settlement and also due to it cost efficiency. The anticipated founding depth of the raft slab will be confirmed upon receipt of a detailed sub-soil investigation report.

Actual size, depth of raft slab and other relevant geotechnical parameters shall be obtained from the recommendations of the sub-soil investigation report.

3.3 Electrical Engineering

Power supply and distribution

The preliminary electrical load estimate puts the power demand at 2,928 kW or 3,082 kVA (based on a power factor of 0.95). Estimate is based on l00W/m^2 for office and hotel floors 25W/m^2 for car parks and 50W/m^2 for unoccupied areas. A diversity factor of 80% was applied. The actual load breakdown shall be confirmed as the design progresses. Between 10 and 20% spare capacity shall be allowed on distribution panels and the main switchboard. The primary source of power shall be from the Abuja Electricity Distribution network at 33kV (to be determined by the utility company).

We propose to deploy 2nos transformers @ 75% peak load (i.e. 2500kVA) because transformers are sturdy and reliable

Space limitations on the site

The utility supply feed (from Abuja Electricity Distribution Network) shall be taken to a Medium Voltage (MV) switch board in the electrical room at Basement 2. The supply will be stepped down through 2nos 33/0.415kV.2500kVA transformers located at the ground floor. The output of the transformers shall feed into a main Low Voltage (LV) panel which serves as the load center for LV distribution.

Surge protection shall be provided on the MV and LV lines as appropriate Power supply to Chiller unit s on the roof of right-wing tower shall emanates from the Main Low Voltage Panel.

Because of incessant power outage, the proposal is for the standby generators to cater for 100% power requirement on an N+ l basis.

Generator sizing allows for maximum 80%capacity loading. This also allows for major equipment startup - (startup current will be minimized by deploying limiting direct-on-line (DOL) starters)

Proposed configurations are:

1. 4nos @ 35%:1500 kVA sets (3duty/l stand by)
2. 3nos@ 50%: 2,000kVA sets (2duty/l stand by)

Comparative cost for each option is given below (final figures will depend on selected vendor and configuration)

Option	Configuration	Unit Cost (Nm} - ex warehouse	TotalCost (Nm}
1	4nos 1500 kVA	155	620
2	3nos 2000 kVA	230	690

Option l with 4nos (3 duty + l standby) generators offers low redundancy at 35% and will take up more space. However, running cost will be cheaper as the approximate fuel consumption for each set is about 3001/h r.

Option 2 with 3nos (2 duty + 1standby) generators offers greater redundancy at 50%; however, the running cost will be much higher with approximate fuel consumption for each set at about 4001/h r.

Due to space constraints, the preference is for option 2. The generators will be housed in an acoustically treated enclosure in order to meet the requirements of the National Environmental Regulations for mixed residential zones. A purpose-built acoustic room would be needed to meet the stringent night-time noise level rating of 45dBA required by national codes. Because of space constraint only gen sets with containerized acoustic enclosures could be accommodated for the 75dBA@3m rating to be achieved.

Electric Vehicle Charging Stations

Provisions shall be made for Vehicle Charging Stations at selected locations (parking floors and external). The EV charging stations shall be 400V 50Hz, Rapid (30kW) or Fast (7kW to 22kW) types with charging duration of between 2-4hours. Further to the above provision shall be made for 2 parking stations at each parking level. In addition, 2 stations shall be provided in external parking provided as a minimum

Distributed Antenna System (DAS)

Distributed Antenna System (DAS) is proposed to be installed in the building. This is a way to deal with isolated spots of poor coverage inside a large building by installing a network of relatively small antennas. It amplifies signal from a "donor" which shall be located on the roof of right-wing tower and rebroadcast the signal inside the building. The donor signal is amplified by a bi-directional repeater, which is connected to a network of passive components including coaxial cable, splitters, couplers and antennas.

Energy Conservation

Lighting controls using presence detectors and daylighting monitors. Lamp type - LED as primary choice.

Electrical Loading

The table below applies an electrical loading to each area based on the usage of each area. This provides us with a good estimate on the overall electrical demand of the entire development (see **Table 5.1**). It is evident that the final chosen transformer size is 2MVA. This allows for additional capacity of 30% and is then chosen as the next available transformer size. The demand for the development is less than the initial estimation based the first feasibility assessment.

Table 3. 1: Electrical Loading per Area

Elements of the development	Area	Loading (W/m2)	Total (W)	Parking area	Loading (W/m2)2	Total (W)3
AFREXIMBANK office	3 000		150 000			18 000
Trade centre offices	475		23 750			3 000
Contingency offices / short term rental offices	3 000	50	150 000	1,800	10	18 000
Conference centre & Exhibition space	2 000	40	80 000	1,200	10	12 000
Seminar & meeting rooms	300		22 500			3 000
SME business innovation & incubation hub						
Knowledge centre & library	300	40	12 000	180	10	1 800
Long term corporate office rentals	3 000	50	300 000	1 800	10	36 000
Hotel	5 500					
Total	**17 575**		**838 250**	**10 560**		**103**
Total Load (kW)						
Total Load (kVA)		**1108**				
Final Transformer Size Selected		**2000**				

Connection Point: The connection point for the development has not yet been fully defined by the supply authority. From the available information received to date the connection point is likely to be derived from the soon to be constructed substation, provided construction is complete by the time AFREXIMBANK requires power. Should the substation not be complete power supply can be derived from the 33kV overhead line across Sani Abacha Way.

Connection Costs: Connection costs can be subdivided into 2 sections. The first is the connection costs that will be payable to the supply authority for providing the supply and all associated infrastructure that will remain the property of the said authority. The second is the cost of the infrastructure and equipment that the client will need to supply and install in order to reticulate the power from the point of supply to the client's connection point on the boundary of the property.

The two sections however are very much reliant on the feedback that we receive from the supply authority, which unfortunately to date is outstanding. Final connection costs will only be made available at the time of application, when the electrical subcontractor has been appointed.

Back up Supply: As the national grid supply is not reliable in Abuja, a back-up supply solution will be proposed for the development. There are a few options in this regard. Firstly the entire development can be backed up with a secondary power supply, namely diesel generator. Secondly only certain sections of the development can be supported by a back-up supply. This would result in lower running costs and potentially lower capital expenditure initially, but would have the negative effect of having parts of the development offline during power outages. The last option would be to only allow for critical sections of the development to be backed-up, this would be the least cost option, but would mean that only a very limited critical section of the development would be fully operational under a power outage. With the unreliable grid, this is not really a feasible option.

As the designs progress the back-up solutions will be further developed. A solar PV system including batteries can act as a further back-up supply in times of power outages.

Energy Saving Approach/Renewable Energy: Use will be made of energy saving options wherever available. This will be further expanded as the design progresses. A few initiatives that could be introduced would include:

- Energy-Efficient Lighting;
- Intelligent building management controls and automation;
- Smart metering; and
- The electrical engineer will work very closely with the mechanical engineer to optimize the heating and cooling, which are typically the largest consumers of electricity.

Renewable energy will certainly form part of the energy offering, in particular a Solar PV system. This will be designed and priced, as well as the return on investment on implementing such a solution calculated.

There are potentially a few challenges to the implementation of a solar PV solution, with large neighboring buildings potentially creating any nuisance shading. Because of the unreliable grid in Abuja, the solar PV system should be to be able to operate both in conjunction with the grid network and the back-up diesel generator. The solar PV system will act as a cost saving measure in terms of limiting the reliance on grid supply and diesel. The inclusion of batteries as part of the system allows it to act as a further back-up supply.

Risks Identified: The following risks to the project have been potentially identified and are detailed in the risk register:

- No electrical infrastructure to the site;
- Electrical supply will be unavailable from the supply authority
- Delay in municipal approvals

3.4 Water Supply

The AATC has been proposed by the architect to have a total size of 17,575m² GLA consisting of offices, medium to long term accommodation and other business spaces (knowledge centre, library, incubation hub, etc.). The water supply demand for the proposed AATC is shown in **Table 3.2**.

Table 3. 2: Water Demand

Land Use	Unit	Quantity	Unit Demand (l/day/unit)	Total (kl/day)
Offices	Occupants (Max Envisaged)	2345	70	165
Accommodation	Unit	15	400	6
Business Spaces	100m² of Gross Floor Area	3	400	1.5
Total Average demand (TAD)				**172.5kl/d**
Plus 15% losses				**190Kl/d**
Peak demand - peak factor of 4 (Excl. Fire flow)				**9.2l/s**
Fire flow (medium risk)				**20l/s**
ESTIMATED DESIGN PEAK DEMAND (Incl. fire flow)				**34.2l/s**

The peak demand of the AATC excluding fire flow is estimated at 9.2 l/s. The risk of fire and of spread of fire is described as moderate and therefore a medium risk approach has been taken. Including the fire flow, the estimated design peak demand will be 34.2 l/s.

Back-Up Supply: The water supply in the area is intermittent and unreliable. To mitigate potential water rationing in the area, a borehole system and a 650kl on-site storage are proposed. Geohydrological investigations need to be carried out on the site area to determine the yield and depth of the boreholes.

Connection and Bulk Costs: The total construction cost for water consists of the water pipeline to connect into the existing municipal line, water storage, pumping facilities and connection fees. The municipality calculates their fees based on area of development, type of development and

size of pipe connecting into the bulk services which could not be obtained at this stage. Refer to **Table 3.3** for the construction cost breakdown.

Table 3. 3: Water Construction Cost

DESCRIPTION	ESTIMATED CONSTRUCTION COST (Excluding VAT)
Water	
Water Pipeline (Approx. 125m)	USD 15 200.00
Water and Fire Storage (650kl)	USD 715 600.00
Booster Pump Station (with ancillaries)	USD 204 500.00
Municipal Connection Fees	-
Total	**USD 935 300.00**

The following was taken into consideration for the costing:

- South African construction rates have been used and multiplied by a factor of 2.3 obtained from the appointed Quantity Surveyor.
- No internal reticulation costs are included.
- Professional fees, Preliminaries and Generals (P's and G's), Contingencies and VAT are excluded from the construction estimate.
- No importation of material, commercial or otherwise was considered.
- No escalation included in the final costing.
- Reservoir has 48 hours storage capacity due to unreliable water supply.
- No borehole costs have been included, as that can only be determined after hydrogeological investigations.
- Average excavation depth of 1m has been used.
- Costing does not include any municipal bulk upgrades; these will be highlighted by the municipality at design stage if required.

Risks Identified: The following risks to the project have been potentially identified and are detailed in the risk register:

- Risk of infrequent water supply from the local municipality;
- Risk of inadequate bulk services capacity; and
- Delay in municipal approvals.

3.5 Civil Engineering

All civil infrastructure, roadways, pavements, storm drainage, bulk earthworks, etc. shall be designed in accordance with the relevant Nigerian Local Authority Building Regulations by others and with the existing master-planned facilities and criteria to the extent that they do not reduce in value to what is suitable and adequate for the site. All 'plug-in' (connection) points to the existing infrastructural provisions will be established in agreement with the Municipality and the Owners' facility management team, and designed to meet internationally acceptable standards

Bulk Earthworks

Earthworks will be specified to comply with BS 6031: 2009 and all material testing specifications will be in accordance with BS 1377-1 and 2: 1990. Method statements for excavations, disposal placement of imported fill and compaction shall all be produced by the contractor and will be in accordance with detailed technical Specifications to be supplied prior to letting of the construction contract.

Sewer Flows: The sewer flows for the AATC are derived from the architectural elements of development for a total size of 17 575m² GLA consisting of offices, medium to long term accommodation and other business spaces (knowledge centre, library, incubation hub, etc.). An 80% return to sewer from the unit demands has been used. The estimated sewerage design flows are shown in **Table 3.4**.

Table 3. 4: Sewer Flows

Land Use	Unit	Quantity	Unit Demand (l/day/unit)	Total (kl/day)
Offices	Occupants (Max Envisaged)	2345	56	132
Accommodation	Unit	15	320	4.8
Business Spaces	100m² of Gross Floor Area	3	320	1.2
SUB-TOTAL				**138 kl/d**
PLUS INFILTRATION (15%)				**158.7 kl/d**
TOTAL DAILY WET FLOW (DWF)				**1.6 l/s**
INCLUDING PEAK FACTOR (2.5)				**4 l/s**
PEAK DAILY WET FLOW (PDWF)				**4 l/s**

The daily wet flow of the AATC is estimated at 1.6 l/s. Using a peak factor of 2.5, the estimated peak daily wet flow is 4.0 l/s.

Connection and Bulk Costs: The cost to connect to the existing water pipe consists of connection fees, which will be paid to the municipality and the construction cost to extend the existing line to the site. The municipality calculates their fees based on area of development, type of development and size of pipe connecting into the bulk services which could not be obtained at this stage. Refer to **Table 3.5** for the construction cost breakdown.

Table 3. 5: Sewer Construction Cost

DESCRIPTION	ESTIMATED CONSTRUCTION COST (Excluding VAT)
Sewer	
Sewer Pipeline (Approx. 150m)	USD 14 800.00
Road Crossing (excavation and reinstatement)	USD 3 500.00
Municipal Connection Fees	-
Total	**USD 18 300.00**

Risks Identified: The following risks to the project have been potentially identified and are detailed in the risk register:

- Risk of inadequate bulk services capacity; and
- Delay in municipal approvals.

3.6 Storm water

Storm water Control: Survey Data relating to the conditions of the adjacent city drainage network is required, from the tendered topographical survey brief. We will attempt to obtain where available, the capacity of the council's waste water system. These requirements are necessary in order to effectively design the storm water drainage system on the site, however if not sufficient/existent to cater for the waste water demand of the development, thus on site waste water treatment will be required. If it is found that sufficient capacity for the development's waste water demand is provided in the local council system, a connection manhole will be provided for the development.

Adequate pumps are to be provided by the Fire Consultant to ensure sufficient water pressure from the on-site water tanks is achieved to meet the fire requirements of the development and the relevant structures will be designed to meet the regulatory minimum fire standards, it is

recommended to make provision for the design for fire water tanks to ensure the development is self-sufficient for a minimum of three days. Supply lines will be routed to a designated area where these tanks will be built and then to each parking and office level. Internal reticulation will be as per the Wet Services consultant.

The lowest floor levels will be set in conjunction with the architectural requirements for the building visibility. Entrances and accesses and optimized as far as possible for storm water control and minimization of cart-to-spoil quantities.

Temporary lateral supports for the excavations of the two-level basement parking floor levels will be required due to the excavation depth and the assumed collapsible nature of the material in the area (geotechnical investigation to confirm) should this not be possible then steel sheet or concrete piles will be adopted to provide permanent soil retention during excavation. The lowest level of the basement will be checked for buoyancy based on the possibilities of shallow water table (geotechnical investigation to confirm). Alternatively, should horizontal space constraints not be an issue, the sides of the basement excavation could be sloped in order to avoid extensive lateral supports the decision of which option to adopt is equally dependent on the results of the geotechnical investigation.

The contractor will need to make allowance for temporary sumps and pumps to control any storm water and groundwater that may be evident on the site as will be confirmed during the geotechnical investigations.

Perimeter subsoil cut off drainage will be provided at base level behind retaining walls within the backfilling. Rodding eyes will be provided for maintenance purposes. Vertical wick drains will be installed behind retaining walls which will filter water from the backfill down the subsoil drain. The perimeter sub soils will discharge into a centralized pumped sump located in the lowest parking level of the parking structure.

The sump will contain two submersible pumps which will load balance to extend the service life. The sump will be pumped to external storm water manholes raised above the natural ground water level.

The ground floor slab of the parking structure will be sloped to the centralized sump. A cut-off drain will be provided at the bottom of the parking ramp to intercept any driven rain and storm water entering through the weather louvres. A gravity drainage line will connect the cut- off drain to the centralized sump. The centralized sump will be pumped into the external perimeter open

storm water channels. A crystalline waterproofing admixture will be added to the reinforced concrete ground floor parking slab and a damp proof membrane will be placed under the lowest parking floor level to prevent ground water from passing through the concrete slab into the building.

The ground level slabs of the building will be raised above the natural ground level by a minimum of 600-750mm to accommodate the anticipated run-off water and local flooding. It is advisable to have a sump pit with two submersible pumps located adjacent the lift shafts.

Storm water Management: There are no streams visible, from satellite imagery and physical site verification, in close proximity to the site – so we can conclude that no flood lines affect the site. In the pre-development scenario, the proposed site currently drains via surface flow towards Independence Avenue. In the post-development scenario, it is recommended that a storm water cut-off berm and subsoil drain be incorporated along the southern and south western site boundary of the proposed AATC. This will ensure that runoff from the higher ground will be intercepted and disallow it from draining onto the site. The storm water from the cut-off berm will discharge into the proposed connection point.

Connection and Bulk Costs: The cost to connect to the existing storm water pipe consists of connection fees, which will be paid to the municipality and the construction cost to extend the existing line to the site. The municipality calculates their fees based on area of development, type of development and size of pipe connecting into the bulk services which could not be obtained at this stage. Refer to **Table 3.6** for the construction cost breakdown.

Table 3. 6: Storm water Construction Cost

DESCRIPTION	ESTIMATED CONSTRUCTION COST (Excluding VAT)
Storm water	
Storm water Pipeline (Approx. 20m)	USD $5 100.00
Municipal Connection Fees	-
Total	**USD $5 100.00**

Risks Identified: The following risks to the project have been potentially identified and are detailed in the risk register:

- Risk of inadequate bulk services capacity; and

- Delay in municipal approvals.

3.7 Mechanical Engineering

This section provides information relating to Cold Water Supply and Hot Water Generation.

- **Cold Water:** Cold water will be supplied to Centre from the local supply authority adjacent to the site as discussed under the bulk services supply section of the document. The cold-water supply is envisaged to enter the building below ground. The connection will be metered inside the building for tenant monitoring purposes. Cold Water Storage will be required given the occupation type and the intended utilization of the development. Forty Eight hours of water storage is recommended. Bypass capabilities will also be provided to ensure water can be supplied to the development should there be any power supply interruptions to the water supply installation.
- **Hot Water Generation:** Hot water will be generated using one or a combination of the following methods.

- Electrically driven direct emersion type calorifiers/Geyser;
- Electrically driven indirect Heat Pump systems; and
- Solar Thermal (ST) Hot Water Systems.

Table 3.7 provides a description of each system as well as the pros and cons of several of the determining factors of the installation.

Table 3. 7: Hot Water Generation Comparison

Parameter	Geyser	Heat Pump	Solar Thermal
Description	Electric Geyser installed locally to provide hot water	Heat pump will be used to supply hot water continuously throughout the day.	Solar Panels on the roof generate hot water via a heat exchanger in hot water storage.
Heating Mechanism	Direct Electric Heater	Refrigeration cycle	Sunlight
Installed Costs	Cheapest	Mid-Range	Most Expensive

Running Cost	Most Expensive. Direct Electrical usage creates high electricity bills	Mid-Range – good efficiencies and heat recovery reduces the bills	Cheapest – Heating costs are practically zero while the pumping costs are very little.
Reliability	Most Reliable	Very Reliable	Very Reliable
Maintainability	Easiest to Maintain	Easy to Maintain	Easy to Maintain

Combining two or all three of the systems into a single offering creates a highly efficient and fully redundant installation ensuring very little possibility that hot water generation will be limited. The combination would be as follows:

- The Solar Thermal System would provide the initial hot water heating. In broad daylight, this system has the potential (if a large enough system can be installed) to heat the entire hot water load required;
- The heat pump system would provide a backup system to the Solar Thermal as well as provide additional hot water required should the weather adversely affect the operation of the solar thermal (i.e. a cloudy or rainy day);
- Electric Heating could be added as a second redundancy should one or both of the other two systems fail.
- Basic Lifecycle Costing shows that the efficiency of the HP and the Solar Thermal Systems far outweighs the lifecycle costs for a direct emersion geyser system. Payback periods of 10 years on solar thermal and less than 5 years on HP could be achieved if properly operated and maintained;
- The typical costs of the Combined HP and ST system falls in between the two individual systems but could potentially fall below the HP system costs should the system be properly programmed, utilised and maintained. Choosing the Combined system will increase the “Green” credentials of the development should this be a requirement.

3.8 Water Reticulation

Generally, all above ground water pipework will be apex based, aluminium supported, multilayer pipe system used for the water reticulation system (Geberit Mepla or equally approved) for all pipes between 20mm and 75mm. This type of pipe has proven itself to be:

- Easy to install;
- Not susceptible to theft as in the case with copper tubing; and
- Uses fewer fittings due to the possibility of bending the pipe as the pipe, after bent, retains its bent shape.

For pipes exceeding 75mm in diameter, galvanised steel will be used. All hot water supply and reticulation pipes shall be insulated to reduce energy losses from the system. The reticulation system will be designed to achieve the following:

- Minimised large bore pipework;
- Hot Water recirculation will be implemented to ensure hot water is supplied at the taps promptly;
- Water velocities in the pipework will be selected to ensure pipe knocking does not occur
- Pressure will be maintained and achieved to reduce water use while still providing good pressures for flow throughout the system. This would be very dependent on the cold-water supply and storage system selection.

3.9 Foul Drainage

Foul drain shall be discharged to the FCDA sewerage network (using lift pumps where required). Grease trap for kitchen waste Rainwater collection and disposal to site and storm drainage system. The foul water drainage system will comprise HDPE pipework that will cleanly and efficiently remove all foul waste from the building, connecting to the bulk connection as set out in the bulk services section of this document. The system will comprise several main foul water stacks into which the sanitary fixtures and fittings will connect. The ventilation for the pipework will run up to the roof of the building and discharge above roof level in order to minimize possibly intrusion of smells into the building. Air admittance valves will be avoided as far as possible to reduce maintenance and odour issues.

Generally, the following size connections will be used to the fittings listed below:

- Basins: 32mm Ø trapped connection;
- Showers and Sinks: 40mm Ø trapped connection; and
- WCs: 110mm Ø connection.

Generally, front of house drainage pipes will be chrome coated and back of house will plastic. However, this will follow the interior design and architectural requirements. Where possible

pipework will be hidden in service voids or boxed in. This pipework will connect into the bulk foul reticulation system that will be designed by the Civil Engineers.

3.10 HVAC (Heating Ventilation and Air Conditioning)

We have considered various types of air-conditioning systems (chilled water system and VRF system) based on our design strategies and present options that are best fit for purpose.

Chilled water system, this system shall comprise of air-cooled chillers, pumps and other system equipment mounted on the roof. Chilled water pipes shall be run in service risers to the air handling units (AHUs) and indoor fan coil units (FCUs) on the office and hotel floors.

VRF System, this system shall comprise several outdoor units and indoor units. One outdoor unit can serve as much as 8 or more indoor units. A set of outdoor units located on the roof shall be used for each office and hotel floor. This approach provides independence of the floors and easier for management. Refrigerant pipes shall run through service risers to the indoor units.

The indoor units shall be ceiling concealed ductable or ceiling recessed cassette units located within the office spaces as appropriate. The system will be designed to reduce the energy required by installing highly efficient fans and energy efficient cooling and space heating systems that will combine and be controlled to ensure energy is only used when necessary.

- **Fresh Air:** All buildings must have sufficient fresh air supply to ensure human comfort is maintained. This will be done using either forced mechanical systems or natural systems. Generally, the development will be naturally ventilated as far as possible taking advantage of the opening sin the building that would allow people to enter and leave the building. Mechanical fresh air will be required for all spaces that do not have direct connection to outside. This air will be provided using a supply fan and ducted system to the relevant areas. The system will have filters to ensure the air is fresh and free of dust at all times. Where cooling and heating are required to maintain internal comfort, the fresh air for the space will be supplied directly to the heating and cooling system. The fresh air will then be conditioned by the heating or cooling system and supplied to the space. This will also be done using a fan and ducted system. Rooms where odour and stale air might be a problem (toilets, for example) will have an extract system that will pull the air from the space and exhaust it directly to outside.
- **Cooling and Heating:** Cooling and heating will be provided by a central Reversible

Heat Recovery VRF system. The system comprises the following:

- External Condenser units that will be mounted on the roof or in a plant room. These units will serve the entire building; and
- Internal units will be installed on a per room and area basis to provide internal comfort to each specific room and area within the building as might be required.

The primary benefit of using a Heat Recovery VRF system is that you can “recover” heat from the system. Essentially this means that the heat taken out of one space can be used to heat an adjacent space, basically “free” heating. Following this principal, the heat rejected from the system can also be used to supply heat the Hot water system, increasing the efficiency of the HVAC and Hot water generation systems immensely.

3.11 Sustainability and “Green” Buildings

A green building can be defined as an energy efficient and sustainably constructed and managed building. For all intents and purpose this means, at a minimum, the following:

- The building is designed in terms of location, orientation and layout to minimize energy required for cooling, heating and electrical use;
- Building is constructed using sustainable products and locally produced products as far as possible;
- Building water use is minimized using rainwater harvesting, greywater recycling and other water reducing and saving measures;
- Building energy use is minimized using highly efficient plant and equipment;
- The building uses an intelligent building management system to control energy use:
    1. By ensuring systems are only and when absolutely needed;
    2. By ensuring systems run at optimal efficiency points; and
    3. Staff training as to how the building works and what needs to be done to ensure that the building remains “Green”.

A 'Green· design with potential for Excellence in Design for Greater Efficiencies (EDGE) classification (Design. Construction and Maintenance) shall be preferred.

The building industry in Nigeria follows a mixture of British and American Standards along with the following national standards

- FRN National Building Code
- FRN National Fire Safety Code
- NERC Regulations for Electrical Installations in Nigeria

BS 7671:2018 - Requirements for Electrical Installations (IET Wiring Regulations 18th Edition)

Design standards and guidelines as issued by the British Standards Institution (BSI) the Chartered Institution of Building Services Engineers (CIBSE), NFPA and the American Society of Heating. Refrigerating and Air-conditioning Engineers (ASHRAE)

Ambient Conditions

The design of the services will be based upon the following ambient conditions:

- Mean Ambient Temp: 28^{o}C
- Max Ambient Temp: 42^{o}C
- Design Outdoor Temp: 38^{o}DB/28^{o}C WB
- Relative humidity: 65 - 90% (non-condensing)

Solar System

A renewable solar energy source as an alternative power supply is proposed to drive some essential loads within the building. The intention is to develop a design solution which is functional and meets the operation al requirement of a modern GREEN building. The solution shall be flexible and technologically advanced that presents a pleasant working environment.

CHAPTER FOUR

4.0 DESCRIPTION OF PROJECT ENVIRONMENT

Introduction

This chapter focuses on the project environment with a view to describing the existing baseline conditions of the proposed project site before its takeoff and to identify environmental issues associated with the proposed project by predicting them as well as proffering measures to mitigate/ minimize and avoid their adverse effects. The environmental components studied are climate and meteorology, noise, air quality, soil, vegetation, surface water body, as well as socio-economics of the host community which could be affected by the proposed project. The environmental characteristics of the project area were established in this study through comprehensive field sampling/measurements, laboratory analysis, literature review, stakeholder consultation and data interpretation. Fieldwork for the baseline data was conducted between 13thand 14th February 2020 for the dry season and 26th and 27th June 2020 for the wet season by IESL study team; this environmental data covers a dual season (dry and wet season) sampling.

4.1 Study Methodology

The methodology adopted was based on the FMEnv guidelines for EIA study; they are as follows:

4.1.1 Pre-Field Investigation Visit

IESL EIA team was taken to the site on 14th January, 2020 by the technical team of AFREXIM Bank for site verification and reconnaissance survey prior to data collection with the objectives of setting boundaries of the study area. Visual observation within 500m radius of the project area was made to determine resources.

4.1.2 Quality Assurance (QA)

The standard methods adopted in this study include Charging and Calibration of all the in – situ equipment 24hours before moving to site to ensure consistency and accuracy, ensuring that the holding time of the parameters was obeyed. For analysis that could not be analyzed in – situ, samples of soil were collected in aluminum foil and water samples for heavy metal and organics analysis were acidified with 1ml/litre of conc. HNO_3 for preservation to inhibit precipitation of metal ions and then taken to the laboratory while water samples for physiochemical and microbiological parameters were preserved in ice packed containers (coolers) in the field and later transported to the laboratory and refrigerated at 4^{o}C for further analysis. These standard methods and analytical procedures were strictly adhered to in the course of this study during sample collection, labeling,

analyses and data verification. The methods of analyses used in this study were in accordance with national and international analytical procedures, in order to ensure the reliability of the data.

4.1.3 Sampling design and strategy

The sampling strategy for this study was based on the land mass (size) which is mostly an excavated land, proximity to the road and other preexisting buildings. A total of 60 soil samples were collected from 30 stations at both top soil of between 0-15cm and bottom soil (15-30cm), 27 stations was collected with grid sampling pattern were within the site while the three control stations were located 166m to the north, 266m to the west and 255m to the east of the site.

- Air and noise measurements were carried out at seven stations within the site with emphasis placed on the entrance, part of the site in close proximity to the road and the centre of the site, while three control stations were located 166m to the north, 266m to the west and 255m to the east of the site
- Water was sampled at 3 locations with preexisting boreholes in close proximity to the site and two locations at farther proximities as control samples.

A summary of the number of samples collected is presented in **Table 4.1 below** while the coordinates of the sample points are represented in **Table 4.2**

Table 4. 1: Summary of Sampling Points

Sample Type	Sampling points	Controls	Total no. of stations	Total number of samples collected
Soil (Top soil and Bottom soil)	27	3	30	60
Ground Water	3	2	5	5
Air	7	3	10	-

Source: IESL Field Study, 2020

Table 4. 2: Sample Coordinates (Soil, Water and Air Quality)

Coordinates of Soil sampling points

S/No	Sample ID	Northings	Eastings
1	AF/EIA/S/TOP1	09º03' 16.6"	007º29'50.2"
2	AF/EIA/S/BOT1		
3	AF/EIA/S/TOP2	09º03'16.5"	007º29'50.3"
4	AF/EIA/S/BOT2		
5	AF/EIA/S/TOP3	09o03'16.3"	007º29'50.5"
6	AF/EIA/S/BOT3		
7	AF/EIA/S/TOP4	09º03'16.2"	007º29'50.6"
8	AF/EIA/S/BOT4		
9	AF/EIA/S/TOP5	09º03'16.0"	007º29'50.6"

10	AF/EIA/S/BOT5		
11	AF/EIA/S/TOP6	09º03'15.6"	007º29'50.9"
12	AF/EIA/S/BOT6		
13	AF/EIA/S/TOP7	09º03'15.2"	007º29'51.1"
14	AF/EIA/S/BOT7		
15	AF/EIA/S/TOP8	09º03'14.8"	007º29'51.4"
16	AF/EIA/S/BOT8		
17	AF/EIA/S/TOP9	09º03'14.4"	007º29'51.7"
18	AF/EIA/S/BOT9		
19	AF/EIA/S/TOP10	09º03'13.9"	007º29'51.1"
20	AF/EIA/S/BOT10		
21	AF/EIA/S/TOP11	09º03'14.5"	007º29'50.8"
22	AF/EIA/S/BOT11		
23	AF/EIA/S/TOP12	09º03'14.9"	007º29'50.9"
24	AF/EIA/S/BOT12		
25	AF/EIA/S/TOP13	09º03'15.2"	007º29'50.3"
26	AF/EIA/S/BOT13		
27	AF/EIA/S/TOP14	09º03'15.5"	007º29'50.2"
28	AF/EIA/S/BOT14		
29	AF/EIA/S/TOP15	09º03'15.7"	007º29'50.0"
30	AF/EIA/S/BOT15		
31	AF/EIA/S/TOP16	09º03'15.8"	007º29'49.7"
32	AF/EIA/S/BOT16		
33	AF/EIA/S/TOP17	09º03'16.0"	007º29'49.5"
34	AF/EIA/S/BOT17		
35	AF/EIA/S/TOP18	09º03'16.1"	007º29'49.3"
36	AF/EIA/S/BOT18		
37	AF/EIA/S/TOP19	09º03'15.5"	007º29'48.9"
38	AF/EIA/S/BOT19		
39	AF/EIA/S/TOP20	09o03'15.3"	007o29'49.0"
40	AF/EIA/S/BOT20		
41	AF/EIA/S/TOP21	09º03'15.0"	007º29'49.1"
42	AF/EIA/S/BOT21		
43	AF/EIA/S/TOP22	09º03'14.8"	007º29'49.3"
44	AF/EIA/S/BOT22		
45	AF/EIA/S/TOP23	09º03'14.5"	007º29'49.5"
46	AF/EIA/S/BOT23		
47	AF/EIA/S/TOP24	09º03'14.2"	007º29'49.7"
48	AF/EIA/S/BOT24		
49	AF/EIA/S/TOP25	09º03'13.9"	007º29'49.8"
50	AF/EIA/S/BOT25		
51	AF/EIA/S/TOP26	09º03'13.8"	007º29'50.4"
52	AF/EIA/S/BOT26		
53	AF/EIA/S/TOP27	09º03'13.6"	007º29'50.6"
54	AF/EIA/S/BOT27		
55	AF/EIA/S/TOP Ctrl1	09º03'20.0"	007º29'46.4"
56	AF/EIA/S/BOT Ctrl1		
57	AF/EIA/S/TOP Ctrl2	09º03'21.9"	007º29'56.6"

58	AF/EIA/S/BOT Ctrl2		
59	AF/EIA/S/TOP Ctrl3	09º03'11.2"	007º29'41.7"
60	AF/EIA/S/BOT Ctrl3		

Coordinates of Air quality sampling points

S/No	Sample ID	Northings	Eastings
1	AF/EIA/AQ1	09º03' 13.8"	007º29'50.1"
2	AF/EIA/AQ2	09º03'14.4"	007º29'51.7"
3	AF/EIA/AQ3	09º03'16.7"	007º29'50.2"
4	AF/EIA/AQ4	09º03'16.2"	007º29'49.5"
5	AF/EIA/AQ5	09º03'15.7"	007º29'48.8"
6	AF/EIA/AQ6	09º03'15.2"	007º29'49.9"
7	AF/EIA/AQ7	09º03'14.5"	007º29'49.2"
8	AF/EIA/AQCtrl 1	09º03'20.1"	007º29'46.5"
9	AF/EIA/AQCtrl 2	09º03'21.9"	007º29'56.7"
10	AF/EIA/AQCtrl 3	09º03'11.2"	007º29'41.7"

Coordinates of Water quality sampling points

S/No	Sample ID	Description	Northings	Eastings
1	AF/EIA/W/P1	Potable water AFREXIM Bank	09º03' 13.5"	007º29'49.9"
2	AF/EIA/W/P2	Existing borehole Yobe Investment house	09º03'13.6"	007º29'50.1"
3	AF/EIA/W/P3	Labour House	09º03'13.4"	007º29'49.9"
4	AF/EIA/W/Ctrl 1	Borehole Plateau house	09º03'07.8"	007º29'55.5"
5	AF/EIA/W/Ctrl 2	Finance Building	09º03'12.4"	007º29'53.1"

Plate 4. 1: Map of the site showing sampling points

4.2 Climate and Meteorology

Information on the climate of the study area was obtained largely from existing literature from Nigerian Meteorological Agency of the Federal Ministry of Aviation, Maitama Abuja; eleven years data (2004 – 2014) were used for rainfall, relative humidity, temperature, sunshine, wind speed and wind direction. The two weather conditions that exist in the year in the Federal Capital Territory as well as the Central Business District (CBD) in Abuja Municipal area council are extremely dry season, and rainy season. In between these seasons, is a short period of harmattan accompanied by the North East Trade Wind with features of dust haze. The climatic characteristics of the area studied are: rainfall, temperature, humidity, sunshine and wind speed and direction.

4.2.1 Weather

The study area has two main seasons; the rainy season (April-October) and the dry season (November-March). The high influence of undulating terrain of the area act to provide a regulating influence on its weather. During the dry season, temperature records are at peak in the month of March. During the rainy season, temperature records drop considerably due to large cover of thick convective clouds like Cumulonimbus and Nimbostratus. This is notable in the months of July-

August. The relative humidity of the study area tends to be high during the rainy season as compared to low records during the dry season.

The weather elements of the area studied are: rainfall, temperature, humidity, sunshine and, wind speed and direction. All the data were sourced from Nigerian Meteorology Agency, Abuja (NIMET).

Table 4. 3: Average Annual Rainfall of the study area (in mm) between 2004-2014

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2004	0	0	Trace	58.3	138.6	144.7	276.6	214.8	255.2	110.1	0	0
2005	0	Trace	0.5	96	94.5	152.6	354	333.4	245.9	101.6	0	0
2006	0	0	70.5	79.7	82	227.7	450.3	487.8	353.1	263.3	6.9	0
2007	0	23.7	19.3	82	167.7	340.9	482.7	257.6	249.5	82.2	0	0
2008	11.5	0	64.3	222	310.7	255.5	302.6	164.9	202.7	5.9	0	0
2009	0	0	26	63.2	100.4	477	265.7	211	168.3	202	0	0
2010	13.2	21.5	46.6	32.5	136.2	101.1	189.8	384.5	186.6	199.6	0	0
2011	0	0	24.1	102.6	78.9	160.8	314.9	317.5	264.4	126.5	0.4	0
2012	0	0	27	35.2	65.6	218.9	183	370.9	195	75.7	0	15
2013	6.7	5.7	Trace	74.6	121.5	182.7	154.7	409.4	187.5	224.3	50.6	0
2014	0	0.6	7.5	74.2	109.2	267.2	314.8	278.3	258.4	238.2	Trace	0

Source: NIMET

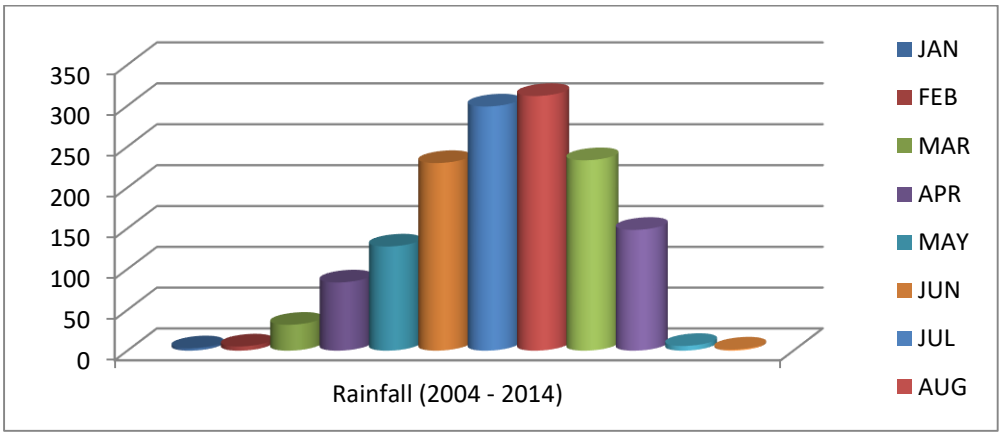


Figure 4. 1: Average Rainfall (mm) of the study area between 2004-2014

Table 4. 4: Annual Minimum and Maximum Temperature of the study area between 2004-2014

TEMPERATURE ºC

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
JAN	**Min**	18.7	17.3	17.7	19.7	22	18.5	22.5	18.8	17.4	18.9	19.3
	Max	35.9	34.7	35.1	35.5	37	34.5	35.8	36.1	35.3	35.4	35.5
FEB	**Min**	19.8	20.4	21.1	22.4	25	24.9	24.6	18.6	21.5	22	23.2
	Max	35.8	36.5	36.3	37.3	38	38	36.1	37.6	38	36.7	37.4
MAR	**Min**	23.3	24.3	25	25.1	24	26.3	25.4	24.1	24	24.6	25
	Max	38.2	37.8	37	37.5	33	38	36.1	37.2	38.1	36.9	37.7
APR	**Min**	24.8	30.3	25.5	25	24	25.6	25.1	23.2	26	23.5	25.7
	Max	35.3	35.5	34.7	35.2	32	36.2	37.3	34.1	37.6	35	36.6
MAY	**Min**	23.7	24.3	24.7	24.7	23	24	23.4	22.1	23	23.1	24.6
	Max	33.7	33.4	34.3	34.5	31	32.5	35.8	32.1	33.4	32.7	35.8
JUN	**Min**	21.9	22.4	22.8	22.4	22	22.9	23.4	22.1	22.4	22.6	23.2
	Max	30.6	31	31.7	30.6	30	29.4	31.4	31	31.3	31	30.2
JUL	**Min**	22	22.2	22.3	23	22.2	22.9	23.1	22.2	22.1	22.1	22.3
	Max	29	29	29.6	30	29.9	29.5	30.1	29.5	29.1	28.9	28.7
AUG	**Min**	21.9	21.7	22	22.3	22	22.6	20.8	21.9	22.4	22	22.5
	Max	28.9	28.2	29	29.1	30	28.5	31	29.5	28.3	28.8	28.7
SEP	**Min**	21.6	21.6	21.9	22.3	23	22.5	22	21.6	22.1	21.6	22.2
	Max	30.1	29.1	29.1	29.7	32	30.2	30	30.9	29.9	29.4	29.5
OCT	**Min**	21.9	22	22.3	22.5	21	22	22.4	21.6	19.7	21.9	21.8
	Max	31.2	32.3	31.1	31.7	33	31	31.1	31.3	31.1	30.7	30
NOV	**Min**	19.9	20.1	20.4	20.8	19	20	19.5	20.3	19	20.4	21.6
	Max	35	35.6	33.8	33.5	35	34.6	33.8	33.2	34.5	34.3	33.7
DEC	**Min**	18	18.6	18.1	18.2	18.5	19.7	16.9	17.8	18.2	17.3	17.2
	Max	35	36.2	35.4	35.1	35.3	35	35.3	34.2	35.2	35.2	35

Source: NIMET

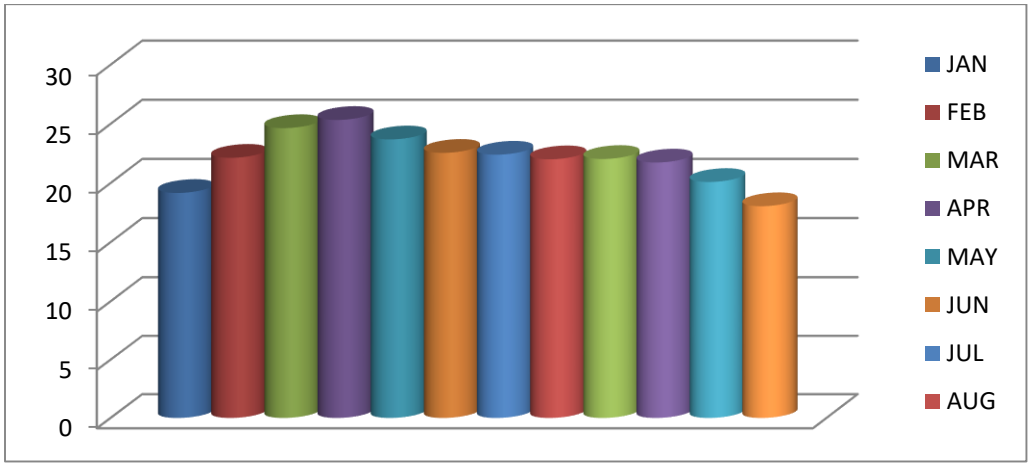


Figure 4. 2: Average Minimum Temperature of the study area between 2004-2014

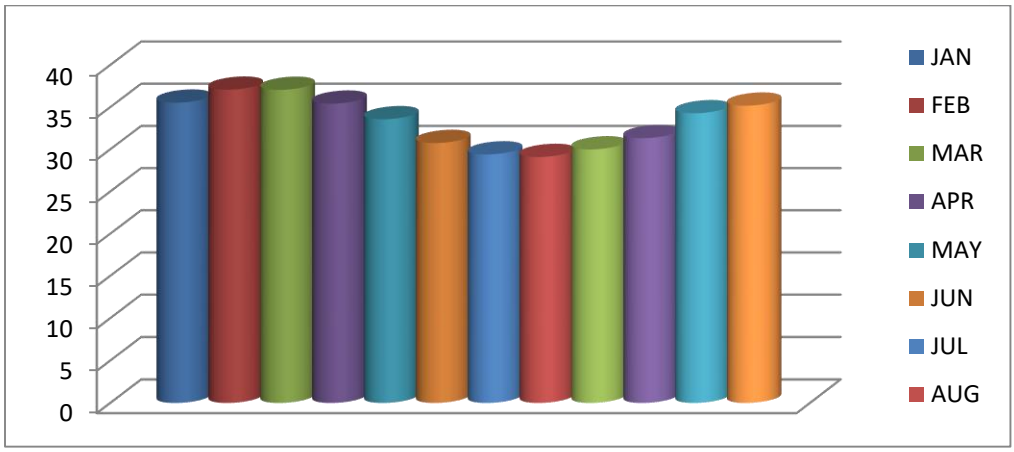


Figure 4. 3: Average Maximum Temperature of the study area between 2004-2014

Table 4. 5: Annual Relative Humidity of the study area between 2004-2014

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2004	41	26	38	65	72	81	85	87	85	77	51	40
2005	30	27	67	64	70	82	87	90	85	70	48	35
2006	29	34	59	71	72	80	86	87	84	79	55	37
2007	43	45	43	69	73	81	85	87	84	78	55	15
2008	42	29	38	71	80	81	85	87	95	78	65	49
2009	36	52	61	67	78	82	87	76	84	77	53	51
2010	56	58	62	59	77	79	84	89	85	81	50	37
2011	43	52	60	65	76	82	85	87	85	79	39	41
2012	40	22	45	72	78	81	87	87	81	79	66	45
2013	38	35	35	65	80	86	87	84	84	79	58	43
2014	43	50	62	62	76	81	86	87	83	78	64	36

Source: NIMET

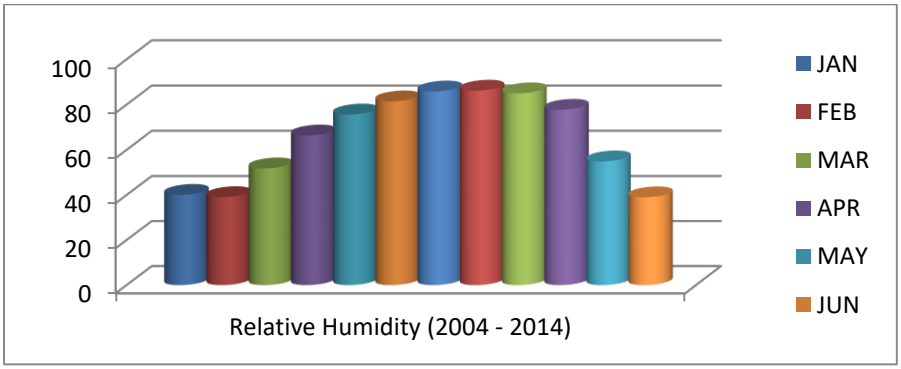


Figure 4. 4: Average Relative Humidity of the study area between 2004-2014

Table 4. 6: Annual Wind direction of the study area between 2004-2014

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2004	E	E	NE	SW	SW	SW	W	W	W	E	E	E
2005	E	E	NE	SW	SW	SW	SW	SW	SW	SW	E	E
2006	E	E	NE	SW	SW	SW	SW	SW	SW	E	E	NE
2007	E	NE	NE	SW	SW	W	SW	SW	W	W	NE	E
2008	E	E	NE	SW	SW	SW	W	W	W	E	E	E
2009	E	NE	NE	SW	SW	W	SW	SW	W	W	NE	E
2010	E	E	NE	SW	SW	SW	W	W	W	E	E	E
2011	E	E	NE	SW	SW	SW	SW	SW	SW	SW	E	E
2012	E	E	W	SW	SW	SW	W	W	SW	E	E	E
2013	E	E	E	W	W	SW	W	SW	W	SW	E	E
2014	E	NE	E	E	SW	SW	SW	W	W	W	E	NE

Source: NIMET

Table 4. 7: Annual Wind Speed of the study area between 2004-2014

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2004	4.7	5.7	5.8	6.1	5.7	5.5	5	4.2	4.6	4.5	5	4.6
2005	4.5	5.8	6.1	6.2	5.6	5.7	5.4	5.3	5.3	5.5	5.3	4.9
2006	5.5	4.6	5.3	3.7	3.8	3.2	3.3	3.3	3.4	2.6	2.4	2.5
2007	2.9	2.7	3	3	3.1	2.9	2.2	2.3	2.8	2.8	2.2	1.9
2008	1.9	1.9	2.6	3	2.4	2.4	2.5	2.1	1.8	2.2	1.6	1.3
2009	1.2	1.6	2.5	2.5	2.5	2.1	2.3	2.1	2.3	2.4	2.1	2.2
2010	2	2.4	2.6	3.2	3.1	3.2	2.8	2.5	2.2	2.2	2.5	2.1
2011	2.7	4.1	3.7	3	2.3	0.3	2.4	2	0.2	3.8	3	2.2
2012	2.8	3.3	3.4	4.1	4.4	4.2	4.1	4.3	4.2	4	3.3	3.2
2013	2.4	3.5	4.5	5.6	4.7	4.5	5	4.8	4.1	3.7	3.5	3.1
2014	2.9	3.7	3.5	5	4.9	4.7	3.7	4.2	4.1	3.3	3	3.2

Source: NIMET

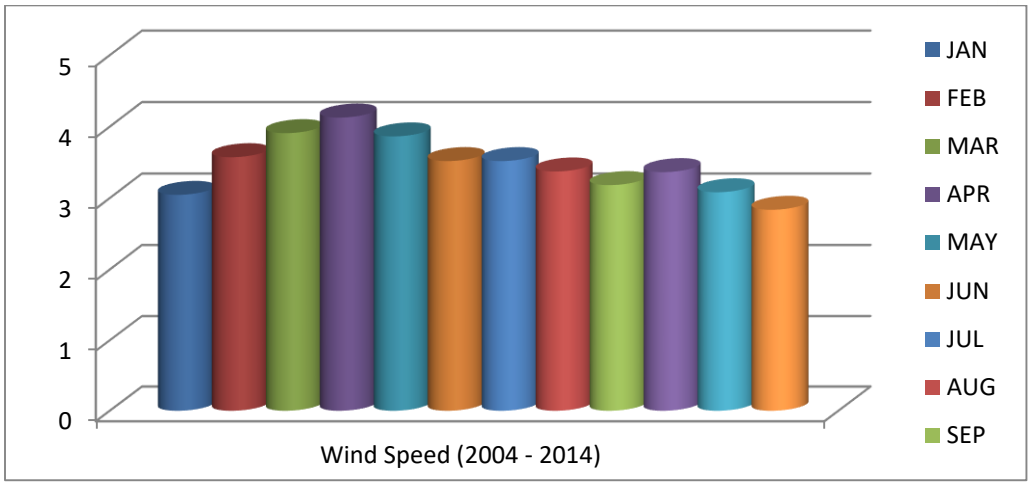


Figure 4. 5: Average Wind Speed of the study area between 2004-2014

Table 4. 8: Annual Sunshine Data of the study area between 2004-2014

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2004	6.5	7.1	7	3.9	7.3	6.5	4.3	5.7	6.2	7.9	9.1	7.6
2005	6.9	7.4	4.9	7	9	6.3	5.5	6	4.9	8.4	8.2	6
2006	5.8	7.1	3.7	6	7.9	6.1	4.2	3.9	5.4	5.7	8.1	9.1
2007	7.2	7.4	8.6	7.7	7.5	6.1	4.2	3.7	4.5	6.8	8.4	8.9
2008	8.7	7.1	6.7	7.2	7.9	8.1	4.9	4.4	5.4	6.1	7.9	7.5
2009	6.1	5.7	5	7.1	7.2	6.2	5.7	4.9	4.9	6.6	8.6	8
2010	7.7	7.3	8.1	6.5	7.7	7.9	5.2	5.4	4.6	6.2	8.4	7.9
2011	7.6	6.9	8.1	6.9	7.9	7.7	4.9	5.2	4.6	5.7	8.3	8.2
2012	7.5	5	8.3	7.5	7.8	7	4.3	3.2	4.9	8.3	9.3	8.4
2013	7.4	5.9	8.5	7.4	7.7	7	4.4	4.4	5.1	6.9	9.6	8.8
2014	7.3	7.5	8.2	7.5	7.4	7.5	4.5	5.2	5.2	6.8	9.2	8.8

Source: NIMET

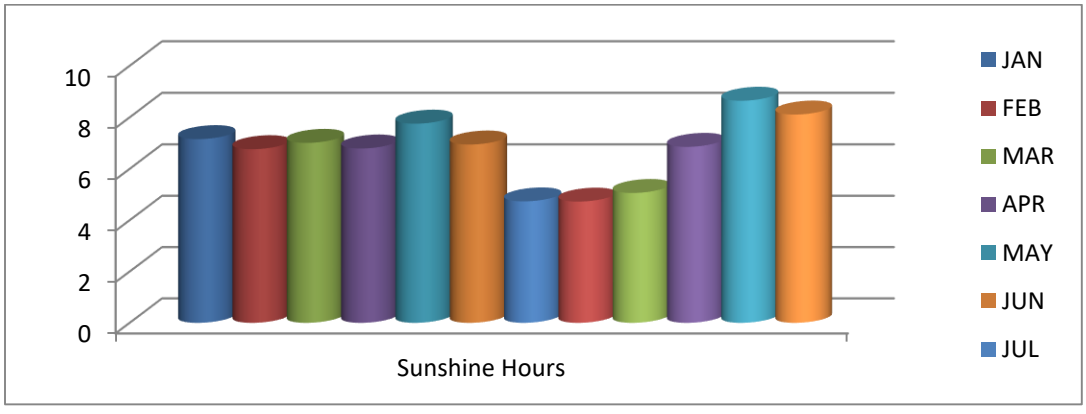


Figure 4. 6: Average Sunshine Hours of the study area between 2004-2014

4.3 Air and Noise Quality

4.3.1 Air Quality and Noise Level Measurement

A total of 10 points were sampled for air quality with three (3) of these points serving as control points during the field investigations. The following parameters were measured at each of the locations; Nitrogen Oxides (NO_x), Sulphur Oxides (SO_2), Ozone (O_3), Carbon monoxides (CO), VOCs, Noise and Suspended Particulates Matter (SPM). In-situ measurements of air, particulate matter and noise level within and around the site were carried out using Hand held Digital air, particulate and noise measuring meters to determine the concentrations. The oxides of (Nitrogen and carbon), sulphates, ozone, hydrogen sulphide and VOCs were measured in micrograms per cubic metre ($\mu g/m^3$) using hand held portable BH-4S Multi Gas Detector while noise level were measured in dB(A). At each sampling station, readings were taken between 9:00am and 12.00am and *etrex Legend* GPS meter was used to locate the coordinates of the sampling point.

Plate 4. 2: In-situ Air Quality and Noise Level Measurement

4.3.2 Air Quality and Noise Level Analysis

Average ambient temperature was 36.77^0C, average relative humidity was 20.31% in the dry season and in the wet season the values for ambient temperature and relative humility were 30.37^0C and 53.36% respectively, , average wind speed recorded was 1.47m/s in the dry season and 0.97m/s in the wet season, the mean noise level in around the site was recorded in the dry season as 69.80dBA with high values of 85.2dBA(AQ5) and 82.1dBA (AQCtrl 2) recorded due to their proximity to the highway while in the wet season average noise levels was 65dBA.

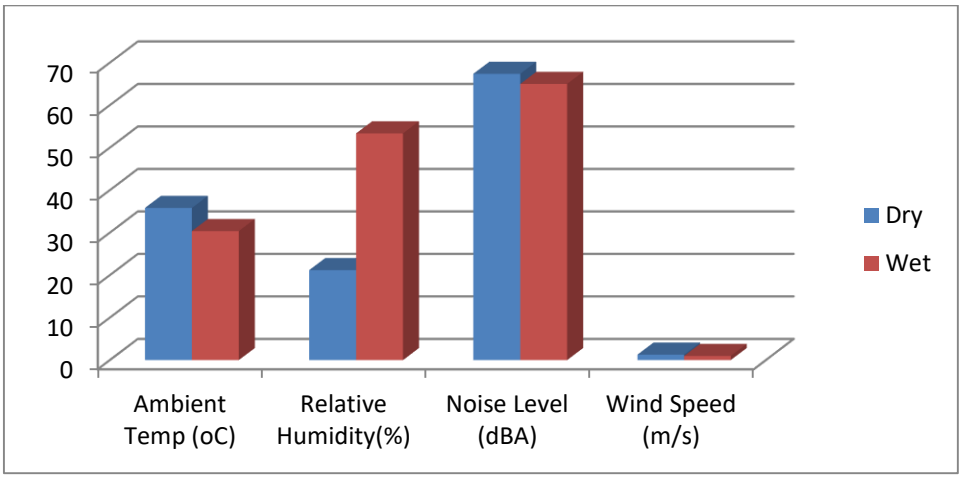


Figure 4. 7: Noise levels measured in the Dry and Wet season

4.3.3 Sources of air emission and Noise level

Sources of noise at this study area were from vehicular emissions due to the proximity of the site to the independence highway and probably from the use of powered generators in buildings around the site. These sources have been observed to generate CO, NO_2, SO_2, THC, NH_3, H_2S and particulate matter as well as noise level into the atmosphere. These pollutants when present above the permissible limits are known to affect man and his environment in a number of ways.

4.3.4 Suspended particulate matter

Particulates alternatively referred to as particulate matter (PM) or fine particles, are tiny particles of solid or liquid suspended in a gas. Increased levels of fine particles in the air are linked to health hazards such as heart disease, malfunctioning of the lung and lung cancer.

Suspended particulate matter across the ten (10) sampling locations around the project site was relatively low, the average particulate matter recorded was 32µg/m^3 for $PM_{2.5}$ and 65.5µg/m^3 for PM_{10} in the dry season and in the wet season; the levels were 20.14 µg/m^3 and 122.14 µg/m^3 for $PM_{2.5}$ and PM_{10} respectively.

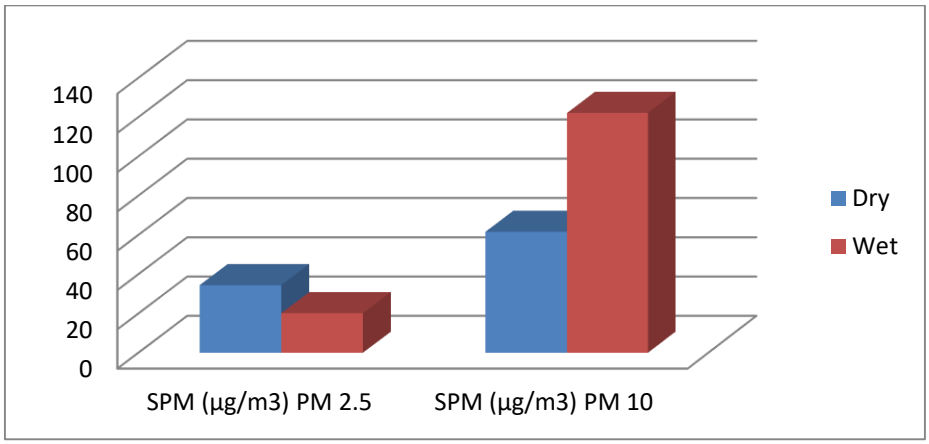


Figure 4. 8: Suspended Particulate Matter measured in the Dry and Wet season

Suspended particles may result from a variety of natural activities or human sources such as combustion processes in vehicles around the project site. Other sources include road dust, and dust resulting from other human activities around the site.

4.3.5 Pollutant Gases

SO_2 and O_3 were not detected in air quality parameters measured in both seasons, average NO_2 measured in the dry and wet season were 0.06 and 0.03 µg/m^3 respectively, average CO was 0.008 and 0.01 µg/m^3 in the dry and wet season respectively, average H_2S in the dry was 0.0002 µg/m^{3}as H_2S was not detected in the wet season, average VOC in the dry and wet season was 0.0009 and 0.001µg/m^3

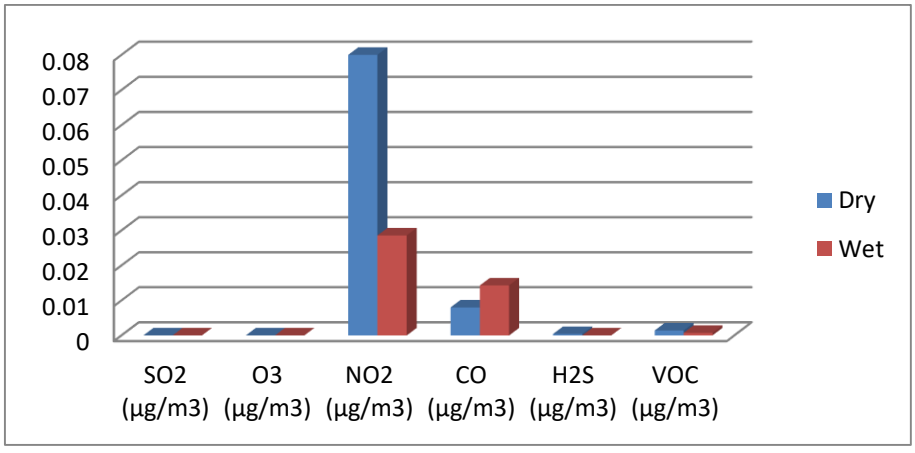


Figure 4. 9: Gaseous parameters measured in the Dry and Wet season

The major pollutants, which together contribute more than 90% of global air pollutants, are carbon monoxide, CO, oxides of nitrogen, NO_x, oxides of sulphur, SO_x and Particulates. These pollutants

are known to affect man and his environment in a number of ways. In this study, these pollutants were all analysed and the results given in fig 6.9.

Nitrogen dioxide is one of the several nitrogen oxides, a chemical compound with the formula NO_2. This reddish-brown toxic gas has a characteristic sharp, biting odor. NO_2 is one of the most prominent air pollutants. In this study, however, it occurs minimally within the range of 0.00 – 0.2 µg/m^3 in the dry season and 0.00 – 0.1 µg/m^3 in the wet season.

Carbon monoxide is a colourless, odourless, non-irritating but very poisonous gas. It is a product of incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide. The concentration recorded in this study falls within 0.00 – 0.02 µg/m^3 for the dry season and 0.00 – 0.01 µg/m^3 in the wet season.

Sulfur oxides especially sulfur dioxide, a chemical compound with the formula SO_2. SO_2 is produced by various industrial processes. Since coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain. This is one of the causes for concern over the environmental impact of the use of these fuels as power sources. In this study however SO_2 was not detected in both seasons.

4.3.6 Volatile organic compounds (VOC)

VOC level recorded in all the ten (10) sampling points in the study area averaged at 0.004 µg/m^3 and 0.001 µg/m^3 in the dry and wet season respectively. The harmful effect of this group of air pollutants depend on their concentration in the air and the exposure duration. Some VOCs are dangerous to human health as well as the environment and most scents or odours are of VOCs. VOCs are organic chemicals that have a high vapour pressure at ordinary temperature and are pollutant compounds that contaminate the air.

4.4 Water Quality Study

Ten (10) samples of ground water were collected from preexisting boreholes and potable pipe-borne water. Unstable physico-chemical parameters (pH, temperature, salinity, conductivity and total dissolved solids) were measured *in-situ* while for the other physico-chemical parameters and microbiological parameters, water samples were sub-sampled, samples for heavy metals were fixed with dilute solution of HNO_3 to avoid precipitation and samples for organics analysis were preserved using HCl (by adding drops of these solutions into the water samples) to avoid oxidation and refrigerated for subsequent analysis in the laboratory.

The examination of the water was divided into two analytical classes: Physical examination and chemical examination with the objective of determining the degree of clarity and ascertain the nature of matter in suspension and to determine the chemical quality of the water.

Plate 4. 3: Water sample collection

pH:

The average pH value recorded in this water study from the project site was 8.0 in the dry season and 7.5 in the wet season and is within NESREA effluent limit thereby indicating almost neutral nature of the water. pH value expresses the acidity or alkalinity of the water or the concentration of hydrogen ion in the ground water body.

Turbidity, Colour, Odour and Mineral oil:

The turbidity recorded was 2.2 NTU for both dry and wet season, the water sample from the site is clear, transparent, colourless and free of any offensive odour. Mineral oil was not detected.

Conductivity and Total Dissolved Solids (TDS):

TDS comprises inorganic salts and small organic salts dissolved in water and the principal constituents are usually the cations such as calcium, magnesium, sodium, and potassium and the anions: carbonates, bicarbonates, chlorides, sulphates and particularly nitrates. In this study, average TDS detected were 47.46 mg/l in the dry season and 43.2mg/L in the wet season, while conductivity recorded was 95 and 93.4 µS/cm in the dry and wet season respectively.

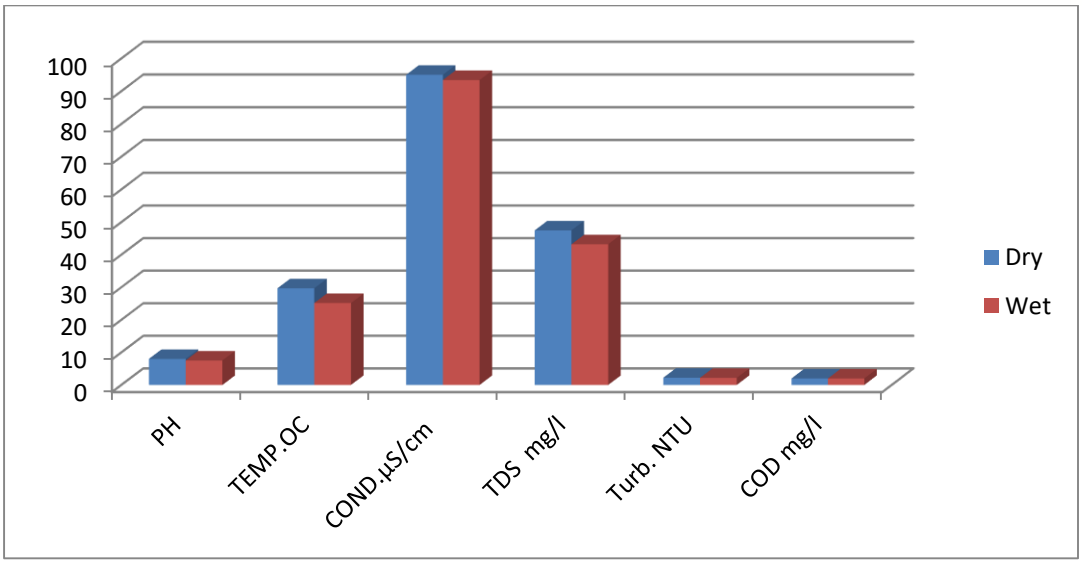


Figure 4. 10: Physico-Chemistry Results for Analysis of Water Samples in the dry and wet season

Organics and Microbiology

Organics (Oil and grease and Total hydrocarbon) recorded in both dry and wet season was below 0.01mg/L as shown in fig 6.11, average microbial parameters shows in the dry and wet season respectively; $2.33x10^2$ cfu/ml and $1.8x10^2$ cfu/ml for Total heterotropic bacteria, 2.06 $x10^2$ cfu/ml and 3.5 cfu/ml for Hydrocarbon utilizing bacteria, 1.26 $x10^2$ cfu/ml and 6.42 $x10^2$ cfu/ml for Total heterotropic fungi, 1.44 $x10^1$ cfu/ml and 4.2 cfu/ml for Hydrocarbon utilizing fungi.

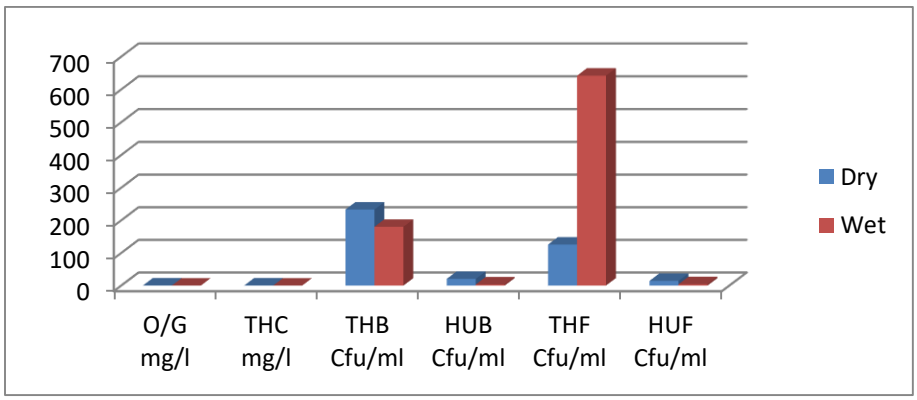


Figure 4. 11: Organics and microbiological parameters in the dry and wet season

Heavy Metals:

Heavy metals are persistent pollutants that can be accumulated in the food chains becoming increasingly dangerous to human and wildlife. Heavy metals investigated in this water study shows that chromium, lead, cobalt, silver and vanadium were below the instrument detection limit

of 0.001mg/L. Mean Nickel concentrations were found to 0.09 mg/L in the dry season and 0.21 mg/L in wet season, cadmium levels were 0.005 mg/L and 0.05 mg/L in the dry and wet season respectively, copper levels were 0.001 mg/L and 0.105 mg/L in the dry and wet season respectively, iron levels were 0.055 mg/L and 0.044 mg/L in the dry and wet season respectively, zinc levels were 0.001 mg/L and 0.029 mg/L in the dry and wet season respectively and manganese was detected only in the dry season with average concentration of 0.018mg/L.

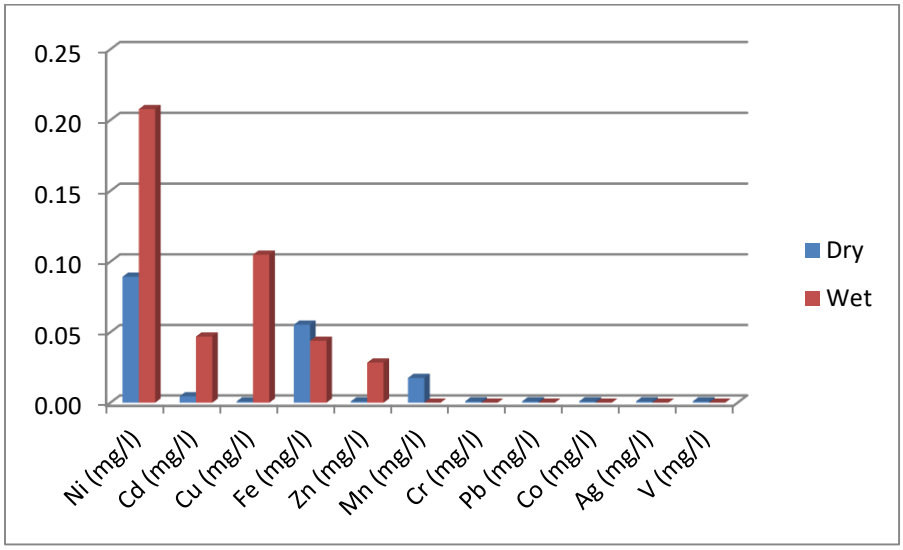


Figure 4. 12: Organics and microbiological parameters of water in the dry and wet season

4.7 Geology of the Study Area

The geological features of the study area are founded on basement complex structures that characterize much of the country with formation of Precambrian Basement Complex rocks which consists mainly of granites and small occurrences of quartzite, pegmatite, amphiboles, gneisses and schist with migmatite. Granite with quartzite occupies the northern and eastern part of the area. At the location of the site the migmatite complex (migmatite, migmatite gneiss, granite gneiss, porphyroblastic granite gneiss, leucocratic granite gneiss) occur. The surrounding areas are underlain by diorite, granites (biotitic and muscovitic, i.e. melanocratic and leucocratic), gneiss, metasediments and pegmatities. The simplified geology of Abuja and the location is indicated below (see **Plate 4.4**).

Plate 4. 4: Map of Abuja showing Geological mappings

The geology at the proposed development is comprised of migmatites. The mineralogical composition is up to 70% quartz hence sandy soils are expected to have developed from the migmatite. The ground was found to be comprised of sands, sandy gravels, sandy clays and gravelly clays, with bedrock in excess of 5m deep

4.8 Soil of the Study Area

Soil in the study area is generally reddish brown in colour. The nature of the soil represents an interface between intensive chemical weathering of rocks, and an active surface and subsurface denudation system, fueled by intensive rainfall and rapid runoff. The properties of the soils therefore represent complex relationships between intensity of weathering and rate of lateral and vertical eluviations of materials, which are in turn related to lithology, topography, climate, vegetation and other environmental controls. The soil type found in the study area can be classified as ferruginous tropical soils.

The Ferruginous Tropical Soil

The soil in most part of the study area are developed on the deeply weathered Basement Complex granitic rocks (mostly migmattites, gneisses, granites, and quartzite).The exact character of the soil is dependent on such factors as nature of parent material, topographical relation, and anthropogenic modification. The colour ranges from dark grey or grayish brown in the topsoil to yellowish red or yellowish brown in the subsoil. The topsoil develops a moderate medium

subangular blocky structure, and the lower horizons weak fine or strong coarse subangular blocky structure. The soil are highly porous, with common to many, fine to coarse pores in the upper horizons; these extending down into the subsoil. They are well drained over most of the year, although the presence of reddish mottles and iron segregation, especially in the middle and lower slope positions, suggests that many do become saturated at depth for at least brief periods. The top horizons are sandy loams or loamy sand, with clay content generally less than 15 percent. The subsoil is less sandy, often sandy clay loams or sandy clays, with clay content between 25 and 40 percent. A large proportion of the soils are gravelly within 40cm of the surface. The gravel content, especially at the soil surface, tends to be greater on steep slopes and at the on the base of the rock outcrops where land is more or less under permanent cultivation. In terms of consistency, the upper few centimeters of soil are loosed even when moist.

These are commonly observed throughout the site area and dotted with gravel which could be due to previous construction deposit on the site.

4.8.1 Soil Quality Study

Soil samples for analysis were collected, randomly from twenty seven (27) different locations of the project site at a depth of 0 – 15cm and 15 – 30cm and three (3) control points in each of the sampling point using soil auger. Soil study was divided into three components: Soil physicochemical, Alkali & Alkaline Metals (K, Na, Ca, Mg), and Heavy Metals: (Cd, Cr, Cu, Fe, Pb, Zn, Ni, Co, V), and Organics (Total Hydrocarbons (THC) (or “Oil and Grease”).

Plate 4. 5: Soil sample collection

pH

The soil pH values recorded in thirty (30) sampling points of this study show that pH increases with increase in soil depth with an average of 7.6 and 7.58 in the dry and wet season for the top soil and 7.63 and 7.66 in the dry and wet season for bottom soil and all within the range of (7.1 - 7.9) with the highest in sampling point S8 Top around the south western area of the site and the lowest in sampling point S16 Top around the northern axis of the project site. These values show characteristics of slightly alkaline soil.

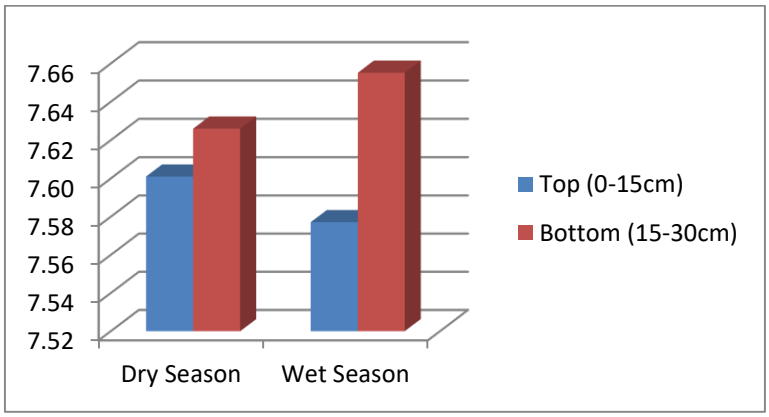


Figure 4. 13: Mean pH values for soil sampled during dry and Wet season

Nitrate (NO_3^-)

Nitrate from the sampling points vary between 0.1 to 20.9 mg/kg and an average of 1.19mg/kg and 0.56mg/kg in the top and sub soil respectively in the dry season and an average of 0.82mg/kg and 1.56mg/kg in the top and sub soil respectively in the wet season. Nitrates are highly soluble compounds and as such move readily and available to plant roots at the top soil. The value of nitrate from study area may be attributed to the use of Nitrate fertilizers by the local farmers within the site. Nitrates are also subject to leaching if they move out of the root zone and can eventually cause contamination of ground water if present in excess. Nitrate is a byproduct of biological decay from plant and animal matter.

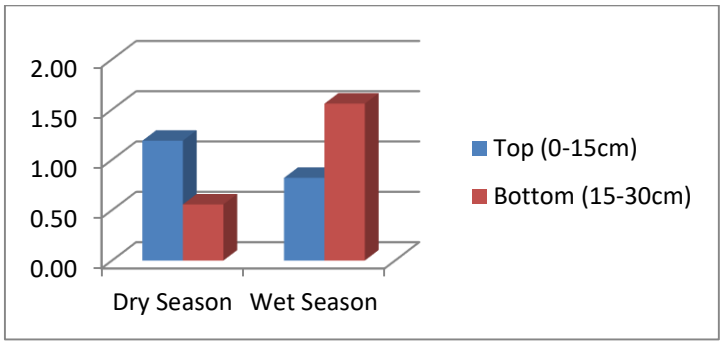


Figure 4. 14: Mean Nitrogen levels in the soil sampled during dry and Wet season

Sulphate (SO_4^{2-})

The concentrations of sulphate ion in this study across the four sampling points are in the range of 1 to 65 mg/kg and an average of 6.23mg/kg in both the dry season and wet season with the highest of 65mg/kg recorded at sampling point S6 Top. Sulphate is a major ion containing in soil and is one of the raw ingredients required for the formation of acid sulphate soil which may affect key environmental values or uses such as aquatic ecosystem, drinking water, recreation and aesthetics.

Exchangeable Cations

Mean concentration of the cations in the study area was measured: Calcium 1077.21mg/kg and 1048.13 mg/kg for top and sub soil respectively; potassium at 6308.87 mg/kg and 5940.23 mg/kg for top and sub soil respectively .Sodium has average concentration range of 2555.94 mg/kg for the top soil and 2240.38 mg/kg for the sub soil. Exchangeable cations are responsible for nutrient mobility in soil. Calcium and magnesium levels are primarily affected by soil type, drainage and cultural practices. Concentrations of both ions increase with increasing soil pH.

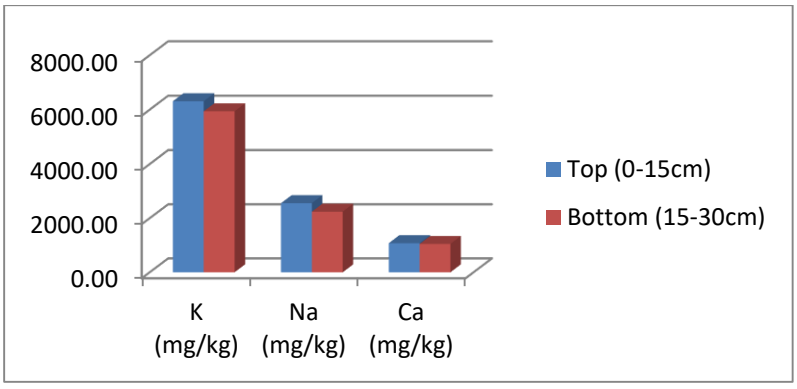


Figure 4. 15: Mean Exchangeable Cation levels in the soil sampled for both Dry and Wet season

Organics and Microbiology

In this study, the THC detected are 702 and 303 mg/kg in the top and sub soil for the dry and wet season while oil and grease recorded are 1765 and 765 mg/kg in the top and sub soil for the dry season. THC is a group of compounds that are mostly colourless, flammable, non-toxic gases with very characteristic odours associated to the various compounds e.g methane, ethane, propane and butane. Some reactive hydrocarbons can be toxic to humans, animals and vegetation.

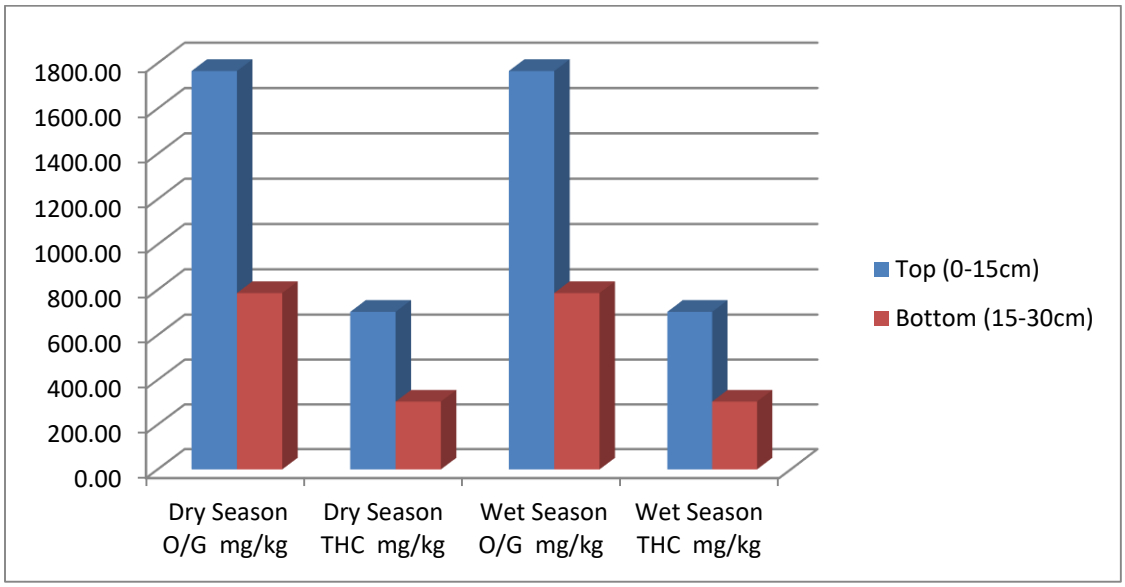


Figure 4. 16: Mean Organics levels in the soil sampled for both Dry and Wet season

The average microbial parameters shown in the dry and wet season respectively; $2.64x10^6$ cfu/ml and $9.76\ x10^6$ cfu/ml in the top soil and $2.54\ x10^6$ cfu/ml and $2.54\ x10^6$ cfu/ml in the sub soil for Total heterotrophic bacteria, $1.48\ x10^6$ cfu/ml and $1.56\ x10^6$ cfu/ml in the top soil and $1.45\ x10^6$ cfu/ml and $1.57\ x10^6$ cfu/ml in the sub soil for Total heterotrophic fungi, $1.17\ x10^6$ cfu/ml and $1.05\ x10^6$ cfu/ml in the top soil and $1.0\ x10^5$ cfu/ml and $1.09\ x10^5$ cfu/ml in the sub soil for Hydrocarbon utilizing fungi and $4.75\ x10^5$ cfu/ml and $3.88\ x10^5$ cfu/ml in the top soil and $3.17\ x10^5$ cfu/ml and $2.66\ x10^6$ cfu/ml in the sub soil for Hydrocarbon utilizing bacteria.

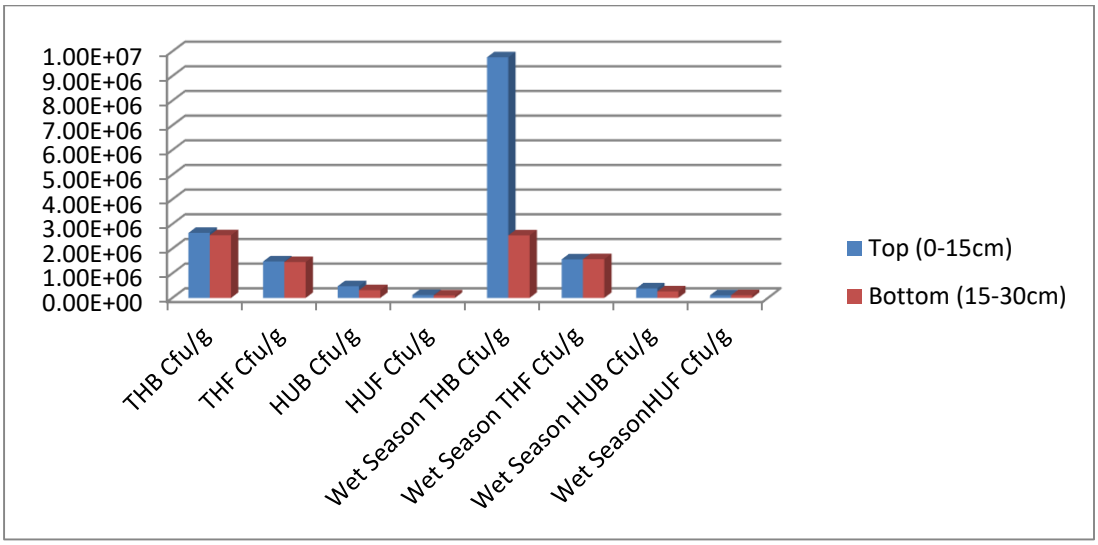


Figure 4. 17: Mean Microbial levels in the soil sampled for both Dry and Wet season

Heavy Metals

The heavy metals tested for in this study include Ni, Cd, Zn, Fe, Cu, Pb, Co, Mn, Cr, V, and Ag. The concentration of nickel in the dry season was 31.32 mg/kg and 24.07mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 73.51 mg/kg and 65.41mg/Kg for the top and sub soil respectively, cadmium concentration was 27.88 mg/kg and 32.16 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 8.29 mg/kg and 6.99 mg/Kg for the top and sub soil respectively, copper concentration was 22.31 mg/kg and 20.73 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 32.88 mg/kg and 29.73 mg/Kg for the top and sub soil respectively, iron concentration was 332.15 mg/kg and 335.11 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 465.43 mg/kg and 439.35 mg/Kg for the top and sub soil respectively, zinc concentration was 44.84 mg/kg and 41.17 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 65.88 mg/kg and 41.38 mg/Kg for the top and sub soil respectively, manganese concentration was 250.4 mg/kg and 260.2 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 357.6 mg/kg and 278.6 mg/Kg for the top and sub soil respectively, lead concentration was 31.92 mg/kg and 35.43 mg/Kg for the top and sub soil respectively while in the wet season, the average concentration was 201.1 mg/kg and 203.9 mg/Kg for the top and sub soil respectively, chromium concentration was 114.45 mg/kg and 106.99 mg/Kg for the top and sub soil respectively and cobalt concentration was 23.52 mg/kg and 23.29 mg/Kg for the top and sub soil respectively. Cobalt and chromium was not detected in the wet season while Silver and

vanadium were not detected in any of the sampled areas. Heavy metals with severe adverse health effect in human metabolism including (lead, cadmium, and vanadium) which present obvious concern due to their persistence in the environment as well as documented potentials for serious health implications.

Seasonal variations in heavy metals concentrations could be due to the slanty nature of the topography of the site which allows carriage of washed soil and other materials during rainfall across the site before disposal through the northernly corners of the site with chances of percolations along its flow.

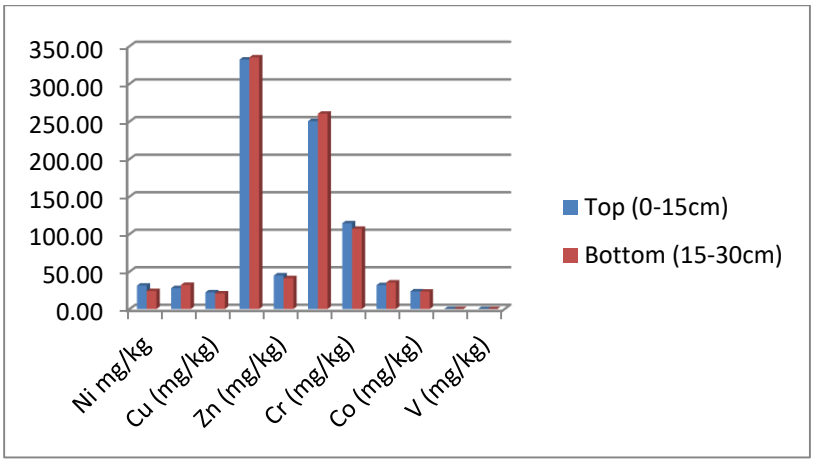


Figure 4. 18: Mean Heavy metals concentrations levels in the soil sampled for the Dry season

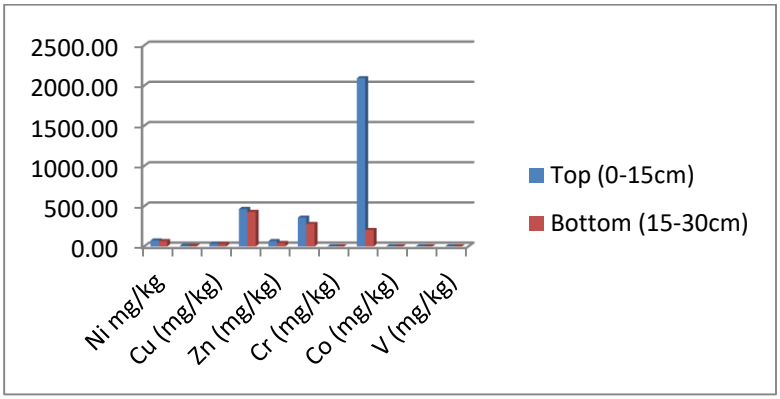


Figure 4. 19: Mean Heavy metals concentrations levels in the soil sampled for the Wet season

4.9 Wildlife Study of the Proposed Project Area

The wildlife assessment involved a survey of reptiles, birds, and mammals in the study areas following methodology described by Agbagwa and Ndukwu, 2014 and Aigbokhan, 2016. Animals such as the reptiles, and birds, were easily observed and census was done with direct count method. The indirect count technique was employed for the very secretive forms, particularly the mammals. This entailed the use of evidence of the animals preserve / occupancy to estimate their abundance (Dasmann, 1964).

The study area falls within the central Business district of the Federal Capital territory, Abuja, where a lots of development projects have been undertaken. The implication of this is that wildlife habitats may have been destroyed and most of fauna gone into extinction. However, wildlife censored were non-game species with avian fauna dominating the vertebrate assemblages. The composition of the assemblages within the project location includes:

- Two (2) mammalian species;
- Sixteen (16) Avian species;
- One (1) reptilian species.

Mammalia

The mammalian fauna was dominated by the Sciuridae (Black rat) and Muridae (Giant rat) and censored by directing sighting during the field survey and information from respondents working around the project area.

Aves

The project area has a diverse population of avian species. High vocalizations and footprints were sighted during the wet and dry season survey. Dominant avian species identified in the study area include: Pin-tailed whydah (*Vidau macroura),* Grey - headed sparrow *(Passer griseus),* Great White Egret *(Egretta alba),* Lizard Buzzard *(Kaupifalco monogrammicus),* Greater Short-toed lark (*Calandrella brachydactyla)* and Lesser grey shrike *(Lanius minor).*

Reptilia

The dominant reptilian species in the lowland ecotype were the Agama Lizard -
Agama agama.

Table 4. 9: Check List of Mammalian fauna in the study area

ANIMALS	STATUS IN STUDY AREA	WCMC	ACT 11 of 1985	MODE OF DETECTION	Wet season	Dry season
Sciuridae						
Black rat – *Rattus rattus*	C	++		Direct sighting	+	+
Muridae						
Giant rat - *Cricetomys gambianus*	C	+++	-	Questionnaire	+	+

KEY: *C=Common, WCMC= National Ranking in WCMC's 1988 Nigeria Biodiversity Report: ++ = Common; +++ = Abundant, Decree/Act 11 = Ranking in Federal Endangered Species Act 11 of 1985 (Schedules 1 – 2).*

Table 4. 10: A checklist of Avian species in the study area

BIRDS	STATUS IN STUDY AREA	WCMC	ACT 11 of 1985	NUMBER SEEN	MODE OF DETECTION	Wet season	Dry season
Apodidae							
Apus barbatus	C	++	-	1	Direct sighting	+	+
Ploceidae							
Black - headed weaver - *Ploceus melanocephalus*	C	++	-	-	Questionnaire	+	+
Grey - headed sparrow - *Passer griseus*	C	+++	-	1	Direct sighting	+	+
Pin-tailed whydah - *Vidau macroura*	C	+++	-	1	Direct sighting	+	+
Ardeidae							
Great White Egret - *Egretta alba*	NU	++	-	1	Direct sighting	+	+
Turdidae							
Turdidae pelios	C	+	-	1	Direct sighting	+	+
Pycnonotidae							

BIRDS	STATUS IN STUDY AREA	WCMC	ACT 11 of 1985	NUMBER SEEN	MODE OF DETECTION	Wet season	Dry season
Pycnonotus barbatus	C	+	-	1	Direct sighting	+	+
Motacillidae							
Yellow Wagtail - *Matacilla flava*	C	+	-	1	Direct sighting	+	+
Plain-backed Pipit - *Anthus leucophrys*	C	+	-	-	Questionnaire	+	+
Estrildidae							
Bronze manikin – *Lonchura cuculiata*	C	++	-	1	Direct sighting	+	+
Accipitridae							
Lizard Buzzard - *Kaupifalco monogrammicus*	C	+++	1	-	Questionnaire	+	+
African cuckoo Hawk – *Aviceda cuculoides*	A	+++	-	2	Direct sighting	+	+
Black-shouldered kite – *Elanus caeruleus*	C	+++	-	1	Direct sighting	+	+
Alaudidae							
Greater Short-toed lark – *Calandrella brachydactyla*	C	+++	-	-	Questionnaire	+	+
Laniidae							
Masked shrike – *Lanius nubiscus*	C	+++	-	-	Questionnaire	+	+
Lesser grey shrike – *Lanius minor*	C	+++	-	-	Questionnaire	+	+

KEY: *C=Common, NU= Not uncommon (Animals or birds that will be seen by anybody who makes effort to search for it in the area), A=Abundant, IUCNWCMC= National Ranking in WCMC's 1988 Nigeria Biodiversity Report: + = Few; ++ = Common; +++ = Abundant, Decree/Act 11 = Ranking in Federal Endangered Species Act 11 of 1985 (Schedules 1 – 2).*

Table 4. 11: A checklist of reptiles in the study area

REPTILES	**STATUS IN STUDY AREA**	**WCMC**	**ACT 11 of 1985**	**MODE OF DETECTION**
Agamidae				
Agama Lizard - *Agama agama*	C	+++	-	Direct sighting

KEY: C=Common, IUCN= International Union for the conservation of nature, WCMC= National Ranking in WCMC's 1988 Nigeria Biodiversity Report: +++ = Abundant, Decree/Act 11 = Ranking in Federal Endangered Species Act 11 of 1985 (Schedules 1 – 2).

Bush Sparrow

Agama lizard

Plate 4. 6: Vertebrate assemblages censored from the project area

4.10 Vegetation Study of the Proposed Project Area

Vegetation is the collective term for plant life or flora of an area. It is classified on the basis of life form which is mainly trees, shrubs, herbs and mosses. AMAC which is the location of proposed project falls within the Southern Guinea Savanna (Hopkins, 1974). Four (4) transects identified and designated as VG1-VG4 and VGC1 – VGC2 (control stations) were surveyed using the Transect area method. Floristic composition was identified in situ and plant species that were doubtful were photographed and evaluated at the Herbarium. The main parameters evaluated include vegetation types and floral composition. Additional pathological studies were conducted

by collecting data on the plant/crop health status by the identification of health conditions, fungi and bacterial disease of plants at the designated ecotype (Aigbokhan, 2016).

Determination of species composition

Visual reconnaissance surveillance along transects were conducted and plants were identified, classified and catalogued according to their taxonomic (species and family) names, growth form and biogeographical status (native or exotic). The following literature: Hutchinson & Dalziel (1954, 1963, 1968, and 1972), Akobundu and Agyakwa (1998), Arbonnier (2004) and Aigbokhan (2014) provided clarity and insights around plant identification. To verify the exact identity of each plant, the folowing literature sources were also examined: *West African Botany* by Irvine (1985), *Taxonomy of West African Flowering Plants* by Olorode (1988), and *Annotated Checklist of Vascular Plants of Southern Nigeria* by Aigbokhan (2014). For each plant species identified, an aspect on the economic primary uses following the format and designation outlined in Bosch *et. al.* (2002) are also presented.

Pathological investigations were carried out by traversing along all the established transects in the study area. This was aimed at determining as well as listing the pests and diseases of the plants in the study area. Disease severity for each plant was determined by the use of standard disease severity index expressed as infection indices similar to those of Alasoadura and Fajola (1970) and Emua (1980) (**Table 4.12**).

Table 4. 12: Infection indices for different levels of disease severity

Infection Index	Description
0	No infection
1	Very light infection
2	Moderate infection
3	Severe infection

Modified from Alasoadura and Fajola (1970) and Emua (1980)

Vegetation Structure

The project area consists primarily of lowland fallowed vegetation ecotype dominated by Herbs, Sedges, Shrubs, Grasses and Vines with generally no climaxed vegetation ecotype in the urban center (Labour house, Central Business District, Abuja). A total of Forty -three (43) plant species were recorded along transects surveyed and distributed among thirteen (13) plant families within the project area in the wet and dry seasons. The low-lying terrain and prolonged rainfalls during the wet season generally influenced the floral assemblages along the study transects (VG1. VG2,

VG3 and VG4). The floristic composition of this lowland fallow ecotype was vertically stratified into two layers and comprised the nanophanerophytes predominantly the herbs and shrubs lifeforms (**Plate 4.7 and 4.8**). The assemblages around the control stations (VGC1 and VGC2), off the Shehu-Shagari Way, Central Business District (CBD) were significantly different as exfoliating shrubs dominated the life forms and sparse saplings. Plant habits in both climatic regimes were distributed in accordance to predominant growth forms. In order of percentage distribution and species number, the growth forms were as follows: Herbs >> Grasses>> Shrubs/Sedges >> Vines in the dry and wet season (**Table 4.13**). The total number of life forms censored in the project area and control stations were thirty-nine (39) species in the dry season and sixty-six in the wet season.

Nineteen (19) species representing 48.72% of the censored species were herbaceous plants in the dry season and twenty-eight (28) species, 42.42% in the wet season. Similarly, seven (7) species represented the Grasses (17.95%) and fifteen (15, 22.72%) in dry and wet seasons. The percentage composition and species numbers for sedges and shrubs compared favourably in the dry and wet seasons. Six (6) species each was censored for sedges and shrubs in the dry season comprising 15.38%. Sedges were represented by ten (10) species (15.15%) in the wet season and eight (8) species comprising 12.12% of the floristic composition. Furthermore, the Asteraceae dominated the taxa classification comprising about 20.51 and 205.8% in both climatic regimes. Well represented species of the family Asteraceae predominantly herbaceous in life forms include: Acanthospermum hispidum., Adenostemma perrottetii., Aspilia africana., Aspilia helianthoides., Chromolaena odorata., Emilia praetermissa and Emilia sonchifolia. The Poaceae followed closely with percentage distribution of 17.95 and 12.75% in the dry and wet seasons and were dominated by: Acroceras zizaniodes., Andropogogon gayanus., Chrysopogon aciculatus., Cynodon dactylon., Eragrostis tremulla., Setaria barbata., and Oplismenus burmannii. Generally, the lifeforms and floristic composition recorded within the project area have also been censored in disturbed habitats and fallow lowlands within the Abuja Metropolis. Details of floristic composition of plant species censored in the dry and wet season is presented in **Table 4.14**.

Furthermore, the native plants comprised 59.52% of plant assemblages in the project location and were predominantly represented by Abutilon mauritianum, Acanthospermum hispidum, Acroceras zizaniodes, Acrostichum aureum, Andropogogon gayanus, Bulbistylis pusilla, Aspilia helianthoides, Cyperus amabilis, Cynodon dactylon and Kyllinga erecta. The exotic species followed closely with 38.10% introduced to the project sites by agents of pollinations and runoff during the peak of the wet season. Waltheria indica, Oxalis corniculate, Emilia sonchifolia,

Chromolaena odorata, Calopogonium mucunoides, Asclepias curassavica, Andrographis paniculate, Acanthospermum hispidum and Aeschynomene americana recorded high exotic species number.

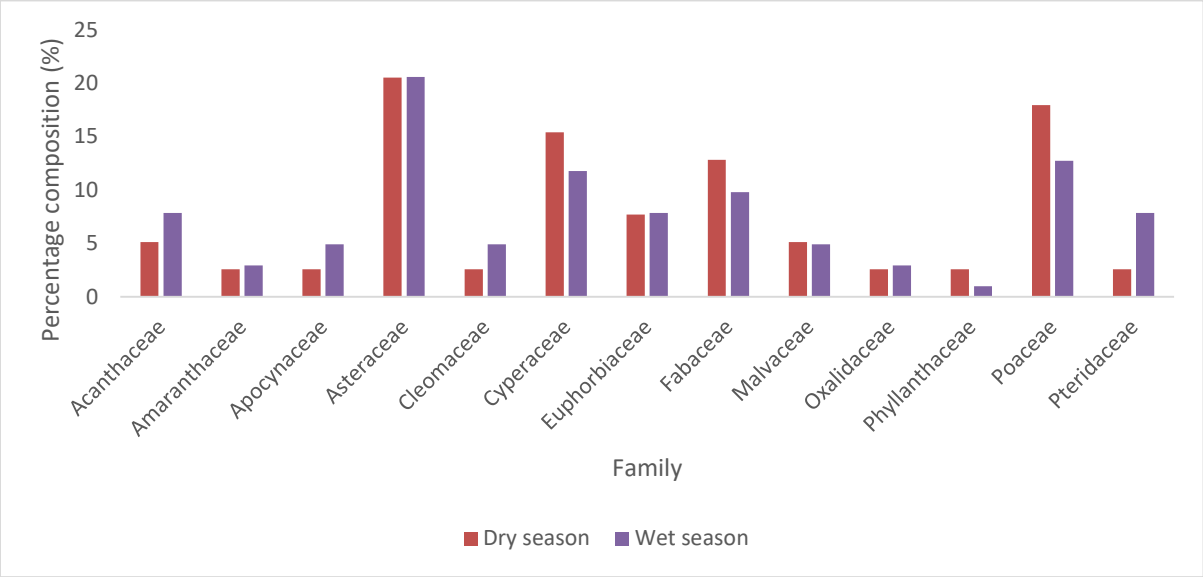


Figure 4. 20: Percentage composition of Plant families censored in the dry and wet season

Table 4. 13: Summary of the distribution of plants in the study area in the dry and wet season

Transect ID	Shrubs	Herbs	Grasses	Sedges	Vines
VG1	2, 3	5, 2	2, 6	1, 1	1, 10
VG2	2, 5	4, 7	1, 3	1, 6	0, 0
VG3	1, 5	1, 5	1, 2	1, 9	0,0
VG4	0, 7	5, 10	1, 3	1, 5	0,0
VGC1	1, 4	2, 5	1, 3	1, 2	0,0
VGC2	0, 5	2, 4	1, 1	1, 1	0,0

4.10.1 Ethnobotanical use

The classification of plants based on primary use profiles are presented in **Table 4.14**. The Asteraceae dominated the ethnobotanical use with 59.2% of plant species supporting medicinal use. The ethnomedicinal uses vary from common cuts/laceration to hospitalized ailments (fever, diarrhea and respiratory ailments). Vegetative plant parts for medicinal use range from leaves, roots, stem, bark to fruits only, or a combination of two or more species. Well represented plant species include but not limited to the following: *Chromolaena odorata, Acanthospermum*

hispidum, Acrostichum aureum, Adenostemma perrottetii, Cyperus rotundus, and *Euphorbia hirta.*

Ecosystem services

The biodiversity contribution of the plant species censored in this eco-geographical location is fundamental to the provision of ecosystem services. The diversity is the significant strength and provides the capacity to maintain its equilibrium in the face of man-made pressures or natural interactions. In line with the Millennium Ecosystem Assessment framework, the plant species are selectively categorized into two:

- Provisioning services – providing food, fiber and genetic resources. A few plant species identified supporting these services include: *Alternanthera tenella*., *Alysicarpus ovalifolius., Ageratum conyzoides., Chrysopogon aciculatus., Cyperus rotundus., Emilia sonchifolia., Euphorbia hirta., Oxalis corniculate., Chamaecrista mimosoides., Aspilia africana., Andrographis paniculate., Alchornea cordifolia* and *Afrotrilepis pilosa.*
- Regulating services – providing pollination support and climate regulation. Well represented plant species include: *Adenostemma perrottetii., Acrostichum aureum., Acroceras zizaniodes., Acanthospermum hispidum., Chromolaena odorata., Acalypha ciliate, Alternanthera tenella., Andropogogon gayanus and Asclepias curassavica.*

Plate 4. 7: Chromolaena odorata providing regulating services to the project location

Plate 4. 8: Ageratum conyzoides supporting provisioning services

Table 4. 14: Floristic composition of plant species censored within the project area and ethnobotanical use

Plant name	**Family**	**Common name**	**Habit**	**Origin**	**Local name (Hausa)**	**Primary use**	**Secondary use**	**Wet season (2017)**	**Dry season (2020)**
Abutilon mauritianum (Jacq.) Medik	Malvaceae	African Mallow, Bush Mallow	Shrub	Native	Ambru	Fibres	Vegetables, medicinal plants, miscellaneous	+	-
Acalypha ciliate Forssk. (Schumach.&Thonn)	Euphorbiaceae	Copper leaf Plant	Herb	Native		Medicinal plants	Forages	+	+
Acanthospermum hispidum DC	Asteraceae	Bristle starbur	Herb	Exotic	Kaashin yaawoo	Medicinal plants	Spices	+	-
Achyranthes aspera L.	Acanthaceae	Devil's horsewhip	Herb	Native	Kaimin kadangare	Medicinal plants	Forages, auxiliary plants	+	+
Acmella oleracea(L.)	Asteraceae	Brazilian cress	Herb	Exotic		Vegetables		+	+

Plant name	Family	Common name	Habit	Origin	Local name (Hausa)	Primary use	Secondary use	Wet season (2017)	Dry season (2020)
Acroceras zizaniodes (Kunthh) Dandy	Poaceae	Oats grass	Grass	native	Geeron tsuntsaaye e	Forages		+	+
Acrostichum aureum L.	Pteridaceae	Golden leatherfern	Herb	native		Medicinal plants		+	+
Adenostemma perrottetii DC.	Asteraceae	Medicinal plants	Herb	Native		Medicinal plants	Auxillary plants	+	+
Aeschynomene americana L.	Fabaceae	Shyleaf	Herb	Exotic	Bambamk o	Forages		+	+
Afrotrilepis Pilosa (Boeck.) J. Raynal	Cyperaceae	African Trilepis	Sedge	Native		Fibres	Miscellaneou s	+	+
Alchornea cordifolia (Schum. & Thonn.) Muell. Arg	Euphorbiacea e	Christmas bush	Shrub	Native		Medicinal plants		+	+
Alternanthera tenella Colla.	Amaranthacea e	Red threads	Herb	Exotic		Ornamentals	Medicinal plants	+	+
Alysicarpus ovalifolius (Schumach.) J. Leonard)	Fabaceae	One leaf clover	Herb	Exotic	Gadagii	Forages	Medicinal plants	+	+
Andrographis paniculate (Burm. F) Wallich	Acanthaceae	Creat	Herb	Exotic		Medicinal plants		+	+
Andropogogon gayanus Kunth.	Poaceae	ganbagras s	Grass	Native	Shibcii	Forages	Auxilliary plants	+	+
Arivela viscosa (L.) Raf.	Cleomaceae	tickweed	Herb	exotic		Vegetables	Auxilliary plants	+	+
Aspilia africana (Pers.) C.D. Adams	Asteraceae	Haemorrh age plant, Bush marigold	Herb	Native		Medicinal plants	Miscellaneou s	+	+

Plant name	Family	Common name	Habit	Origin	Local name (Hausa)	Primary use	Secondary use	Wet season (2017)	Dry season (2020)
Aspilia helianthoides (Schumach.) Olive. & Hiern	Asteraceae		Herb	native	Nnake	Medicinal plants	Miscellaneous	+	+
Asclepias curassavica L.	Apocynaceae	Redmilk weed	Shrub	exotic	Rizgar kureegee	Ornamentals	Fibres	+	+
Ageratum conyzoides L.	Asteraceae	Billygoat weed	Herb	Native		Medicinal plant	Forages, Auxiliary plant	+	+
Bridelia ferruginea Benth.	Phyllanthaceae		Shrub	native	Riga kafi	Fuel plants	Fruits	+	+
Bulbistylis pusilla (De Wild)	Cyperaceae	Hairsedge	Sedge	Native		Fibres		+	+
Calopogonium mucunoides Desv.	Fabaceae	Calopo	Vine	Exotic		Auxiliary plant	Forages	+	+
Cajanus cajan (L.) Millsp.	Fabaceae	Pigeon-pea	Shrub	Exotic	Waaken tantabara	Cereals & pulses	Auxiliary plant	+	+
Chamaecrista mimosoides (L.) Greene	Fabaceae	Feather-leaved cassia	Herb	native		Auxiliary plant	Miscellaneous	+	+
Chromolaena odorata (L.) R. King & H. Robinson	Asteraceae	Siam weed	Shrub	Exotic		Auxiliary plant	Medicinal plants	+	+
Chrysopogon aciculatus (Retz.) Trin	Poacea	Love grass	Grass	Exotic		Forages	Auxiliary plant	+	+
Cynodon dactylon (L.) Pers.	Poacea	African star grass	Grass	Native		Forages	Auxiliary plant	+	+
Cyperus amabilis Vahl	Cyperaceae	Foothill flat sedge	Sedge	native	Kii taabeewaa	forages	Miscellaneous	+	+
Cyperus rotundus L.	Cyperaceae	Yellow nutsedge	Sedge	Cosmo politan	Gwaigywaya	Medicinal plants	Forages	+	+

Plant name	Family	Common name	Habit	Origin	Local name (Hausa)	Primary use	Secondary use	Wet season (2017)	Dry season (2020)
Emilia praetermissa Milne-Redhead	Asteraceae	Emilia	Herb	Native		Vegetables	Medicinal plants	+	+
Emilia sonchifolia (L.)	Asteraceae	Emilia	Herb	Exotic		Vegetables	Miscellaneous	+	+
Eragrostis tremulla Steud.	Poaceae	Love grass	Grass	Native		Forages	Miscellaneous	+	+
Euphorbia hirta L.	Euphorbiaceae	Hairy spurge	Herb	Native	Noonon kurclyaa	Medicinal plants	Ornamentals	+	+
Kyllinga pumila Michx.	Cyperaceae	Spike sedge	Sedge	Exotic	Ayaa ayaa	Species	Exudates	+	+
Kyllinga erecta Schumach.	Cyperaceae	Spike sedge	Sedge	Native	Geemun kwaadoo	Spices	Miscellaneous	+	+
Setaria barbata (Lam.) Kunth	Poaceae	Bristle grass	Grass	Native		Forages	Medicinal plants	+	+
Waltheria indica L.	Malvaceae	Boater bush	Herb	exotic	Farar hankufaa	Forages	Miscellaneous	+	+
Oxalis corniculate L.	Oxalidaceae	Yellow oxalis	Herb	Exotic		Medicinal plant	Miscellaneous	+	+
Oplismenus burmannii (Retz.) P. Beauv.	Poaceae	Basket grass	Grass	native		forages	Miscellaneous	+	-
Helianthus annuus L.	Asteraceae	Sunflower	Shrub	Native		Medicinal, Oil, and Food	Ornamentals	+	+
Pennisetum purpureum Schumach.	Poaceae	Elephant grass	Grass	Native	Yambama	Forages	Auxiliary plants	+	+
Manihot esculenta Crantz.	Euphorbiaceae	Cassava	Shrub	Exotic	Kaaraajii	Carbohydrates	Medicinal plants, auxillary plant	+	+

Plate 4. 9: Floristic composition of the project area during the dry season

Source: Field survey, 2020

Plate 4. 10: Floristic composition of plant species in the wet season

Source: Field survey, 2017/2020

4.10.2 Phytochemistry

All the macronutrient elements analysed were below the internal concentrations of essential elements for higher plants with potentials for phytotoxicity or harm consumers (Kabata-Pendias, 2001).

Table 4. 15: Concentration of heavy metals in leaves of common plant species censored in the wet and dry season

Plant species	Cd(mg/kg)	Zn(mg/kg)	Fe(mg/kg)	Cu(mg/kg)	Pb(mg/kg)	Ni(mg/kg)	Mn(mg/kg)
Manihot esculenta Crantz.	<0.001	15.3	<0.001	1.8	<0.001	<0.001	<0.001
Helianthus annuus L.	<0.001	10.1	<0.001	2.3	<0.001	<0.001	<0.001
Ageratum conyzoides L.	<0.001	18.6	<0.001	1.5	<0.001	<0.001	<0.001
Chromolaena odorata (L.) R. King & H. Robinson	<0.001	21.7	<0.001	1.07	<0.001	<0.001	<0.001
***Ranges of toxic concentrations in plants**		**100-400**		**20-100**			**400-1000**

4.10.3 Pathology

The evaluation of the health status of plants revealed the presence of fungal and bacterial infections on the aerial parts especially the leaves. The prevalent pathological conditions were leaf spots, leaf blight and leaf variegation. The detailed etiological agent identified is shown in Table 4.16.

Table 4. 16: Diseases of common food crops grown in the study area

S/No	Plant species	Disease symptoms	Disease severity index	Identified causative agents
1	*Manihot esculenta* Crantz.	Leaf variegation,	3	*Mycosphaerella* sp.
2	*Helianthus annuus* L.	Leaf spots, leaf variegation	3	*Mycosphaerella* sp., *Cercospora* spp.,
3	*Ageratum conyzoides* L.	Leaf blight and leaf variegation	2	*Mycosphaerella* spp.
4	*Chromolaena odorata* (L.) R. King & H. Robinson	Leaf spots, leaf blight and leaf variegation	3	*Erysiphe* sp.

4.11 Socio-Economic Study

A systematic effort was undertaken to identify, analyse and evaluate the social impact of the proposed project on the individuals or social groups within the community. The socio-economic survey collated baseline socio-cultural, economic and infrastructure indices of the study area, while the consultation process elicited responses on stakeholders concern and expectations from the proposed project.

Purposive sampling procedure was utilized to select individuals/group that were sampled for the survey. In depth interview session Focal Group Discussion (FGD) sessions Questionnaire administration, Participatory Rural Appraisal (PRA), Key Informant Interviews (KII) and walk through surveys were the primary data collection sources. Relevant published documents acted as secondary data collection sources. Collated data were analysed using descriptive statistics.

The objectives of socio-economic study in this EIA include:

- To increase knowledge on the part of the project proponent and the impacted community and residence in a better position to understand the broader implications in the proposed project.
- To identify the aspects of the demographic, social, cultural and economic environment which may be impaired, positively or negatively, by the proposed project activities, both on the short, medium and long run;
- To establish and gather baseline data on these aspects with a view to making such available for respective planning, management and development of proposed field activities; and.
- To recommend appropriate ameliorative measures in consonant with the observed attitude, perception and behaviour of the stakeholders.

The socio-economic component of the proposed World Trade Centre, Abuja is targeted towards identification stakeholders within the project environment. It identifies the following:

- Social, cultural and economic characteristics of the project environment.
- The human activities and interests on the project.
- Probable impacts of the project activities negative or positive and
- Feasibility ameliorative measures.

4.11.1 Study Approach and Methodology

Socio-economic data collection methods

The methodological design of the study involved descriptive or survey research, which attempts to describe current baseline conditions of the project area using a variety of primary and secondary sources. Primary data were largely used in the study and leveraged on a variety of information gathering tools to optimize the datasets. These tools include: Questionnaire administration, Participatory Rural Appraisal (PRA), Focus Group Discussion (FGD), Key Informant Interviews (KII) and walk through surveys. The field engagement was supported with photographic documentation of socioeconomic features within the project area. Representatives of the Federal Ministry of Environment, Abuja and other stakeholders provided a second-tier assurance to data gathering processes and protocols which added credence to the study.

Sampling technique

A total of 500 questionnaires were administered to four routes within a spatial boundary of 2.5km of the project location. This represents a sample size of 9.8% of the total population size based on the 2006 census figures with annual growth rate of 3.2% (NPC, 2006). The routes/potential area of influence of the project activity include:

- Access through undeveloped road (4th Street) between Federal Ministry of Finance building and Africa Re-Insurance Corporation property off Ralph Shodeinde street.
- Ralph Shodeinde Junction along Sani Abacha way,
- Labour road Junction along Sani Abacha way,
- Ralph Shodeinde intersection along Ahmadu Bello way.

Furthermore, a non-proportional to size sampling was adopted with sample size not less than 50 along each route. In order to obtain qualitative information that may be difficult to get through the use of the questionnaire, Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were conducted in each area of influence of the project. A total of 4 FGDs and 2 KIIs were conducted along each route. The discussion groups consist of Adult males, adult females, young males and young females. Each discussion group had between 5-10 discussants. 2 Key Informants-1 adult male and 1 adult female were interviewed along each route. Table 4.17 and 4.18 shows the socioeconomics and health data needs captured by the data collected during the study.

Table 4. 17: Socio-Economic Data Needs

S/N	Socioeconomic Features	Variables
1	Demography	Population size and distribution (age, gender, population density, and sex ratio) and educational attainment
2	Livelihood	Income distribution, employment status, occupation, land ownership, and other economic activities
3	Social Infrastructure	Transportation; water supply, electricity, communication, waste management facilities
4	Perception of the study area	Perception of associated risks and impacts on quality of life, pleasure/displeasure with proposed study, expectations
5	Vehicular Traffic Analysis	Vehicular volume count, origin and destination survey, incidence and records of motoring accidents, etc.

Table 4. 18: Health Data Needs

S/N	Health Parameters	Data Requirements
1	Demographic profile of the Communities	Population, age-sex distribution, migration pattern, occupation, religion, marital status, educational attainment, fertility rate, crude birth rate (CBR), life expectancy.
2	Morbidity/Mortality Patterns	Pattern of morbidity and mortality in the area; computation of crude death rate (CDR); age-specific death rate (infant mortality rate, under 5 mortality rate, maternal mortality ratio, etc.) Epidemiological concerns
3	Healthcare facilities	Inventory of existing healthcare facilities and the types/ quality of services rendered; health programs available and their providers etc. Qualifications, experience and competence of local health professionals; availability of Medical Emergency Response Facilities (MEDEVAC)
4	Maternal and Child Health	Maternal mortality ratio; <5 mortality rate, immunization status; number, distribution and patronage of traditional birth attendants
5	Knowledge, Attitude Practice and Behaviour (KAPB)	Behaviour/Lifestyle that could influence Health (e.g. Substance abuse, e.g. drug and alcohol); reproductive health behaviour;

S/N	Health Parameters	Data Requirements
6	Environmental health factors/Concerns	Water supply, sanitation, housing, waste management practices (disposal of human and domestic wastes), noise levels, air quality (indoor and outdoor) and levels of radioactivity.

Analytical Techniques

The study applied a variety of analytical techniques, especially univariate summary statistics (means, medians, modes, percentages, ratios and rates). The following formulae (Blalock, 1979) for means and standard deviations for grouped data (e.g. for income) were found particularly useful:

(a) Group Mean

$$\bar{X} = \frac{\sum_{i=1}^{k} f_i m_i}{N} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where f_i = number of cases in the i^{th} category

m_i = mid-point of i^{th} category

k = number of categories,

N = number of cases, and

$\bar{X}$=mean

(b) Standard Deviation

$$S = \sqrt{\frac{\sum_{i=1} f_i x_i^2}{N}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where f_i = number of cases

k = number of intervals

X_i = mid-point of class

N= number of cases

S = standard deviation

The **Sex Ratio**[1] is expressed as:

$$\frac{\text{No. of Males in Group i}}{\text{No. of Females in Group i}} \times 100 \quad \ldots\ldots\ldots\ldots \quad (1)$$

Population Projection Models:

The Exponential Growth Model[2] is given by:

$$P_n = P_o (1 + r)^n$$

[1] *Ibid.*
[2] *Ibid.*

……(2)

Where:

P_n= Population after n years

P_o= Base population

a = Growth rate

Fig 4.21 shows among others, that five major units of analysis (or levels of aggregation) were employed to describe both empirical and secondary data: national; state; community; household; and individual.

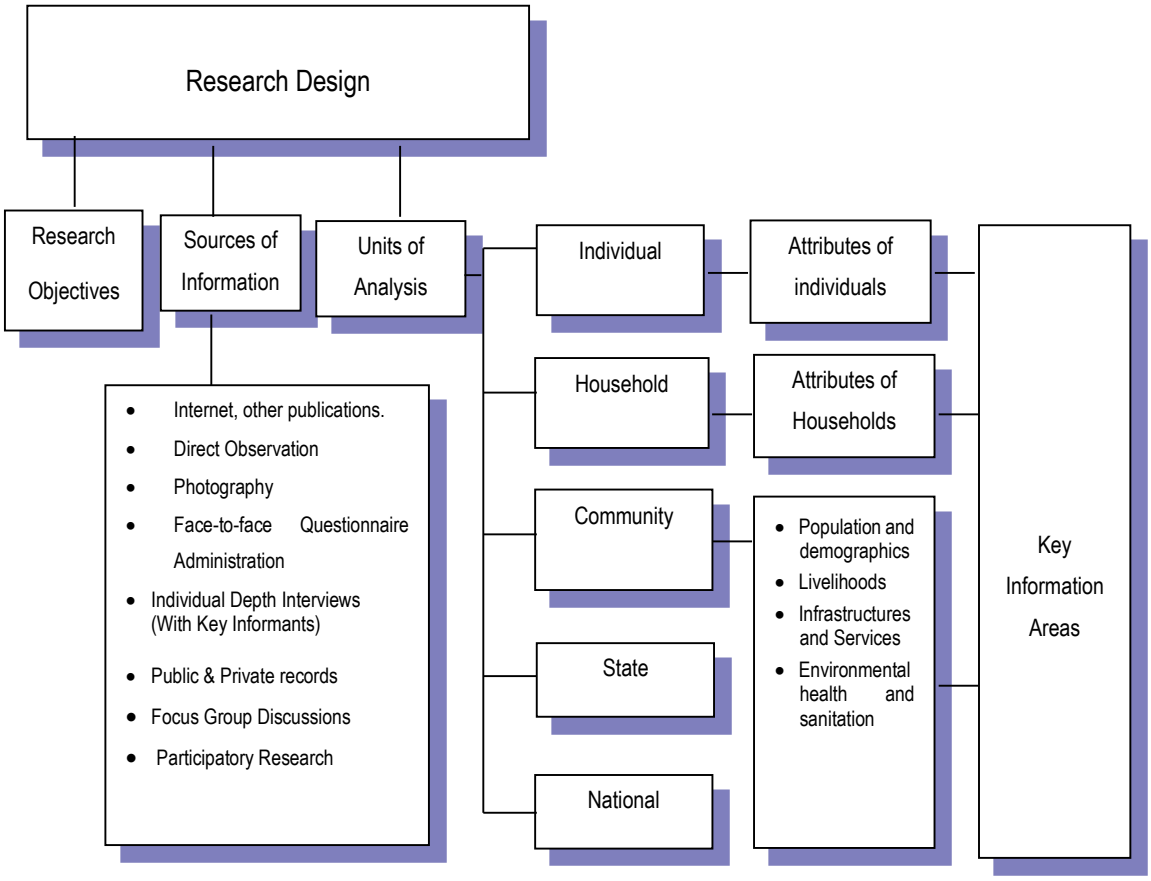


Figure 4. 21: Research and Analysis Strategy

4.11.2 Baseline Information on Socio-Economics

The Host Community (Central Business District)

Abuja's Central District, also called Central Area, spans from the foot of Aso Rock, across the Three Arms Zone, to the southern base of the inner ring road. It is like the city's spinal cord, dividing it into the northern sector with Maitama and Wuse, and the southern sector with Garki and Asokoro. While each district has its own clearly demarcated commercial and residential sectors, the Central District is the city's principal Business Zone, where practically all parastatals and multinational corporations have their offices. An attractive area in the Central District is the region known as the Three Arms Zone, so called because it houses the administrative offices of the executive, legislative and judicial arms of the federal government. A few of the other sites worth seeing in the area are the Federal secretariats alongside Shehu Shagari Way, Aso Hill, the Abuja Plant Nursery, Eagle Square (which has important historic significance, as it was in this grounds that the present democratic dispensation had its origin on 29 May 1999) and the Tomb of the Unknown Soldier across the road facing it. The National Mosque and National Church of Nigeria are opposite each other on either side of Independence Avenue. A well-known government office is the Ministry of Defense, colloquially nicknamed "Ship House".

Affected Communities and People

Prior to the designation of Abuja as the Federal Capital City in 1991, the project location was settlers with the Gbayi language dominating the area (FCDA, 2018) which gave the room to the high influx of people with different ethnic groups. Virtually all the affected communities surveyed have mixed ethnic inclinations with the community leaders' Gbagys as the indigenes. The major occupation of these indigenes is farming. The Gbagyi people are known to be peace-loving, transparent and accommodating people. In addition the Gbagyi people have emerged as a unique.

Other ethnic groups in the territory include the Bassas, Gades, Gwandaras, Koros and Ganaganas, all of which have strong linguistic affiliations with the Kwa language group that dominated the present middle belt region of northern Nigeria. Following the influx of people post 1991 and relocation of the Federal Government of Nigeria Administrative headquarters to Abuja, there has been a massive growth in the population within the city and a displacement of the indigenous settlers to suburban and rural districts within the Federal Capital Territory (FCT). Growth rate within the city centre is projected to be 3.5% (Abuja facts, 2017) and population

surged in a geometric progression with figures around the metropolis estimated to be circa 6 million people (Jaiyeola, 2016 and FTAN, 2020).

The Central Cadastral Area Zone (CCAZ) is managed by the Abuja Municipal Area Council (AMAC) and among the ten (10) cadastral zones in the phase 1 developments efforts by the FCDA. The CCAZ is the Abuja City's principal business hub and hosts Federal Government Ministries and Parastatals, Multinational Corporations, State Government Liaison offices and the three Arms Zone (administrative offices of the executive, legislative and judicial arms of the federal government).

4.11.3 Traditional Governance

The people of the present Abuja were administered as autonomous kingdoms with diverse inter-ethnic and political setting. The political and administrative setting of the area was based on native authority (NA) institution, where emirs were heads of the administrative and judicial hierarchy. The emirate was further broken into districts headed by district heads and village heads. Today traditional rulers are placed under the Area Council chairman.

4.11.4 Demographic Characteristics

In Abuja, there are other ethnic group such as Igbo, Hausa, Yoruba, Igala, Idoma and other small minority ethnic groups living and carrying out economic activities. English is the common language.

(a) Population

By the 2006 population census, Abuja has a population of 1,405,201. The demographic features of the population show that the population of people under the age of 35 is 70.6% of the total population. This shows high rate of youths to adult in the state. However, an exponential growth model was employed to project the present-day population estimates using two average annual growth rates of 3.5% and 5.0% illustrates the population dynamics to 2030. In view of the massive influx of people to the CCAZ for Job hunts, private and government businesses, population figures are estimated to be around 1,206,546 (3.2%) and 1,563,272 (5.0%) annually. Details of the population projections using Exponential Growth Model with Average Annual Growth Scenarios of 3.5% and 5.0% are presented in Table 4.20 and Fig 4.21.The populations of the host Area Council is presented in Table 4.19 below.

Table 4. 19: Population of the Host Area Council in 2006 Census

LGA	Male	Female	Population
AMAC	422,133	356,434	778,567

Source: National Bureau of Statistics, 2006

Table 4. 20: Population Projections for the Study Locations using the Exponential Growth Model and Assumed Average Annual Growth Rates of 3.2% and 5.0%

LGA	1991 population	2006 population	2020 projection		2030 projection	
			3.2%	5.0%	3.2%	5.0%
AMAC	226,949	776,298	1206546	1563272	1673272	2577400

Source: National Population Census 1991, 2006

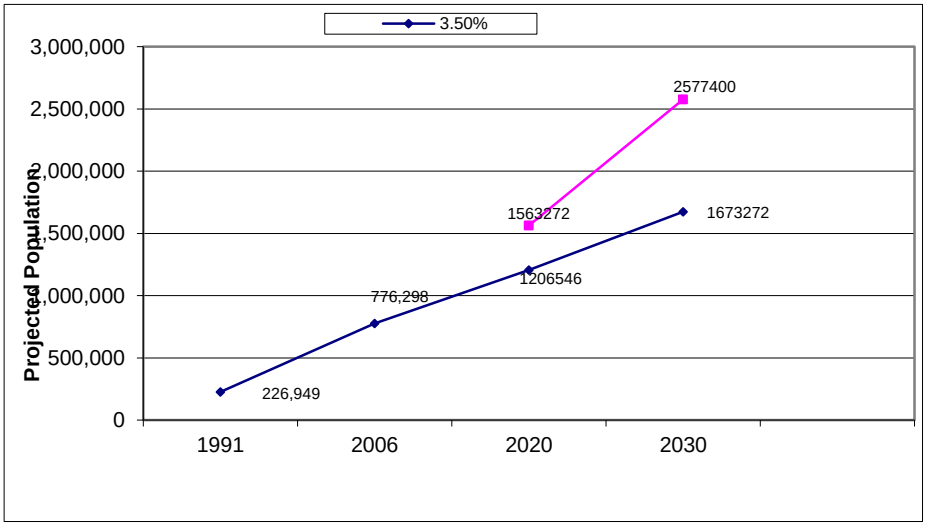


Figure 4. 22: Projected Populations of the Study Area for 39 years (1991 – 2030) using Exponential Growth Model with Average Annual Growth Scenarios of 3.5% and 5.0%

Population Structure of the Study Area

Population structure according to Palmer and Gardner (1983) is characterised with reference to two main attributes: The age-sex distribution and demographic ratios (the sex and dependency ratios). Computations from the age-sex pyramids showed a predominant population of the working group (31-40 and 41-50 years old). These age group represented >80% of the population around the four designated locations (Access through undeveloped road (4th Street) between

Federal Ministry of Finance building and Africa Re-Insurance Corporation property off Ralph Shodeinde street; Ralph Shodeinde Junction along Sani Abacha way; Labour road Junction along Sani Abacha way and Ralph Shodeinde intersection along Ahmadu Bello way) within a 2.5km of the project site censored.

The influx of population was domiciled around the labour house and Ralph Shodeinde street. This further lends credence to the high population of working group (31-40 and 41-50 years old) due to the location of Federal Ministry of Finance, State Government Liaison offices (Yobe Development House, Katsina State, Edo State, Plateau state, Imo State and Plateau state), Jaiz Bank, Korea Cultural Center and other Federal Government Parastatals.

Furthermore, the female population were the most dominant gender within the proposed project location with estimated 2:1 ratio. This data compared favourably with NPC national averages for age-sex distribution (NPC, 2011). The dominance of the female gender maybe attributed to increased gender-based advocacy conversations by Non-Governmental Organizations (NGOs), Government based agencies and the foremost need to support family finances.

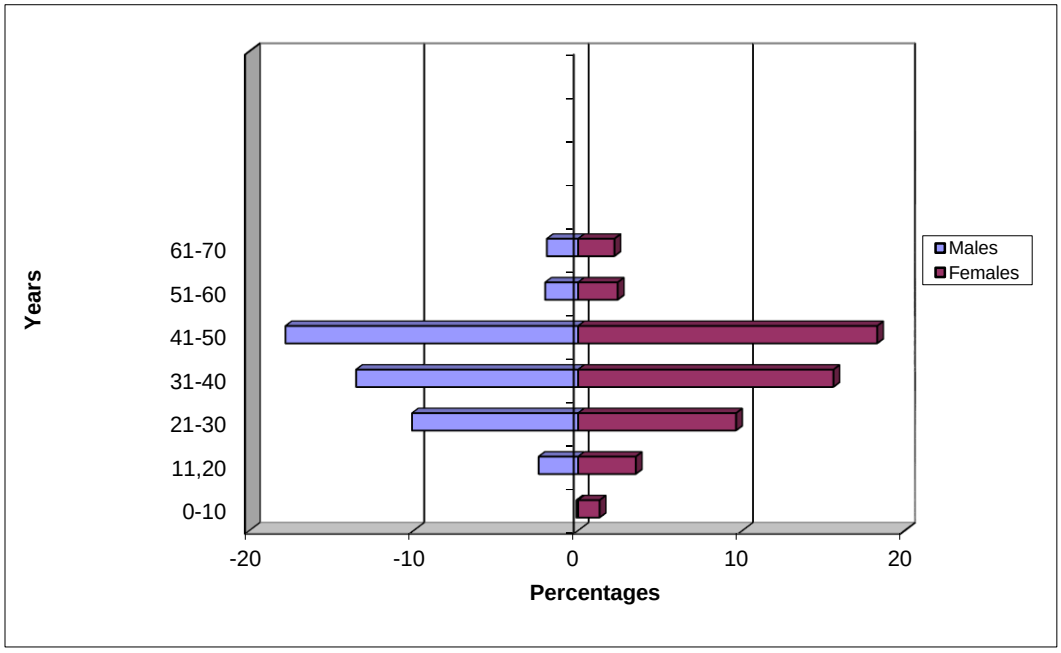


Figure 4. 23: Age – sex distribution within the proposed project location

The size of the population is such that, majority of people found in this community are neither residents nor indigenes, nevertheless our study indicated that the population varies, this is because there are more of commercial buildings and office complexes than residential, which

implies that during the workdays the population is high, but by weekend or holidays the population is fewer. Therefore, the population of people who comes to engage in productive activities on a daily bases are put at 70% while the resident of the community is 30% of the entire population of the area. The population of Abuja Municipal Area Council is 776,298 according to the 2006 national Census with growth rate of 2.7 per annum.

Demographic characteristics of the Study Area

Abuja was planned as a capital where all Nigeria's ethnic groups, tribes and religions would come together in harmony. The population of AMAC includes the Afo, Fulani, Gwari, Hausa, Koro, Ganagana, Gwandara and Bassa ethnic groups. English is the official language. Other languages spoken in the study area include Hausa, Yoruba, Igbo and Fulani. Muslims make up 50 percent of the population, Christians 40 percent while the remainder adheres to indigenous beliefs.

Gender and Age Distribution

Percentage distribution shows 57.20% for male and 42.80% for their female counterpart. Age distribution shows that children of age <1 – 15 years constitute about 20% of the population mostly children who live and school in the study area. Those between 16 – 30 years constitute about 30%. Age 30 years and above constitute about 50% of the population. This distribution represents the age bracket of people who either work, school, live or carryout businesses in the study area.

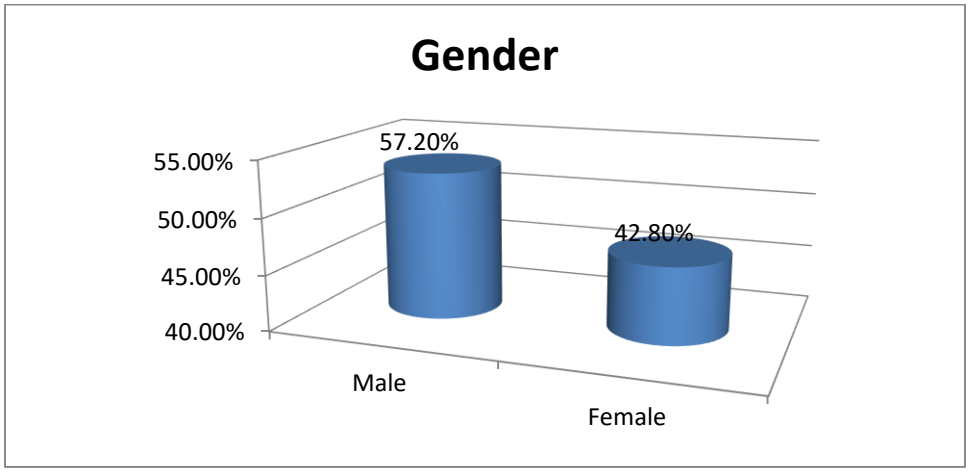


Figure 4. 24: Population Distribution of Respondents according to Gender

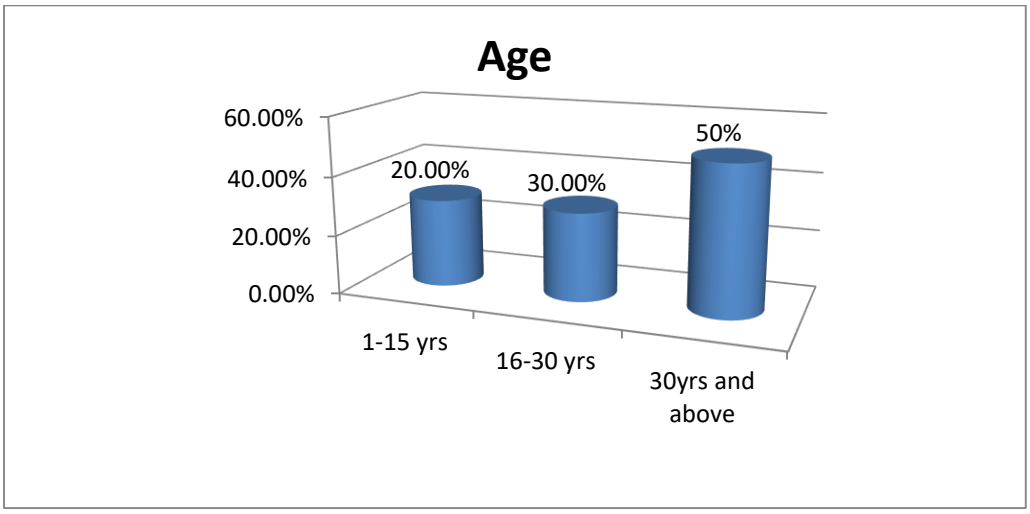


Figure 4. 25: Population Distribution of people according to Age

4.11.5 Household Characteristics and Size

Occupation and Income

The data from respondents revealed the dominance of the civil service workforce comprising 49.6% of the total respondents, 40% of private businesses and 10.4% of small-scale businesses supporting these institutions. Government agencies/parastatals employ a significant percentage of respondents around the CCZA and this is ascribable to the Federal Ministry of Finance, Yobe Development House, Katsina State Government Liaison office, Edo State Government Liaison office, Plateau state Government Liaison office, Imo State Government Liaison office, Oyo State Liaison office and Plateau State Government Liaison office.

Table 4. 21: Occupation distribution of censored respondents

	Employment status	**N**	**%**
1.	Civil Service (Federal Ministry of Finance, State Government liaison offices, etc.)	248	49.6
2.	Private businesses (Banks, Telecommunications etc)	200	40
3.	Small scale businesses (Food, Clothes, water vendors)	52	10.4
	Total	**500**	**100**

Income is an important variable that influences socio-economic status of individuals and its distribution pattern has the potential of influencing other demographic variables.

Information from respondents revealed the annual modal income profile was NGN 80,000 – NGN 89,000 comprising 26% of the total respondents. The high economic profile of the CCZA and dominance of businesses and government parastatals/agencies is a reflection of the earnings of

paid workforce around the project area. Similarly, the Federal Government minimum wage benchmark corroborates with the income profile of respondents around the project area and preponderance of middle-class workforce. The low-income profile at the bottom of the income pyramid within the minimum wage benchmark were generally attributed to small scale food vendors supporting businesses and governmental parastatals/agencies.

Table 4. 22: Income profile of the project area

S/No	Income Category (NGN)	Income Mid-point (NGN)	Frequency	%
1	Less than 10,000	5,000	0	0
2	10,000 – 19,000	15,000	0	0
3	20,000 – 29,000	25,000	10	2
4	30,000 – 39,000	35,000	100	20
5	40,000 – 49,000	45,000	100	20
6	50,000 – 59,000	55,000	80	16
7	60,000 – 69,000	65,000	10	2
8	70,000 – 79,000	75,000	20	4
9	80,000 – 89,000	85,000	130	26
10	90,000 – 99,000	95,000	10	2
11	100,000 and above	>105000	40	8
	Total		**500**	**100**

Plate 4. 11: Labour house building beside the proposed project site

Plate 4. 12: Federal Ministry of Finance Headquarters adjacent to the proposed project site

Plate 4. 13: Small scale food vendors along Labour house road

Source: Field Survey, 2020

Household expenditure

Respondents were asked to rank eight items in their monthly expenditure in their order of importance. Food had the highest respondents representing 31.6% was ranked 1st.This was followed by healthcare representing 28.1%, was ranked 2nd. Other items are clothing, accommodation; education, transportation, household maintenance, and energy were ranked 3rd, 4th, 5th and 6th 7th and8threspectively. Energy, household maintenance and transportation were identified as the least in the domestic priority list of household expenditures. The chart below represents this analysis.

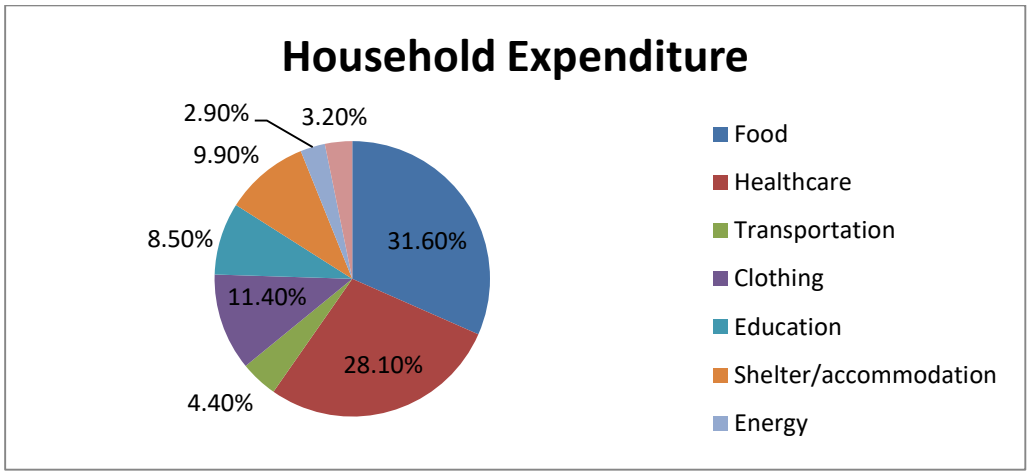


Figure 4. 26: Distribution of Household Expenses according to Respondents

4.11.6 Land Ownership

Land ownership within the Central Cadastral Zone Area (CCZA) is procured from the public/government (Federal Capital Development Authority) and private purchase. Land acquisition by the FCDA is allocated by the Honourable Minister of the Federal Capital Territory (FCT) with the Abuja Geographic Information System (AGIS) acting as the administrators of the process. AGIS has the power to either grant or refuse your application. Private landed properties are allocated and registered to a private individual or organization. Furthermore, land purchase can be considered under government acquisition and others government committed. Government acquisition land is acquired by government for future use. As these lands are not “committed”, purchase can be initiated through the AGIS (Villaafrika, 2020).

4.11.7 Educational Attainment

The gender distribution of educational attainment from the data analysed showed that the modal education category for male and female was ‘’Tertiary completed’’ comprising 44.6 and 50.7% respectively of the total respondents. Followed closely, is the ‘secondary completed’ totalling about 17.9% and 16.3% of the male and female respondents respectively. The educational attainment computation further lends credence to the high population of the female gender within the working group around the project location. The number of businesses, government offices and Banks around the labour house and Ralph Shodeinde street further corroborates this assertion. The least represented were those with no formal education and dominated the lowest section of the education pyramids within the proposed project location. This group dominated the

small-scale businesses comprising local food, potable water and fabric vendors. Details of the gender distribution of educational attainment in presented in Table 4.23.

Table 4. 23: Gender Distribution of Educational Attainment around the study area

S/N	Education Attained	Project location			
		Male		Female	
		N	%	N	%
1	No Formal Education	4	1.79	12	4.35
2	Pre-Primary	10	4.46	10	3.62
3	Primary (Uncompleted)	10	4.46	10	3.62
4	Primary (Completed)	25	11.16	28	10.14
5	Secondary (Uncompleted)	10	4.46	11	3.99
6	Secondary (Completed)	40	17.86	45	16.3
7	Tertiary (Uncompleted)	20	8.93	15	5.43
8	Tertiary (Completed)	100	44.64	140	50.72
9	Not Ascertained	5	2.23	5	1.81
Total		224	100	276	100

4.11.8 Employment Status

The employment distribution of censored respondents is detailed in Table 6.24. The modal status revealed about 77.3% and 71.4% of male and female respondents were gainfully employed in business around the Labour house and private and government establishments around Ralph Shodeinde Street. A high female population was censored (n=280) and further lends credence to the age-sex distribution of the study area and the high business activity of the Central Cadastral Zone Area (CCZA). The construction phase of the AFREXIM Trade centre will further drive the employment status upwards with influx of skilled workers to the project site. However, the unemployment rate was at variance with the national average unemployment rate of 33.5% (NBS, 2020). This may be attributed to the high business activity around the project area.

Table 4. 24: Employment distribution of censored respondents

S/No	Employment Status	Gender			
		Male		Female	
		N	%	N	%
1.	Employed	170	77.3	200	71.4
2.	Unemployed	50	22.7	70	25
3.	Retired	0	0	10	3.6

	Total	220	100	280	100

4.11.9 Religion affiliations

The Muslim population dominated the religious groups within the study area with percentage composition of 54% of all respondents. Followed closely was the Christian denomination comprising 44% of the total population interviewed. The proximity of the Abuja National Mosque and worship centres within the premises of Government agencies/parastatals and the timing of the field survey (Friday) may be attributed to the high Muslim followership and sampling. The National Christian Centre (NCC), along Sani Abacha Way also supports high population of Christian gatherings on special scheduled events around the proposed project location. In-service Christian fellowships are also a common occurrence within business premises.

Table 4. 25: Religious affiliations of respondents within the proposed project area

	Religious affiliations	**N**	**%**
1.	Christians	220	44
2.	Muslims	270	54
3.	Others	10	2
	Total	**500**	**100**

4.11.10 Social Amenities

These include transportation, water supply, electricity and telecommunication, in the project area.

(a) Transportation Infrastructure

There are good road networks in AMAC, making transportation less difficult. The major means of transportation is by cars. Majority of the people own private cars, some individuals use public transport especially those coming into the community for business transaction. People using private cars are put at 65% while 25% for people who take public transport system (Fig 4.26). Access to the project area is adorned with good city road network consisting of interconnected paved carriageways designed to carry buses, cars, articulate vehicles and accommodate pedestrian traffic (Plates 4.13 and 4.14). The road network facilitates easy connectivity to the Three Arms Zone, Federal Secretariat, Garki, Wuse, another adjoining parts of the city centre and suburban settlements within the Federal Capital Territory (FCT). The road systems also have monitoring system used to manage traffic such as intersection controls with traffic lights and Road Information Panels (DIPS) and Speed breakers. Road network with prevalent traffic exposure include:

- Ahmadu Bello Way/Ralph Shodeinde street;
- Ahmadu Bello Way/Independence Avenue;
- Independence Avenue/Sani Abacha Way and
- Sani Abacha Way/Ralph Shodeinde Street.

Details of road intersections and networks are detailed out in the Traffic Impact Assessment Report contained in the Traffic Impact Analysis in Appendix F

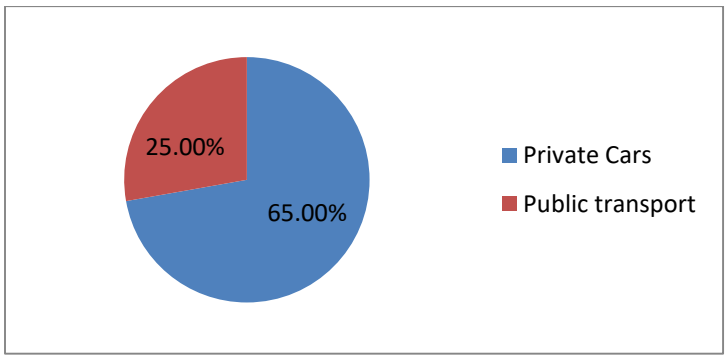


Figure 4. 27: Means of Transportation within AMAC

Plate 4. 14: Sani Abacha Way showing Pedestrian pavements

Source: Adopted from TIA survey, 2020.

Plate 4. 15: Ralph Shodeinde interception with Traffic control and monitoring system

Source: Adopted from TIA survey, 2020.

(b) Water Supply

Major source of water in the study area is from FCT water board, boreholes and vendors. The percentage is summarized as follows;

- Water supply by individual boreholes 20%
- Water supply by FCT water board 70%
- Water supply by water vendors 10%

(c) Energy infrastructure

The project area has a robust energy infrastructure managed by the Abuja Electricity Distribution Company (AEDC). The substations and distribution lines are connected to the National grid and supply businesses at the Labour house, Federal Ministry of Finance Headquarters, Yobe Development House, State liaison offices, Jiaz bank and other businesses around the Ralph Shodeinde street; Ahmadu Bello Way; Independence Avenue; Sani Abacha Way. Information from 70% of respondents interviewed suggests power provision is relatively stable and scheduled maintenance activities are conducted on AEDC infrastructure. The B33 Injection substation including transformers supports electricity management around the Central Cadastral Zone Area.

Plate 4. 16: AEDC Distribution lines along the Labour house road

Source: Adopted from TIA survey, 2020.

(d) Communication

The means of communication in the study area are radio and television broadcasting, General System of Mobile Telephony, letters, personal contact and community development association, and traditional ruler-ship having meetings from time to time. Official communication between government and the led; that is, memo, letters and organizing meetings

4.11.11 Security and violent Crime

It was gathered, that the security of the place is guaranteed. The type of crime prevalent in the community are pick-pocketing and armed robbery. Police stations and police post are seen at strategic places to curb crime. Hence, Police anti-robbery squad and patrol teams, patrol day and night to ensure security of lives and properties.

Neighbourhood Crime/Security Situation Compared to One Year Ago

More than half (55.8%) of the respondents in the Study area said that the crime/security situation had improved compared to one year ago. 44.2% of respondents signified no improvement.

Opinion on how Improved Communication can Promote Social Cohesion and Increased Security in the Study area

Respondents were asked to express their opinion on how they feel improvement information flow and communications service delivery can impact on social cohesion, reduction in crime rate, reduction in unemployment rate and promote economic emancipation. Table 6.23 summarizes their responses.

Table 4. 26: Opinion on how to improved communications service delivery can promote social cohesion and security

Response	% of respondents who feel improvement in communications can promote social cohesion	% of respondents who feel improvement in communications can reduce crime	% of respondents who feel improvement in communications can lead to economic emancipation	% of respondents who feel improvement in communications can reduce youth unemployment
Yes	45.5	7.9	26.3	28.5
No	56	87.3	69.5	70.1
Do not know	1.5	4.8	4.2	1.4
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**

Police Presence in Host Community and Response to Distress Call

Respondents were additionally required to indicate Police presence in the study area and knowledge of the telephone number of the Divisional Police Officer (DPO) of the area they reside. 34.6% and 50.5% of respondents indicated the presence of Police station and knowledge of Police Chief's phone number (Figure 6.27).

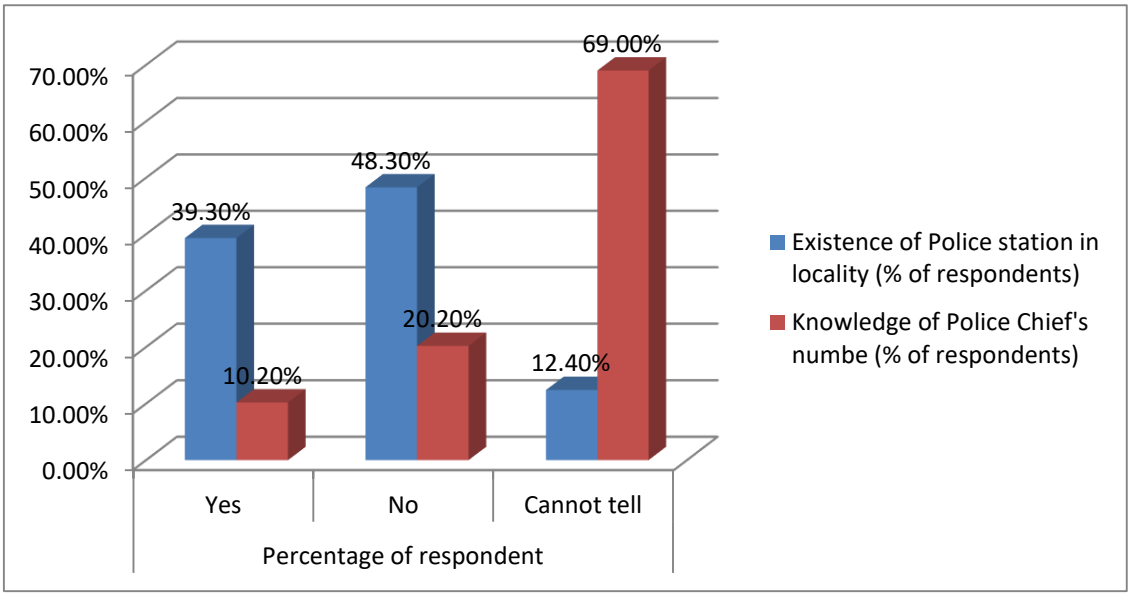


Figure 4. 28: Existence of Police station and knowledge of Police Chief's number in host community

4.12 Traffic Impact Assessment

Seven critical traffic hotspots were identified during the traffic assessment within 2.5km spatial boundary of the proposed project area. These hotspots provided clarity around envisaged volume of traffic through the project lifecycle. On the spot assessment showed high vehicular movements around:

- Ahmadu Bello way to the East of the project
- Independence Avenue to the North of the project
- Ralph Shodeinde Street to the South of the project
- Sani Abacha Way to the West of the project
- Labour Road to the East (current access to the site)
- Ralph Shodeinde intersection along Amadu Bello way
- Ralph Shodeinde Junction along Sani Abacha way

Traffic volume around some designated hotspots within the spatial area of the proposed project location is highlighted in Table 4.24 to Table 4.26. Detailed study outcome of assessments is presented in Appendix F.

Table 4. 27: Vehicle Count along Independence Avenue

Period	Time	Saloon car	SUV	Bus	Truck	Motorcycle	Total
A (am)	6:00-8:00	693	157	46	9	19	924
B(am)	8:00-12:00	2477	562	165	33	66	3303
C(pm)	12:00-4:00	3642	826	243	49	97	4857
D(pm)	4:00-6:00	2732	619	182	36	73	3642

Source: TIA Field survey, 2020

Table 4. 28: Vehicle Count along Sani Abacha Way

Period	Time	Saloon car	SUV	Bus	Truck	Motorcycle	Total
A (am)	6:00-8:00	298	67	20	4	8	397
B(am)	8:00-12:00	1629	369	108	22	43	2171
C(pm)	12:00-4:00	2580	584	172	34	68	3438
D(pm)	4:00-6:00	1935	439	129	26	51	2580

Source: Source: TIA Field survey, 2020

Table 4. 29: Traffic flow from Ralph Shodeinde Street into Ahmadu Bello way

Period	Time	Saloon car	SUV	Bus	Truck	Motorcycle	Total
A (am)	6:00-8:00	70	16	23	7	-	116
B(am)	8:00-12:00	598	155	71	23	3	850
C(pm)	12:00-4:00	1262	305	83	26	5	1681

D(pm)	4:00-6:00	92	16	13	5	1	127

Source: TIA Field survey, 2020

Plate 4. 17: Ralph Shodeinde Street

Source: TIA Field survey, 2020

Plate 4. 18: Independence Avenue road

Source: TIA Field survey, 2020

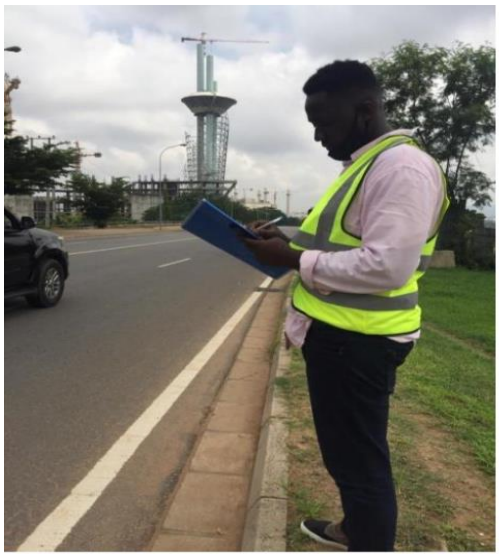



Plate 4. 19: Traffic count assessments at designated hotspots within the CCZA

Source: TIA Field survey, 2020

4.12.1 Road Safety

Road visibility in Abuja is clear, most times of the year. Project visibility will be high if access is by Independence Avenue. Project visibility will be low if access is by Ralph Shodeinde Street and Labour Road. Turning at Ralph Shodeinde Street into the site will have issue due to the presence of AEDC installations. The installations tend to narrow the access, except, if they are decommissioned and removed by AEDC. Application to achieve decommissioning has to be raised to AEDC. Also application to access the site through Independence Avenue has to be raised to Minister of FCT.

No accident data was made available to the study team by the road safety authority, within the vicinity of the project environment.

Plate 4. 20: AEDC installations along 4th Street, off Ralph Shodeinde Street

Public Transport Facilities: There is no limited modal shift anticipated from private car to public transport. The development will however have no impact on public transport within the project area. No future transportation network envisaged because the site location is fully built.

Queues: Queues are virtually non-existence along Abacha Way and Independence Avenue. It is mild at Ralph Shodeinde and Ahmadu Bello Way as a result of traffic control lights that stop vehicles for an average of 90 seconds. Hold up is envisaged on the 4th street during construction and operation.

Pedestrians and Cyclist: Pedestrian facilities are currently provided along Ahmadu Bello and Ralph Shodeinde. No such at Independence Avenue and Abacha Way. No provision for cyclist with the project environment.

Access for People with Disabilities: It is recommended that markings be made at all internal crossing point within the project environment.

4.12.2 Proposed Road Improvement and Development

The project proposed to be developed by AFREXIMBank on plot A00/1573, along Labour road, CBD, a 5,865m^2 land requires access road suitable enough to carry large traffic. Thus, the capacity of Labour road may not be accommodating. In this regard, there is need for the upgrade of Labour road. Currently, the road has no allowance for provision of road shoulder and pavement for pedestrian and cyclist movement, also does not have drainage facility provided to drain storm water. During construction, daily movement of heavy vehicle on this road may cause cracks; also, during operation, traffic that will be generated by the project will cause slow movement of vehicle along the road. Alternatively, 4th Street can be developed to accommodate the impending traffic of the proposed project. This street which can be developed to link Ralph Shodeinde street to Independence Avenue shall allow access to the project site from two directions; thereby, easing traffic while accessing the project during construction and operation phases.

4.12.3 Traffic Growth

Future Traffic Volume

Future traffic volume mainly increases on the peak hour time. Except this peak hour traffic volume remain same to the previous. Mainly morning peak hour intersection in traffic volume

increases but in the morning peak hour intersection out traffic volume remains same as it is before. Alternate situation occurs at the afternoon peak hour time intersection out traffic volume increase but intersection in traffic volume remains same as it is before. Now gives the future increasing traffic volume morning intersection in and afternoon intersection out traffic volume.

Table 4. 30: Morning peak hour intersection in future traffic volume

Intersection				
Road	**Current Volume**	**Added Volume during operation**	**Total expected Volume during operation**	**Road Capacity**
Ahmadu Bello way and Ralph	1096	300	1396	3000-3500
Sani Abacha way and Independence	3274	400	3674	4000-4500
Ahmadu Bello way and Independence	2807	500	3307	3000-3500
Sani Abacha way and Labour road	1226	350	1576	1500-2000

Table 4. 31: Afternoon peak hour intersection in future traffic volume

Intersection				
Road	**Current Volume**	**Added Volume during operation**	**Total expected Volume during operation**	**Road Capacity**
Ahmadu Bello way and Ralph	2434	450	2884	3000-3500
Sani Abacha way and Independence	2104	500	2604	4000-4500
Ahmadu Bello way and Independence	1736	400	2136	3000-3500
Sani Abacha way and Labour road	805	250	1255	1500-2000

From these two tables it can be seen that the future traffic volume cannot exceed the capacity of these four roads. Here, new volume is much low compared to this new volume's PCU which cannot exceed the road capacity's PCU, as the road capacity's PCU is so much high. So there is no impact on traffic if the proposed project commences operation.

4.13 Sanitation and Waste Disposal

In AMAC, majority of the people have their houses connected to central sewer line. Few people maintained soak away pits in their houses. No pit toilet in the study area. The AEPB waste bins are placed in strategic places for proper waste collection. 90% of the buildings in the study area are connected to the central sewer line, while about 20% uses soak away system.

Solid Waste disposal in the study area is handled by Abuja Environmental Protection Board, some persons recycle/reuse their waste. The Abuja Environmental Protection Board provides an organized evacuation of solid wastes around the Labour house, Ralph Shodeinde street and Sani Abacha way. The AEPB conducts a biweekly evacuation of solid waste streams using approved waste bins placed designated spots close to business premises and government agencies/parastatals. Waste streams are managed from cradle to grave through the 4Rs of effective solid waste management. Unsegregated waste bin identified around the Labour house is presented in Plate 6.20.

Plate 4. 21: Waste bins provided by the Abuja Environmental Protection Board identified around the Labour house building

4.14 Health Impact Assessment

Health Facilities

There are both public and private health hospitals in the community. Many people have access to medical facilities based on the level of their income. In the study area, AMAC has primary health care system in place at the area Council and in the various wards of the area council. There is the National Hospital and a host of other private hospitals in the area. The National Hospital Abuja is the closest tertiary facility to the proposed project location. The hospital is a 200 in-patient bed

space hospital supporting family medicine, Obsteristics and Gynecology, Surgery, Oncology, Paediatrics and Dental health. The tertiary facility is open to the general public, and private patients for different health interventions.

Plate 4. 22: National Hospital Abuja complex within the CCZA

4.14.1 Morbidity pattern

Data from respondents interviewed revealed the common cold, stress, malaria, typhoid and injuries were the leading causes of adult morbidity within the Central Cadastral Zone Area (CCZA). Fever is a major manifestation of malaria and other acute infections. Malaria contributes to high levels of malnutrition and mortality in young children and Adults. Malaria is more prevalent after the end of the rainy season (NDHS, 2018). Forty-four (44%) of adults within the age of 20 – 55 years old regularly had symptoms of these illnesses within a fortnight during the survey. Treatment was sought the same or next day for only 35% of the working population. Thirty percent of Adults with these common illnesses were taken to the National Hospital Abuja for treatment and while 70% were taken to a private sector chemist/patent medicine store (PMS) within the Labour house premises. The datasets obtained are generally consistent with National averages for the Federal Capital Territory Abuja (NDHS, 2018).

4.14.2 Mortality Pattern

Adult mortality indicators can be used to assess the health status of the population. Secondary data sources from hospital records identified 58% of Adult deaths per 1,000 population within the age of 30 to 60 years of age and dominated by the male population. Historical trends from records reveal since 2008, the probability of dying between exact ages 15 and 50 has improved among women, declining from 161 per 1,000 women in the 7 years before the 2008 NDHS to 117 per

1,000 women in the 7 years before 2018. Similarly, the probability among men decreased from 168 per 1,000 men in the 7 years before 2008 to 122 per 1,000 men in the 7 years before 2018 (NDHS, 2018). Common causes include but not limited to the following: Gastroenteritis, Car accidents, Respiratory illnesses and Cardiac related illnesses.

Patterns by background characteristics

- The prevalence of malaria and common cold were consistent with age. No significant variation between age groups.
- Interventions of these common illnesses were managed at Pharmacy stores and only a handful were managed at the National Hospital Abuja.

4.14.3 Prevalence of Non-communicable diseases

Non communicable diseases were generally prevalent among the working groups interviewed during the field survey. Sixty-five (65%) of total respondents recorded common NCDs which include: Cardiovascular diseases and Diabetes. NCDs were prevalent among the male population between the age of 45 to 50 years old compared to the female gender. Data showed females recorded about 70% of obese candidates interviewed. Increased blood pressure, overweight/obesity, and high blood glucose levels and family history were the leading risk factors documented during the field survey. No records of NCDs were obtained from young respondents between the age of 20 – 30 years. Primary data obtained from respondents compared favourably with National averages for the Federal Capital Territory (FCT).

4.14.4 Frequency of hospital visit

Data was also collected to ascertain the frequency of hospital visits in the study area. From the information obtained, 60% of the population visit the hospital on monthly basis, 8% visits always while 30% on weekly basis 2% do not visit hospital.

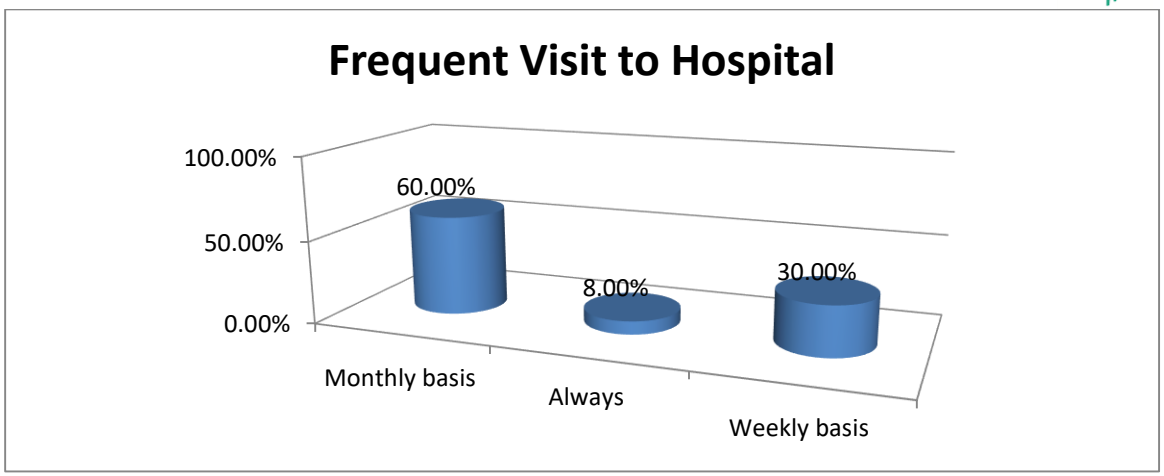


Figure 4. 29: Respondents Frequent Using of Healthcare Facility

4.14.5 Occurrence of Communicable and Non-Communicable Diseases

The occurrence of communicable and non-communicable diseases is summarized in Tables 4.28 and 4.29. For communicable diseases, malaria dominate the area while anaemia dominate the area for non-communicable diseases.

Table 4. 32: Occurrence of communicable diseases by age and sex (Abuja Municipal Area Council Primary Health Care)

Disease	<5 years			5-14 years			15-49years			50-64 years			≥65 years			Total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	
Malaria	4839	4101	8940	1840	1485	3492	2934	5103	7838	1188	2039	3479	168	287	455	24201
Diarrhea	263	184	447	11	7	18	29	33	62	11	11	22	34	28	62	611
Gastroenteritis	335	264	599	41	51	92	127	181	318	19	25	44	41	28	69	1122
Pneumonia	81	66	147	25	15	40	54	24	69	21	22	43	4	0	4	303
Tuberculosis	5	7	12	4	4	8	67	41	108	17	7	24	9	6	15	167
UTI	121	102	223	21	10	31	123	178	301	30	40	70	19	18	37	662
HIV/AIDS	2	5	7	2	0	2	17	20	27	0	1	1	5	4	9	46
Measles	149	116	165	27	37	64	12	13	25	0	0	0	0	0	0	354
URTI	1297	1115	2412	241	233	446	446	621	1067	90	158	248	51	64	115	
Cellulites	58	63	212	69	56	125	89	111	200	33	42	75	17	29	46	567
Conjunctivitis	103	93	196	94	104	198	312	389	701	154	206	360	98	107	205	1660
Skin disease	157	210	467	145	139	284	175	238	413	59	91	150	36	29	65	1379

Source: National Bureau of Statistics, Directory of Health Establishment in Nigeria, 2015

Table 4. 33: Occurrence of non-communicable diseases by age and sex (Abuja Municipal Area Council Primary Health Care)

Disease	<5 years			5-14 years			15-49years			50-64 years			≥65 years			Total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	
Anemia	59	46	105	7	4	11	1	17	18	2	3	5	9	12	21	160
Peptic ulcer	3	3	6	18	20	38	288	549	820	101	131	232	72	103	175	1271
Hypertension	0	0	0	0	0	0	24	43	67	51	71	122	13	33	46	232
Asthma	1	2	3	2	5	7	50	54	104	26	58	84	18	32	50	248
Diabetes	0	0	0	1	0	1	13	19	31	29	26	55	9	14	23	110

Source: National Bureau of Statistics, Directory of Health Establishment in Nigeria, 2015

Use of alcohol and tobacco

An estimated 32% of total respondent predominantly male admitted to the use of alcohol and tobacco and within the age group of 35 – 50 years old. The employment status of group were significantly employed suggesting economic power to purchase this substance. No records of other substance abuse such as cannabis, Tramadol and Cocaine were recorded. This maybe attributed to the cosmopolitan nature of the CCZA and prohibition of these substance at businesses premises and government agencies/parastatals. Alcoholic beverages common include Beers sold by small scale food vendors around the Labour house building and Ralph Shodeinde Street.

Knowledge of HIV/AIDS

Acquired immunodeficiency syndrome (AIDS) is one of the most serious public health and development challenges facing the world today. AIDS is caused by the human immunodeficiency virus (HIV) and weakens the immune system, making the body susceptible to secondary infections and opportunistic diseases (NDHS, 2018). 80% of the male and female respondents interviewed had comprehensive knowledge:

- About the modes of HIV transmission and prevention.
- Of mother-to-child transmission of HIV
- About safe sex

Vector/pest control

The following disease vectors were identified during the field study:

- Anopheles mosquito – the vector for malaria
- Culex mosquito – the vector for filariasis
- Aedes aegypti mosquitoes– the vector for yellow fever
- Sand flies (*Phlebotomus* spp.) – the vector for Leishmaniasis
- Housefly – carrier of enteric infections such dysentery, typhoid and diarrhea; and eye infections such as trachoma and epidemic conjunctivitis

Access to safe drinking water

Potable water within the CCZA is provided by the Federal Capital Territory Water Board with metered distribution water pipes connected to businesses premises and government offices. Bottled and sachet water sources are sold by small scale food vendors in kiosks along the Labour house building and Ralph Shodeinde Street. There is a functional water distribution channel metered within the premises of the proposed AFREXIM trade center.

A view of a metered Federal Capital Territory Water Board distribution line is presented in Plate 4.23

Plate 4. 23: A panoramic view of a metered Federal Capital Territory Water Board distribution line

Perceptions, Assessment and Expectations

The great support received by respondents is suggestive of the optimism of the AFREXIMBank Trade centre construction. An overwhelming 90% of respondents understood the possible

envisaged impacts of the early construction activities along the Labour house road and Ralph Shodeinde street and Sani Abacha way as these are recurring traffic hotspots within the area. Documented expectations from respondents include:

- Provision of job opportunities
- Local contracting opportunities
- Skill transfer during the construction phase

CHAPTER FIVE

5.0 ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACTS

Mixed use developmental projects have associated and potential impacts on the biophysical, Socio-Economic and health aspects of the environment. However, the potential environmental burdens depend on the size and nature of the project and are frequently site specific.

5.1 Associated and Potential Impact Assessment

The field survey determination of the associated and potential impacts of the AATC Abuja on the environment and Socio-Economic variables at Central Business District was carried out using Rau Ad-Hoc Method. This model, though subjective, but very useful in its applications indicates weighted impact values of beneficial (+) positive and adverse (—) negative impacts. It is possible to quickly decide the order of magnitude weight in such significance levels of no effect, problematic, duration — short term, long-term, reversible, and irreversible impacts.

The impacts of the proposed project are seen from the perspectives of effects related to vehicular traffic, air quality, noise level, visual landscape, socio-economics, construction waste management, water supply, runoff water, fauna and flora, and socio-economy.

The environmental impacts associated with the project have been identified by examining the ways in which the activities associated with the different components interact with the environment and its different components. In general, development projects such as the proposed project are usually associated with potential impacts on the bio geophysical, social and health components of the environment.

As indicated in Chapter One of this report, the objectives of the assessment are to identify and describe the potential environmental impacts associated with the proposed project activities, predict the likelihood and magnitudes of such impacts, evaluate the significance of changes likely to result from them, and thereafter proffer measures that will be taken to mitigate the predicted impacts.

The study was conducted in accordance with the provisions of Federal Ministry of Environment's EIA Guidelines on infrastructure and the provisions of Environmental Impact Assessment (EIA) Act No. 86 of 1992) mandating the preparation of an EIA for a project of this magnitude. The main objective of the EIA is to ensure that potential environmental impacts are recognized and addressed. The potential and associated impact assessment covers all stages of the project, from

site acquisition and preparation through construction operation to activities, decommissioning and closure.

In this Chapter of the Report, the likely impacts of the proposed project were identified and evaluated with due consideration to the construction and operation of the project vis-à-vis the current status of the project site environment. The environmental impacts associated with the project have been identified by examining the ways in which the activities associated with the different phases interact with the environment and its different components.

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

5.2 Environmental Components and Impact Indicators

In **Table 5.1**, some main components of the environment and potential impact indicators were identified. The components are those that the project activities are most likely to be impacted upon, while the indicators are the easily observable parameters that will indicate change/deviation, which could be used to monitor the various environmental components during the various phases of the project.

Table 5. 1: Environmental Components and Impacts Indicators

S/No	Environmental Components	Potential Impact Indicators
1.	Climate	Relative humidity, rainfall, temperature, wind speed, and direction
2.	Air Quality	Particulate matters, , CO, H_2S, NO_X, SO_X, CO_2
3.	Noise & Vibration	On-site & Off-site disturbance, noise related health problems, communication interference.
4	Flora and Fauna	Changes in original types, species diversity and general deviation from normal characteristics
5.	Water Quality	Solids, physico-chemical turbidity, salinity, chemical toxicity, and microbiological characteristics.
6	Ecological	Erosion, flooding, desert encroachment, etc.

S/No	Environmental Components	Potential Impact Indicators
7.	Socio-economics	Traffic, Population, security, income, settlement pattern, and infrastructure change. Access to communication facilities, Sense of place/well-being /aesthetic value, Level of income and financial flows, Opportunities for contracting and procurement, Opportunities for local and national employment, Access to transport, Respect for human rights, Promoting equal opportunities
8.	Health and Safety	Accidents, Exposure to nuisance (dust, noise, radiation, etc.), Level of disease vectors, Exposure to STIs/HIV/AIDS, Mortality rate, Morbidity rate, Physical activity, Hygiene, Exposure to commercial sex workers, Access to primary health care, Access to secondary health care, Access to traditional medicine, Access to emergency services

5.3 Impact Identification and Evaluation

The identification and evaluation of impacts associated with the project activities were based on a risk management process which involved in identification of project activities that may interact with the project environment, controls to reduce risk of impacts and monitoring the effectiveness of controls.

The key project activities of the proposed development were identified. The pathways (or events) that may cause impacts to the environment were determined, and their associated potential impacts listed. The risk of the impacts occurring was analysed by determining the consequence severity of the impacts and the likelihood of consequences being realized. The severity of the consequences was determined using a **Consequence Severity** and the likelihood of an impact resulting from a pathway was determined with a **Likelihood Ranking** and then the level of risk was determined using a **Risk Matrix** (**Table 5.2**).

To prevent or minimize the impacts, controls were placed on the pathways in this order of priority:

- Elimination of the activity.
- Substitution with a lower risk activity.
- Engineering solutions to reduce the impact of the event.
- Implementation of administrative procedures to control the activity.
- Clean up or remediation measures to mitigate impacts after an event.

To ensure a comprehensive evaluation, a variety of measures to identify and weigh likely impacts, were considered. These include:

- Overlaying project components on maps of existing conditions to identify potential impact areas and issues;
- Consultation with experts;
- Experience from similar projects;
- Published and unpublished documents that provided guidance on performing impact analysis, and the ESIA provisions of Nigerian's Environmental laws and regulations.
- The sensitivity / vulnerability of the ecosystem component;
- Knowledge of the possible interactions between the proposed project and the environment;
- Envisaged sustainability of the project environment;
- The economic value of the proposed project;
- Projected duration of the impact of each project activity on various environmental components.
- Knowledge of the proposed project activities, equipment types, layout of the project facilities;
- Peculiar observations and results of baseline studies of the study area;
- Checklist of project specific risks and hazards developed using professional judgment.

Table 5. 2: Consequence Severity, Likelihood Ranking & Risk Matrix

Consequence Severity Table		
Level		**Consequence (Hazard effect)**
1	Insignificant	No detectable impact to the existing environment, Minor Injury (e.g. bruising, abrasion)
2	Minor	Short term of localised impact, Injury requiring Medical attention or first aid
3	Moderate	Prolonged but recoverable impact on the environment and commercial industries, 3 Day Injury/Temporary disability
4	Major	Prolonged impact to the environment which may not be recoverable and threatens an ecological community, the conservation of species, Major Injury/Long Term Absence

Consequence Severity Table		
Level		**Consequence (Hazard effect)**
5.	Catastrophic	Non-recoverable change to existing environment leading to loss of endangered Species or creation of human health risk, Fatality/Permanent Disability.
Likelihood Ranking Table		
Level		**Likelihood (Probability)**
5	Almost certain	The incident is expected to occur most of the time (i.e. every time), Will invariably happen - could occur repeatedly
4	Likely	The incident will probably occur in most circumstances (i.e. regularly, weekly), Highly probable - could occur several times
3	Moderate	The incident should occur at some time (i.e. quarterly), Possible: Feasible - could occur sometime
2	Unlikely	The incident could occur at some time during the life of the project, Possible: Might Happen - unlikely though conceivable
1	Rare	The incident may occur only in exceptional circumstances and may never happen, Remote Possibility/Negligible

Table 5. 3: Assessment Matrix Table

		Severity				
Likelihood		Minor injuries/ not detectable	First Aid Injury/ short term	3 day injury temporary disability/ prolonged but recoverable impact	Major injury/Long term absence/ Prolong impacts	Fatality/ catastrophic
P	Remote possibility /rare	1	2	**3**	**4**	**5**
R	Might happen/ unlikely	2	4	**6**	**8**	**10**
O	Feasible/ moderate	3	**6**	**9**	**12**	**15**
B	Highly probable/ likely	4	**8**	**12**	**16**	**20**
A	Invariably happen/most certain	5	**10**	**15**	**20**	**25**
B	**Scale**					

I	+	0	Low	Moderate	High
L	**Decisions and nature of actions**				
I	**Rating**		**Definition**		
T	11-25	H	Unacceptable risk, action required, Risk reduction required – High priority, High Impact – Senior management involvement and planning needed.		
Y	6-10	M	Medium risk – action required so far as is reasonably practical, moderate impact – management responsibility should be specified		
	1-5	L	Low risk – no further action required, Low impact – managed by routine procedure		
	0	0	No impact – Neutral		
	+	+	Positive Impact		

To objectively screen those issues warranting consideration as potential impacts and to determine the likely significance of those impacts, general consequence criteria covering natural (physical and biotic) and Socio-Economic as well as health and safety components were developed. The results of the rating of the various impacts are summarized in **Table 5.11** and some briefly discussed below.

5.4 Positive Impacts

The development of this project shall have a number of significant positive impacts both locally and nationally.

5.4.1 Design phase

5.4.1.1 Creation of Employment and Business opportunities

The design phase of the project will create employment and business opportunities for various professionals/consultants who will be involved in the planning stages of the project. They will include: project managers, engineers, architects, building economists, land surveyors, environmentalists, economists, urban planners among others. These professionals may be employed directly in the project or be consultants whose services will be procured.

5.4.1.2 Generation of Income and Source for Government Revenue

Income generated from the consultancies and services undertaken will provide income which will be taxed and generate revenue for the Federal Capital Territory.

In addition, fees levied for the submission of plans to the authorities at Local and Federal levels for approval and application for services will generate revenue that is used to meet the various

governmental goals and objectives. These include AMAC, FCDA, AEPB and FMEnv amongst others. Additionally in order to operationalize the proposed project financial resources will have to be mobilized and these will be injected into the economy.

5.4.1.3 Environmental opportunities

The design phase of the project will also present opportunities for green / sustainable designing of the project, which support the minimization of environmental impacts whilst fortifying the project to achieve its intended objectives. It's at this stage that the opportunities which will enable the project achieve a sustainable development are discovered, explored and integrated into the project.

5.4.2 Construction phase

5.4.2.1 Employment Creation

Activities involved in the erection, maintenance and management of the proposed AATC Abuja will generate employment i.e. employees involved in the production, sale and transportation of the buildings materials, construction of the building, maintenance of the building and management (caretaker, domestic staff etc.). Security services, cleaning and waste collection are also some of the services that will benefit indirectly. Other employment opportunities that will be created will include for workers involved in the civil and interior works of construction such as engineers, masons, foremen, brick layers, machine operators, interior designers, electricians, masons etc.

5.4.2.2 Market for goods and services

In order to facilitate the construction activities, goods and services including raw materials, plumbing services, electrical fittings, transport landscaping and finishing. It therefore offers a market for these goods and services promoting the primary and secondary sectors involved in their procurement such as: quarrying and brick production; furniture and carpentry; glass production; plant and gardening; tarmac, asphalt and bitumen; chemicals; building contractors; electric fittings; plumbing fittings and water infrastructure, etc.

5.4.2.3 Population Increase

The influx of labour into the area and subsequent people / workers to service them or provide them with goods such as food will be another positive impact of the proposed project. This is taken as positive since the population increase if sustainable will create additional market for goods and services offered in the area, increase the amount of mobilized capital and also increase the social capital in the area.

5.4.2.4 Increase in Economic Activities and Revenue

The construction phase of the project will also increase the economic activities in the project area, and revenue for the government through taxes, through businesses that will be formed to service the increased population. These services include health, food and nutrition, transport and recreation that the workers taking part in the construction will require from time to time.

5.4.3 Operational phase

5.4.3.1 Increased Commercial Viability

The establishment of this project, the goods and services it will offer will increase the commercial viability of Abuja and Nigeria at large and will consequently increase the land values in the surrounding area due to the potential high returns after development. This will attract more high income investors into the Federal Capital territory as well as more middle income groups as settlers.

5.4.3.2 Creation of Employment Opportunities

The proposed project will create employment in three tiers, with the first being the staff that will be primarily involved in its implementation, supervision and maintenance. The second tier will be staff for the businesses that will formed in the commercial and retail area and those involved in these businesses supply and value chains. The third tier of employment creation will be for the people who will take the opportunities presented to service the increased population and the population's amenities. Through these three tiers the project will create employment for high level staff, middle level staff and low level staff in line with all development policies in the country. Also through the third tier and low level staff, the project will in advertently create jobs for locals since this has always been the case with projects of similar nature due to the fact that the locals are readily available and have the shortest access time to the site. It is also important to note that all these employees will be taxed and generates revenue for the government thereby contributing to more government implemented development projects.

5.4.3.3 Increased Accommodation

The project will also increase the amount and quality of housing available in Abuja through the residential component of this project. Housing is generally a challenge in the country mainly due to the high population growth rate therefore the project will contribute to solving this problem and in tandem with development policies of the country.

5.4.3.4 Increased Access to Goods, Services and Social Amenities

The commercial area of the project will increase access to quality goods and services that encompass those that will be provided by the shops, super market and businesses. Also the recreational facilities created by the project will increase both the social and health facilities of the project area, which is psychologically linked to human wellbeing and productivity. This will stimulate other economic activities linked to these services and goods on top of improving the quality of life that is linked this access of goods and services.

5.4.3.5 Increased Economic Activities and Government Revenue

The project will also increase the economic activities that will be carried in the area through those that will be primarily as a result of the project's internal and ancillary activities; its supply chain; its value chain, and those that will be formed as a result of the project to support its occupants. The latter includes businesses that may form around the project site such as shops, kiosks and transport. All these business activities will be taxed and generate revenue for the government in addition to providing a market for their supply and value chains.

5.4.3.6 Urban Development Stimulation

Together with other developments in the area (CBD) the AATC will lead to the way in turning the area into a world class urban area. This has benefits of increasing the quality of life and revenue generation from increased activities. It is predicted that the project will increase the viability of the area to develop more residential areas and commercial establishments since it will increase the market and labour available, and the socio economic status of FCT. This is together with other projects being carried out in the area such as: railway, ring roads etc.

5.4.3.7 Aesthetic Enhancements

The proposed project will result in beautification of the locality. This will include establishment and maintenance off lower beds and greenery belt. The design concept has been inspired by modern lifestyle expectation of space interacting with nature to produce lifestyle targets which uphold current quality of living.

5.4.3.8 Improved Roads

The improvement and development of the project's access road from the Ralph Shodeinde road will increase the amount and quality of roads in the area. This will improve access to the neighborhoods and commercial establishments lying in the western region of the project and therefore increase their business activities.

5.4.3.9 Population Increase

Due to labour influx and economic opportunities as a resultant of the project development, the population of the project area will be increased. This will be positive if the increase is sustainable on the basis of the opportunities and services available leading to the population being an increase inhuman and social capital as well as market for the various goods and services sold in the area.

5.4.3.10 Impetus to Improve Amenities and Services

An increase in population to the area will provide an impetus for the Abuja Municipal Area Council to improve the much needed amenities and infrastructure to the area. It will provide a stronger lobbing group. The influx will also provide an impetus to develop shared facilities and this will have the indirect effect of creating job opportunities in the area. Also, telecommunications companies will also be encouraged to extend their networks to the project areas as there will be a ready and capable market for their services.

5.4.4 Decommissioning phase

5.4.4.1 Creation of Employment and Business Opportunities

The decommissioning phase and its activities will create business for the contracting company that will be charged with pulling down the structure and transporting the resultant materials / debris. Additionally on shutdown moving companies will also benefit from being contracted to move equipment and materials from the different businesses and residential units in the project. All these income streams will be taxed and generate income for the government. Additionally the decommissioning activities will create employment and job opportunities for the different professionals involved in them. These include: engineers, demolition experts, landscaper and garners, foremen, supervisors, masons, truck drivers and crane operators amongst others.

5.4.4.2 Income Generation

Decommissioning the project will create recyclable materials and equipment such as: stones, bricks, metals, furniture, switchboards, pumps, etc. maybe sold for income albeit cheaper than new ones they will generate taxable income for the proponent.

5.4.4.3 Provision of Cheaper Building Materials

The decommission phase of the project will create recyclable building materials such as bricks, stones, metals, glass, wiring, furniture, electronics and water pumps, plumbing, etc. which at present market trends will be cheaper than new materials. This will thus provide cheaper building material for future projects strategically increasing the productivity of the purposes the

establishments in which they are used. It is also possible that the materials maybe donated and used for development projects (schools, hospitals, etc.) in much needed areas. This will assist in promoting development where its mostly needed and generally improve the quality of life in those areas and cumulatively in the country.

5.4.4.4 Environmental Conservation and Restoration

The recycling of the waste to be used as raw materials in other construction process reduces the demand for raw materials. This will in turn reduces the potential impact to the environment that would have been felt if the demand of the raw materials hadn't reduced. For instance leaving the land derelict and destroying the habitat as a result of mining activities.

5.5 Negative Impacts

5.5.1 Construction phase

5.5.1.1 Loss of Flora and Faunal Habitats

Vegetation has a great effect on the general and localized environment and normally can modify microclimate. Usually, the flora creates a good environment for habitats thus the two may go together more often than not. Inconsequence, de-vegetation during construction may result to negative effects on the fauna by creating a disturbance. The vegetation is important in as food and habitat for various animals. It also assists in maintaining the structure of the soil by holding the particles together. This enables the soil microorganisms to flourish as their habitat; the soil is stable, which allows the organisms easily convert the dead leaves and plans to humus which helps enrich the soil as well as preventing soil erosion. Converting the land area to a mostly built environment will minimize the natural process of the existing vegetation.

5.5.1.2 Changes in Surface and Sub-Surface Hydrology

The loss of flora changes the characteristics of the project site and the soil's characteristics from its original state to a more built state will lead to a change in the water regime at the project site. This is because the built areas will increase run-off while reducing percolation of water into the ground and thereby also changing the sub-surface hydrology. The wastes from the construction activities also pose a threat to the quality of water that will be drained from the site through run-off and this may pollute aquifers and water bodies in FCT.

5.5.1.3 Changes in soil characteristics

Changes in the characteristics of the soil may result due to the excavation and compaction of soil for the foundation. The excavation may lead to losses in the accumulated soil carbon and this is known source of GHGs i.e. CO_2. Additively this excavation can also alter the soil's structural

stability and reducing its structural integrity. Compacting the soil to lay the foundation, erecting temporary structures, and also from the heavy vehicles (trucks, tractors etc.) can reduce the soil's percolating ability and thereby increasing run-off. The laying of foundation and erecting of ancillary structures, this will lead to further changes in surface and sub-surface hydrology by changing the flow and recharge rates at the project site.

5.5.1.4 Emission of Air pollutants

The activities associated with this phase of this project will emit various air pollutants which can have negative effects on both human and environmental health. One of these is dusts from the soil excavation and movement of trucks on loose top soil after the land has been cleared. Excavations and the use of cement and sand among other like- materials are bound to increase the dust and particle levels in the air around the development area. Such effects should be avoided through the use of dust screens. Workers at the site should also be provided with protective clothing to avoid negative health effects. Also engines burning fossil fuels (vehicular and generators) will emit oxides of Carbon, Sulphur and Nitrogen, and these also pose risks to human and environmental health on top some of them being GHGs such as (CO_2). Welding operations will also emit gases and fumes such as ozone, chromium particularly in its hexavalent state (Cr^{6+}), nickel (potential carcinogens), cadmium and lead, whilst others include: NO_x, NO_2, CO, CO_2, O_3 from mild and stainless steel welding. The health effects of exposure to these fumes can include irritation of the upper respiratory tract (nose and throat), tightness in the chest, wheezing, metal fume fever, lung damage, bronchitis, pneumonia or emphysema (a lung condition that causes shortness of breath) due to the invisible nature of the noxious gas fumes given off during welding.

5.5.1.5 Noise Generation

Construction activities and processes in and around the project site will generate noise above the ambient levels of the area. One of the sources of this noise would be from the trucks' and tractor's engines moving in the area either undertaking the civil works or ferrying materials, wastes and equipment to and fro the project site and these will form the mobile sources of noise during this phase. Some point sources of noise will include civil works which will be operation specific or localized at the site due to the scope of the activities. This category of noise will include activities such as excavation, hammering, sawing, grinding; moving of material to and fro storage and also the use of generators. One of the risks of the noise would be to the surrounding areas where they may create a nuisance or disturbance. Whereas at the site the loud noises pose a risk to the workers and site personnel since loud noises increase the risk of ear damage and deafness.

Table 5.4 shows some of the levels of noise that can emitted from the project's activities during this phase.

Table 5. 4: Noise Levels of Some Construction Equipment

Equipment	Noise Levels
Back Hoe	85-95dB
Chain Saw	110dB
Front-end Loader	90-95dB
Jack hammer	112dB
Lawn Mower	90dB
Tractor	95-105dB

Source: http://www.lni.wa.gov/wisha/noisebank/noisebasics.pdf

There will be an increase in the levels of noise in the construction site owing to the nature of machinery in use and the activities such as drilling and excavation. The normal levels of 55 decibels recommended by World Health Organization (WHO) and 90 decibels by FMEnv will be surpassed in the duration of the construction process. However this is a minor negative impact since the site area is largely of sparse residential settlement.

5.5.1.6 Increased Pressure on Utilities

The processes and activities involved in the construction of the project would place added pressure on infrastructure services and utilities such as roads, water, drainage and energy. This may contribute to service disruptions since the utility and service requirements of this stage are intensive. This impact is made more probable due to the challenges faced to provide these services and compounded by the growth of the population.

5.5.1.7 Increased Heavy Traffic

In this phase, the main roads leading to the site area will serve the additional vehicles used for the transportation of materials, equipment and staff to the site together with other developments around the project will contribute to increasing the amount of heavy traffic on the roads around it. Heavy trucks could pose the risk of causing accidents due to their limited maneuverability and place added pressure on the roads and can lead to failure (cracks and potholes). This anticipated failure is however a combination of factors including:

- The total of trips of heavy trucks
- The strength of the roads in context of carrying the heavy loads, and
- Resilience of the roads towards weathering.

The roads within the CBD area are in good state and constructed to modern standards, therefore they will not at risk of failure or dilapidation from the cumulative pressure placed on them by the construction project.

5.5.1.8 Population Influx

During the construction phase there will be an influx of people mainly working on the site and an increase of population due to the opportunities presented in providing goods and services to the primary population. This secondary increase will mainly entail retailers of food stuffs and other commodities. Wastes from such commodities might pollute the area if a designated dumping place is not allocated. The population will increase since the opportunities will be open to both local and people from other areas and thereby increasing the population. This increase in population will create pressure on utilities as well as present social risks through the interaction of people. Also it may present a security risk since people with ill intentions may see an opportunity in the belongings of those attracted by the project for economic reasons.

5.5.1.9 Generation of Construction Waste

Millions of tons of solid waste is generated annually by human beings and may therefore pose great hazard if there are no proper disposal and handling systems. The construction phase will also lead to generation of construction wastes from the civil works and operations on the materials involved in the processes. These wastes include: plastics, metal shavings, wood shavings, food wastes, plants, gases (Carbon, Nitrous and Sulphurous Oxides), fumes (from glues and other hydrocarbons), stone shavings, ceramics, bricks, glass, cardboard, soil, cement, asphalt, sand, concrete, paper, paints, sealants, adhesives, fasteners, construction effluent (grey water).This phase will also lead to generation of waste heat through its run-off(water used for cooling) and the electric and diesel machines used in the construction activities. The waste heat can contribute cumulatively with other projects / activities in the area to change the microclimate, while waste heat in run-off can lead thermal pollution if it eventually drains into a river. This type of waste poses risks to both human and environmental health and thus the proposed project would require an adequate waste management strategy, occupational health and safety strategy, and hazardous material safety plan. Some environmental impacts would include oil contamination, water and air pollution, whereas health risks include: breathing complications and respiratory diseases, cancer, skin disorders, poisoning, etc.

5.5.1.10 OHS Risks

Several OSH risks will occur from the activities, processes, materials and equipment involved in the construction phase of the project. These risks are listed in **Table 5.5** alongside their source.

Table 5. 5: Construction Phase OSH Risks

OSH Risk	Source
Injuries or Injurious substances, materials and equipment	• Moving parts of equipment e.g. saws, tractors, grinders, etc.
	• Moving heavy materials
	• Open foundation pits
	• Raised building materials and equipment e.g. bricks, saws, hammers,
	• Sharp edges of nails, knives, saws, glass
	• Open flames, heat generating or using processes.
	• Working at heights
	• Emission of radiation i.e. EMFs from electrical equipment and bright lights from welding operations
	• Corrosive chemicals
Fire	• Flammable liquids & gases, chemicals, electricity, welding, open flames, heated materials and heat producing processes such as grinding, burning fuels, etc.
Intoxication	• Toxic substances, corrosive chemicals, adhesives, waste gases, smoke, dusts and emitted particulate matter.

5.5.2 Operational phase

5.5.2.1 Increased Pressure on Available Utilities

The expected increase in population and the needs of this population would place more pressure on infrastructure, utilities and social amenities in the area during the operational phase of the project. This may mainly be at the early stages of the project since they may not be capable to handle the extra demand created; a considerable amount of demand will be placed on AEDC and FCT water board network. Additionally the roads in the area will experience more traffic due to the increase in population and this can cause more or increase the duration of traffic jams as well as increase the probability of traffic hazards.

5.5.2.2 Micro-Climate Modification

Though the project area is quite small to cause any considerable micro climate change it bears the potential of adding to cumulative effects of other infrastructural development that together

emit GHGs. Change in land surface from natural vegetation to manmade built landscape will have an effect on the area microclimate by reducing the amount of evapotranspiration from the vegetation in the area which are also a GHG sink. The micro climate will also be modified by the project activities that produce waste heat (emitted heat) and this will result in the area producing more heath an originally emitted without the project. Waste heat will be produced from vehicles, electronics, generators, water pump, air-conditioning, etc.

5.5.2.3 Security Threats

The proposed project will attract a variety of people (locals and expats) to the area either as residents, business people, suppliers, visitors and customers. Their variety of economic and social activities will also generate income and increase both the economic and social capital in the area. These may attract thieves and kidnappers to the area since they may target either the businesses or the people themselves and their belongings. Also the diversity of people in the project during its operational phase and the operation of the project may also be a target for terrorists as has been experienced in the past where World trade Centers have been put on high alert towards terror threats.

5.5.2.4 Socio-cultural Impacts

The proposed project will involve a mixed use development that will attract different Nigerians and foreigners to the site. Social cohesion and blending with the existing communities may pose a conflict of interests in the short term since the influx population will come with their differing cultural and social practices. The locals may also be forced to move from the area if the land values increase and they end being bought out to pave way for more commercial developments that are predicted to occur in the area. Thus they would face a loss of social control and ownership to the area if this happens and economic segregation may occur on the basis of richer middle and upper class moving into the area and displacing the local lower class.

However this may be treated as a *minor impact* since most communities in CBD are welcoming and easy to interact with. Also the CBD is a predominantly urban and developed area that has a higher level of social permissiveness than most other urban areas in the country.

Social interactions and increased population may also present public health risks from communicable diseases such as respiratory diseases, HIV/AIDS, typhoid and cholera amongst others. The latter two diseases can be caused as result of increased population without commensurate services in sanitation, whilst the increase in population alone will place pressure on available medical and healthcare.

5.5.2.5 Increased Air Pollution

Cumulatively with other projects and activities proposed to be carried out in the area of the proposed project will emit pollutants to the air that present risks to human and ecosystem health. **Table 5.6** delineates some of the air pollutants expected from the project and the environmental and social aspects that they present a risk on.

Table 5. 6: Operational Phase Air Pollutants, their Sources and Risks

Pollutant	Sources	Risks
CO_2	• Fossil fuel engines (vehicles, generators, water pumps, etc.)	• GHG and micro-climate modification
	• Any burning activities e.g. cooking	• Acid run-off
		• Suffocation – Poisonous in large quantities
CO	• Fossil fuel engines (vehicles, generators, water pumps, etc.)	• Acid run-off
	• Burning activities. e.g. welding, cooking	• Suffocation– Poisonous gas
SO_2	• Fossil fuel engines (vehicles, generators, water pumps, etc.)	• Acidified run-off
	• Welding	• GHG Poisonous gas
		• Respiratory diseases and complications
NO_x, $N_X(g)$	• Fossil fuel engines (vehicles, generators, water pumps, etc.)	• Some forms are poisonous
		• GHG–NO_2
	• Welding	• Smog
		• Respiratory illnesses and complications
Dusts and Particulates (PM-10) *Heavy metals (Pb)	• Fossil fuel engines (vehicles, generators, water pumps, etc.)	• Heavy metals are poisonous when ingested
		• Respiratory diseases
	• Construction activities	• Pollutes underground water
		• Environmental Haze
CFC_s	• Cooling units and Air conditioning systems	• GHG and Ozone depleting

5.5.2.6 Increased Surface run-off

The paved surfaces and the project structures created from the construction phase of the project can lead to increased run-off by preventing the natural percolation of water through the soil leading to changes in the surface and subsurface hydrology as a result of the project. Additionally the increased run-off may lead to soil erosion in the areas where the water drains off to or drainage blockages by overloading the present drainage systems in the area.

5.5.2.7 Increased Traffic

From the traffic impact analysis, it is anticipated that traffic is expected to increase the number of vehicular movement on the roads around the project which may lead to increased traffic jams and hazards in the area.

However as a result of the project and other projects targeting the area, the area will experience an increase in traffic albeit intermittent, and this will increase the risk of traffic hazards since the probability of occurrence of the hazards will be increased by having more cars on the roads.

5.5.2.8 Generation of waste

Several waste streams will be generated from the operational phase of the project and these are delineated in **Table 5.7** below alongside their sources and risks they present if not properly managed.

Table 5. 7: Operational Phase Wastes

Waste	Source	Risks
Municipal Waste | Solid Waste	• Kitchen, restaurants, shops, supermarkets, Hotel/ residential area, offices, repair works, plants, plastics (tubes, binders, wrappings, metals (from clips, pins, lids), paper, cloth, etc.	• Water pollution, nuisances, air pollution on decomposition, soil contamination, waterborne diseases, respiratory illnesses
Garbage, Kitchen & Office Wastes		
Municipal Waste | Liquid Waste	• Kitchen, shops, offices, recreational areas, residential area, washings, cooking oils, adhesives, fuel, chemicals, toilets, soaps and detergents	• Water pollution (surface & subsurface), air pollution, soil contamination, waterborne diseases
Grey water, Sewerage		
Waste Heat	• Electronics, Vehicles, Air Conditioning, Power Generators, Water Pumps, Cooking and Heating activities (in house), Cooling water for machines	• Thermal Pollution of Rivers from run- off

		• Microclimate modification

5.5.2.9 OSH Risks

Several OSH risks will also be created by either the activities, equipment and materials of the operational phase of the project, and these have been listed in **Table 5.8** below alongside their sources:

Table 5. 8: Operational Phase OSH Risks

OSH Risk	Source
Injuries or Injurious substances and equipment	Slippery floors from washing with soaps and detergents, oil spills
	Parking barriers–can hit people passing below them.
	Corrosive chemicals
	Working at heights
	Moving parts
	Vehicles and trucks
	Corrosive chemicals
Fire	Fuel, electricity and electrical equipment that cause heat such as kettles, cookers both electric and or gas, and other electronics and machinery in the project
Intoxication	Chemicals, soaps & detergents, adhesives, inks, fuel

Thus the need of a plan to manage the OSH risks during this stage is important and necessary. This plan may simply be an extension of the one developed for the construction phase and can be further extended to the decommissioning phase.

5.5.2.10 Generation of Noise

The activities in this phase of the project will also generate noise and these will be from various point sources such as if diesel generators without silencers are used and also any repair works that may be carried as necessitated by the project's operations. Mobile sources of noise will mainly include cars and the trucks that will be ferrying goods to the project. Although the noise levels emitted during this stage will be less than during the construction the impact will have more

receptors since there will be more people in the area as a direct result of the project being operational.

5.5.3 Decommissioning phase

5.5.3.1 Generation of Noise

There will be a considerable increase in noise owing to the demolition process. This will be a short term impact and will be felt throughout the demolition process. The main sources of noise will include: cars and trucks; the civil works of pulling down the project's built structures (especially of explosives are used), and mechanized equipment that will be used in the processes involved in this project phase.

5.5.3.2 Generation of Demolition Waste

The decommissioning phase of the project will create demolition wastes which share similar characteristics with construction wastes and therefore similar risks. The only two main differences are that:

- Demolition waste can easily be accounted for before the empty building shell is pulled down, and
- If explosives are used they will form part of the waste.

Waste in form of debris and pieces of metal and wood will arise thus creating a need to disposing off the waste and all the disadvantages associated with waste mismanagement will arise such as spread of diseases. It is hoped that this phase will be implemented only under unavoidable circumstances for instance aging of the building and/or pertinent rights arising.

5.5.3.3 Increased Heavy Traffic

For the processes of this phase, materials from the buildings and equipment will have to be ferried to and from the site with the use of trucks and tractors/bulldozers and these will increase the amount of heavy traffic in the area. Although it is expected that at the time when the project will be decommissioned there will be substantial developments in infrastructure (transport),the trucks with limited maneuverability will pose a risk to the general public and other vehicles/drivers on top of placing extra pressure on the roads.

5.5.3.4 OSH Risks

The decommissioning phase will have several OSH risks from the civil works involved, equipment, materials and processes. This may be added to if explosives are used and although their use is not known for now, an assessment has been made assuming or incorporating their use since they

present a cost-effective way of demolition, which is safe when controlled. **Table 5.9** that follows outlines the major OSH risks from this phase and their sources.

Table 5. 9: Decommissioning Phase OSH Risks

OSH Risk	Source
Injuries or Injurious substances and equipment	• Explosives (if used)
	• Falling debris
	• Moving parts of equipment such as mechanized saws and other cutting equipment
Fire	• Heat from gas cutters, friction from abrasive processes, fuel, electricity and electrical equipment.
Intoxication	• Particulates, dusts from debris; fumes and gases emitted from friction & cutting processes, engines burning fossil fuels

5.5.3.5 Emission of Air Pollutants

The processes, material and equipment involved in this stage of the project and their wastes will also emit air pollutants either: as gases such as oxides of C,N and S from the burning of fossil fuels in engines, or particulate matter from cuttings and breakages of steel, glass, shavings, bricks and movement of soil. These will pollutants will pose risks to both human and environmental health such as air pollution, water pollution, soil contamination, respiratory diseases, skin disorders and irritations.

5.6 Traffic Impact

5.6.1 Impacts of the proposed development

The weekday peak hour periods have been considered to be critical periods for the operation of junctions within the proposed development. Therefore the traffic assessment has been carried out for the AM and PM Peak hours.

The traffic counts undertaken within the project area indicated that the AM peak hour is between 8:00 and 10:00 and the pm peak hour between 12.00 and 16:00.

The traffic assessment is carried out for three scenarios of the development including base traffic conditions, the construction phase and the operational phase of the development.

The following is an outline of the assumptions made with regard to trip generation, trip distribution and trip assignment.

5.6.1.1 Trip Generation during Construction

It is expected that the contractor workforce during the construction phase will peak at 350 people. There is no information available on the trip generation of construction workers and therefore this was based on first principles. To ensure a robust analysis, it is assumed that the trip generation of the majority of construction workers will coincide with the AM and PM peak hour periods as shown in Table 5.10. This is conservative, as construction working hours typically start before the morning peak traffic periods and generally extends beyond the evening peak period.

Table 5. 10: Construction Traffic AM and PM Peak Trip Generation

Proposed Development	**No. of Staff**	**AM Peak**		**PM Peak**	
		08:00 – 12:00		**12:00 – 18:00**	
		In	**Out**	**In**	**Out**
Construction Workers	350				
TG Rate (per worker)		0.7	0.1	0.1	0.7
Trips		245	35	35	245

5.6.1.2 Trip Distribution during Operational Phase

The assumed trip distribution for trips generated by the proposed development during the operational phase was based on the traffic distribution patterns of existing traffic within the vicinity of the AFREXIMBANK site. For this purpose, the traffic counts carried out shows the assumed trip distribution for the AM and PM Peak hour periods.

5.6.1.3 Trip Distribution during Construction Phase

The trip distribution for trips generated by construction workers and staff during the construction phase is assumed to be similar to that of the operational phase. A different trip distribution however, is assumed for the earth removal traffic. The location for disposing of the excavated material need to be identified before construction begins.

5.6.1.4 Residual Impact

During the construction phase, it is expected that in the PM peak hour there will be queues of departing cars on the site access road, within the site. All public roads and junctions in the vicinity of the site are expected to operate within capacity during the construction phase. No significant residual impact is expected during the operational phase.

5.7 Summary and Analysis of Impacts

The summary of identified impacts of the proposed project are presented in **Table 5.11** in terms of their orientation and the project phase whence which they occur, and then they are further analysed in terms of their characteristics to define their significance in **Table 5.12**

Table 5. 11: Summary of Impacts

Positive Impacts	Negative Impacts
Design Phase	
5.4.1.1 Creation of Employment and Business opportunities	
5.4.1.2 Generation of Income and Source for Government Revenue	
5.4.1.3 Environmental opportunities	
Construction Phase	
5.4.2.1 Employment Creation	5.5.1.1 Loss of Flora and Faunal Habitats
5.4.2.2 Market for goods and services	5.5.1.2 Changes in Surface and Sub-Surface Hydrology
5.4.2.3 Population Increase	5.5.1.3 Changes in soil characteristics
5.4.2.4 Increased Economic Activities and Revenue	5.5.1.4 Emission of Air pollutants
	5.5.1.5 Noise Generation
	5.5.1.6 Increased Pressure on Utilities
	5.5.1.7 Increased Heavy Traffic
	5.5.1.8 Population Influx
	5.5.1.9 Generation of Construction Waste
	5.5.1.10 OHS Risks
Operational Phase	
5.4.3.1 Increased Commercial Viability	5.5.2.1 Increased Pressure on Available Utilities
5.4.3.2 Creation of Employment Opportunities	5.5.2.2 Micro-Climate Modification
5.4.3.3 Increased Accommodation	5.5.2.3 Security Threats
5.4.3.4 Increased Access to Goods, Services and Social Amenities	5.5.2.4 Socio-cultural Impacts
5.4.3.5 Increased Economic Activities and Government Revenue	5.5.2.5 Increased Air Pollution
5.4.3.6 Urban Development Stimulation	5.5.2.6 Increased Surface run-off
5.4.3.7 Aesthetic Enhancements	5.5.2.7 Increased Traffic
5.4.3.8 Improved Roads	5.5.2.8 Generation of waste
5.4.3.9 Population Increase	5.5.2.9 OSH Risks
5.4.3.10 Impetus to Improve Amenities and Services	5.5.2.10 Generation of Noise
Decommissioning Phase	
5.4.4.1 Creation of Employment and Business Opportunities	5.5.3.1 Generation of Noise
5.4.4.2 Income Generation	5.5.3.2 Generation of Demolition Waste
5.4.4.3 Provision of Cheaper Building Materials	5.5.3.3 Increased Heavy Traffic
5.4.4.4 Environmental Conservation and Restoration	5.5.3.4 OSH Risks
	5.5.3.5 Emission of Air Pollutants

Table 5. 12: Analysis of the Proposed Project's Impacts

Construction Phase						
REF	**SIGNIFICANCE**	**Reversibility**	**Probability**	**Magnitude/Intensity**	**Duration**	**Public Concern**
5.5.1.1	M	I	H	L	ST	L
5.5.1.2	M	R	M	L	MT	L
5.5.1.3	M	R	L	L	LT	L
5.5.1.4	M	I	H	M	LT	M
5.5.1.5	M	I	H	L	ST	H
5.5.1.6	M	R	M	L	ST	L
5.5.1.7	M	R	M	L	ST	H
5.5.1.8	L	R	H	L	MT	M
5.5.1.9	H	I	H	M	ST	L
5.5.1.10	H	R	H	M	ST	L
Operational Phase						
5.5.2.1	M	R	H	L	MT	L
5.5.2.2	L	R	M	L	LT	M
5.5.2.3	M	R	L	L	LT	L
5.5.2.4	M	R	M	M	LT	M
5.5.2.5	M	R	M	L	LT	M
5.5.2.6	M	R	L	L	LT	L
5.5.2.7	M	R	M	M	LT	M
5.5.2.8	M	R	M	L	LT	H
5.5.2.9	H	I	H	L	LT	M
5.5.2.10	H	I	H	L	LT	L
Decommissioning Phase						
5.5.3.1	M	I	H	M	ST	H
5.5.3.2	H	I	H	H	ST	M
5.5.3.3	L	R	M	L	ST	H
5.5.3.4	H	I	H	M	ST	M
5.5.3.5	H	R	M	M	ST	M

The significance of an impact is ranked and color coded as HIGH, MODERATE or LOW from the characteristics of the impact and its overall effect on the social and environmental baseline conditions as well as the acceptability from the public participation exercise and the legal framework

CHAPTER SIX

6.0 MITIGATION MEASURES

6.1 Mitigation Measures

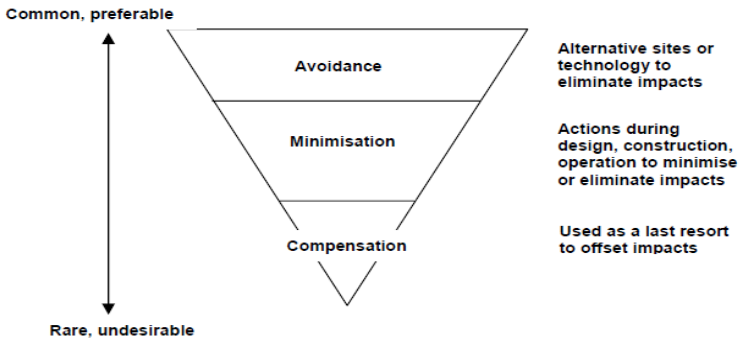
The purpose of mitigation is to identify measures that safeguard the environment and the people affected by proposed project. Mitigation is both a creative and practical phase of an EIA process. It seeks to find the best ways and means of avoiding, minimizing and remedying impacts. Put succinctly, the objectives of mitigation are to:

- Find better alternatives and ways of doing things;
- Enhance the environmental and social benefits of a proposal;
- Avoid, minimize or remedy adverse impacts; and
- Ensure that residual adverse impacts are kept within acceptable levels.

Elements of mitigation are organized into a hierarchy of actions:

1. Avoid adverse impacts as far as possible by use of preventative measures;
2. Minimize or reduce adverse impacts to 'as low as practicable' levels; and
3. Remedy or compensate for adverse residual impacts, which are unavoidable and cannot be reduced further.

A three-step process of mitigation can be applied to relate the hierarchy of elements to the stages of the EIA process when they are typically applied. Generally, as project design becomes more detailed, the concern is to minimize and compensate for unavoidable impacts. However, these distinctions are not rigid and opportunities for creative mitigation should be sought at all stages of project planning. **Figure 6.1** presents the hierarchy of action steps to mitigate impacts.



Source: UNEP, 2002

Figure 6. 1: The Elements of Mitigation

Step One: Impact Avoidance

This step is most effective when applied at an early stage of project planning. It can be achieved by:

- Not undertaking certain projects or elements that could result in adverse impacts;
- Avoiding areas that are environmentally sensitive; and
- Putting in place preventative measures to stop adverse impacts from occurring.

Step Two: Impact Minimization

This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- Scaling down or relocating the proposal;
- Redesigning elements of the project; and
- Taking supplementary measures to manage the impacts.

Step Three: Impact Compensation

This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- Rehabilitation of the affected site or environment;
- Restoration of the affected site or environment to its previous state or better; and
- Replacement of the same resource values at another location.

Indeed environmental enhancements/ mitigations are essential and should be undertaken in the various phases of AATC project, that is, during pre-construction (including those already undertaken), construction and operation stages.

The measures being proposed are specific, measurable, achievable, relevant and time-bound (SMART) to the proposed project. The measures also took into account the environmental laws in Nigeria, and internationally and the principles of sustainable development and best available technology.

Additional measures have been suggested herewith which might include sound operational procedures, good maintenance schedule and good housekeeping. **Table 6.1** shows a summary of mitigation plans for associated impacts might occur from the construction and operation of the AATC

6.2 Mitigation Enhancement Measures

The project's significant (HIGH, MODERATE and LOW) impacts are analysed, further reviewed and mitigation measures are proposed in **Table 6.1** that will enable the impacts to be managed, reduced or avoided where possible.

Table 6. 1: Proposed Mitigation Measures

Construction Phase		
Likely Impact & Reference	**Proposed Mitigation Measures**	**Residual Impact**
Loss of Flora and Faunal	• Landscaping with indigenous species on completion of construction.	Low
Habitats	• Maintaining of landscaped gardens, terraces, conservation and management of the vegetation and gardens. Clearing vegetation only in construction areas and demarcating areas where no clearing will happen.	
Changes in surface and sub-surface hydrology	• During construction, the drainage system design should ensure that surface flow is drained suitably into the public drains provided to control flooding within the site.	Low
	• Drainage channels should be installed in all areas (such as car parking, drive ways and along the building block-edges of the roofs) that generate or receive surface water runoff.	
	• The channels should be covered with gratings or other suitable and approved materials to prevent occurrence of accidents and entry dirt that would compromise flow of run-off.	
	• The channels should be designed with regards to the peak volumes such as periods or seasons when there is high intensity of rainfall which is also not common in the project area but just in case such an event occurs. They should never at any time be full due to the resulting heavy down pours.	
	• The drainage channels should ensure the safe final disposal of run-off/surface water and should be self-cleaning which means it should have a suitable gradient.	
	• Storm water generated from roof catchments should be harvested, stored and made use in various household activities such as general cleaning. This will reduce run-off reaching the drainage channels.	

	• Paving of the side walk ways, drive ways and other open areas should be done using pervious materials such as cabro to encourage water recharge and reduce run-off volume	
	• Sprinkling water on the soil to prevent dust from rising. Creating specific paths for the trucks	
Changes in soil characteristics	• Ensuring there is enough space for normal percolation of water.	Low
	• Preventing pollution from construction wastes by having specific sites for collection, sorting and transport of wastes. Proper installation and configuration of drainage structures to ensure their efficiency.	
	• Installing cascades to break the impact of water flowing into the drains.	
	• Controlling the earth works and ensuring the management of excavation activities. Compacting areas with loose soil.	
	• Landscaping.	
	• Providing soil erosion control structures on the steeper areas of the site & controlling activities during the rainy season.	
Likely Impact & Reference	**Proposed Mitigation Measures**	**Residual Impact**
Emissions of Air pollutants	• Sprinkling water on soil before excavation and periodically when operations are underway to prevent raising of dusts. Enclosing the structures under construction with dust proof nets.	Low
	• Using efficient machines with low emission technologies for the ones that burn fossil fuels. Controlling the speed and operation of construction vehicles.	
	• Regular maintenance and services of machines and engines.	
	• Use of clean fuels e.g. unleaded and de-sulphurized fuels.	
	• Educate and raise awareness of construction workers one mission reduction techniques.	
Generation of Noise	• Using equipment with noise suppressing technologies. Providing workers with PPEs against noise e.g. earplugs.	Low
	• Placing signs around the site to notify people about the noisy conditions.	
	• Regular maintenance of equipment to ensure they remain efficient and effective. Complying with the FMEnv Noise Regulations.	

	• Construction works should be carried out only during the specified time which is usually as from 0800hrs to1700hrs. There should not be unnecessary horning/honking of the involved machinery.	
	• Provision of bill boards at the construction site gates notifying of the construction activity and timings	
Increased Pressure on Utilities	• Employing water conservation techniques and only using the required amounts of water to prevent wastage.	Low
	• Employing power saving techniques such as switching off equipment when not in use, using natural light whenever possible.	
	• Using machines with power saving technologies i.e. high efficiency equipment.	
	• Providing proper sanitary facilities for construction workers.	
	• Inspecting the drainage facilities regularly to ensure they are free of debris that may reduce their efficiency.	
Increased Heavy Traffic	• Placing signs around the site notifying other vehicles about the heavy traffic and to set the speed limit around the site. Ensuring all drivers for the project comply to speed regulations.	Low
	• Making sure the construction doesn't occupy the road reserves and complying to traffic and land demarcation obligations.	
	• Ensuring all vehicles used for the project are in good working condition both legally and commensurate to their intended use.	
Population Influx	• Workers to be issued with jobs cards to monitor their movements in the site area	Low
	• Only authorized personnel should be allowed entrance to the site Presence of a work registry book where workers sign in and out Educating the workers on proper sanitation methods	
	• Sensitizing the worker on HIV/AIDS	
	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes. Ensuring all waste is dumped in their designated areas and legally acceptable methods	
Generation of Construction	• Following AEPB/FMEnv regulations on Waste Management.	Low
Likely Impact & Reference	**Proposed Mitigation Measures**	**Residual Impact**
Waste	• Employing a waste management plan. Using waste minimization techniques such as buying in bulk.	
	• Allocating responsibilities for waste management and identifying all sources of wastes, and ensuring wastes are handled by personnel licensed to do so.	
	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes.	

	• Creating waste collection are as with clearly marked facilities such as colour coded bin sand providing equipment for handling the wastes. The bins should be coded for plastics, rubber, organics, glass, timber, metals etc.	
	• Ensuring all wastes are dumped in their designated areas and through legally acceptable methods and that the bins are regularly cleaned and disinfected.	
	• Assessing and creating opportunities for Regulation, Reducing, Reusing, Recycling, Recovering, Rethinking and Renovation.	
	• Creating adequate facilities for the storage of building materials and chemicals and controlling access to these facilities. Ensuring bins are protected from rodents and the elements	
OSH Risks	• Employing an OSH plan that will outline all OSH risks and provide a strategy for their management.	Low
	• Ensuring all potential hazards such as movable machine parts are labelled.	
	• Raising awareness and educating workers on risks from equipment and ensuring they receive adequate training on the use of the equipment.	
	• Providing the workers with adequate PPEs and monitoring regularly to ensure they are replaced on time when they wear out.	
	• Placing visible and readable signs around where there are risks.	
	• Ensuring there is security in and around the site to control the movement of people.	
	• Providing safe and secure storage for equipment and materials in the site and maintaining MSDSs.	
	• Placing visible and readable signs to control the movement of vehicles and notify motorists and pedestrians around the, and workers in the site.	
	• Providing firefighting equipment and in easily accessible areas as well as ensuring site personnel are well trained to use them as well as maintaining them regularly.	
	• Labelling chemicals and material according to the risks they possess.	
	• Creating safe and adequate fire and emergency assembly points and making sure they are well labelled.	
	• Establishing emergency procedures against hazards and ensuring the workers stay aware/educated on following them and commensurate to the magnitude and type of emergency, by conducting regular rills and involving the neighbours.	

Operational Phase		
Likely Impact & Reference	**Proposed Mitigation Measures**	**Residual Impact**
Increased Pressure on available utilities	• Implementing water conservation techniques such as having faucets with dead manta popeners. Using only the required amounts of water during normal operations.	Low
	• Creating awareness through signs of conservation of water and electricity. Using natural light during the day for lighting purposes.	
	• Using machines and equipment with a high level of power efficiency in the offices and residential houses and servicing them as often as required to maintain their efficiency.	
	• Using gas in the kitchens/restaurants for cooking purposes.	
Increase Land Values and	• Complying to zoning by laws	Low
Land Use Changes	• Collaborating with public and planning officials on the development and future developments	
	• Aligning the project's objectives with those of national, county and district development policies	
Micro-climate modification	• Advocating for the use of other renewable sources of energy such as wind and solar energy	Low
	• Use of clean fuels e.g. unleaded and de-sulphurized fuels in vehicles	
	• Paving should only be carried out where necessary to reduce the reflection of the solar radiations. Landscaping the site with indigenous species of plants	
	• Using sustainable drainage systems that mimic the natural percolation of water into the soil, and green roofs where possible	

	• Using efficient equipment that emit little or no waste heat	
Security Threats	• Employing of security guards/competent security firm at the site and searching all vehicles and people entering the project	Low
	• Use of CCTV cameras to monitor security within the site	
	• Collaborating with the national police on security matters	
	• Placing alarms around the project and establishing emergency preparedness and response procedures	
Socio-cultural Impacts	• Integrating and implementing Equal Opportunity Principles in Procurement and human resource policies. Promoting social cohesion and integration among people in the area.	Low
	• Creating awareness towards the diversity of cultures and different economic background of the people in the project staff and residents through sensitization.	
	• Allowing the residents and businesses to form social groups and networks that build social capital.	
	• Targeting social investment programs towards the local communities and region.	
Increased Air pollution	• Install scrubbers in the exhausts of motor vehicles to filter the toxic fumes	Low
	• Use of clean fuels such as solar and wind energy sources	
	• Use of de-sulphurized and unleaded fuels in vehicles	
	• Banning the burning of wastes and other materials at the site.	
	• Using efficient equipment, machines and engines that emit less pollutants	

Likely Impact & Reference	Proposed Mitigation Measures	Residual Impact
Increased surface runoff	• Using materials that mimic natural percolation of water.	Low
	• Landscaping to ensure there are areas where water will percolate underground.	
	• Constructing proper drains and monitoring them to ensure there are no blockages. This also includes ensuring the size of the drains can accommodate storm flows during the rainy season.	
Increased traffic	• Erecting visible and clear signs to control the movement of vehicles in and out of the site. Having alternative entrances and exits for emergency operations.	Low
	• Placing signs around the site notifying other vehicles about the heavy traffic and to set the speed limit around the site. Ensuring all drivers for the project comply to traffic regulations	
	• Making sure the construction doesn't occupy the road reserves and complying to traffic and land demarcation obligations.	
	• Ensuring all vehicles used for the project are in good working condition both legally and commensurate to their intended use.	
Generation of waste	• Developing and implementing a waste management plan. Following AEPB and FMEnv regulations on Waste Management	Low
	• Using waste minimization techniques such as buying in bulk, buying pre-processed foods in the restaurants etc. Allocating responsibilities for waste management and identifying all sources of wastes, and ensuring wastes are handled by personnel licensed to do so.	
	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes.	
	• Creating waste collection areas with clearly marked facilities such as colour coded bins and providing equipment for handling the wastes. The bins should be coded for plastics, rubber, organics, glass, paper, electrical equipment etc. Ensuring all wastes are dumped in their designated areas and through legally acceptable methods and that the bins are regularly cleaned and disinfected.	
	• Assessing and creating opportunities for Regulation, Reducing, Reusing, Recycling, Recovering, Rethinking and Renovation.	
	• Creating adequate facilities for the storage of materials and chemicals and controlling access to these facilities. Ensuring bins are protected from rain and animals.	
OSH Risks	• Employing and EHS/OSH plan.	Low
	• Provision of PPEs to all personnel working in potentially hazardous areas or with potentially hazardous equipment, and replacing the PPEs on wear and tear.	

	• Placing readable signs alerting people of hazardous such as for slippery floors. Servicing equipment and machine to ensure efficiency.	
	• Providing firefighting equipment and maintaining them to ensure they are fully functional.	
	• Delineating fire and emergency assembly points and creating awareness to ensure all people at site are aware of them e.g. through the use maps on elevators, stair cases etc.	
	• Putting in place and ERP and ensuring all people in the project are aware of it and the procedures to follow commensurate to the level of emergency.	
	• Providing adequate storage for hazardous and flammable substances and controlling access to them.	
	• Monitoring the movement, handling and management of wastes to ensure they safely managed and don't present any EHS risks.	
	• Working state agencies in the management of emergencies and disasters to ensure multilateral land inter-sectoral approaches to this management.	
	• Performing emergency drills on a frequent basis, setting benchmarks for response and evaluating performance to ensure continuous improvement of response and preparedness.	
Generation of Noise	• Erecting signs and notifying other users of noisy activities.	Low
	• Conducting all noisy activities during the day when permissible levels are higher.	
	• Provision of PPEs such as earplugs for employees working in noisy conditions or with noisy equipment. Using equipment with low noise ratings or noise reduction technologies such as for the generators	

Decommissioning Phase		
Likely Impact & Reference	**Proposed Mitigation Measures**	**Residual Impact**
Generation Of Noise	• Carrying out the decommissioning works only during the specified time from 0800hrs to1700hrs where permissible levels of noise are high and acceptable.	Low
	• Machineries should be maintained regularly to reduce noise resulting from friction.	
	• Providing workers with Personal Protective Equipment such as ear muffs when operating noisy machinery and when in a noisy environment.	

	• Provision of bill boards at the construction site gates notifying people of the activities and timings.	
	• Shielding the area to reduce noise propagation	
Generation of demolition waste	• Following AEPB and FMEnv regulations on Waste Management.	Low
	• Employing a waste management plan which will involve assessing and creating opportunities for Regulation, Reducing, Reusing, Recycling, Recovering, Rethinking and Renovation.	
	• Removing reusable and recyclable material from the building before demolition to minimize the amount of waste. Allocating responsibilities for waste management and identifying all sources of wastes, and ensuring wastes are handled by personnel licensed to do so.	
	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes. Ensuring all wastes are dumped in their designated areas and through legally acceptable methods	
Increased Heavy Traffic	• Placing signs around the site notifying other vehicles about the heavy traffic and to set the speed limit around the site. Ensuring all drivers for the project comply to speed regulations.	Low
	• Making sure the construction doesn't occupy the road reserves and complying to traffic and land demarcation obligations	
Likely Impact & Reference	**Proposed Mitigation Measures**	**Residual Impact**
OSH Risks	• Employing an OSH plan that will outline all OSH risks and provide a strategy for their management.	Low
	• Ensuring all hazards such as movable parts are labelled.	
	• Raising awareness and educating workers on risks from equipment and ensuring they receive adequate training on the use of the equipment.	
	• Providing the workers with adequate PPEs and monitoring regularly to ensure they are replaced on time when they wear out.	
	• Placing visible and readable signs around where there are risks and undertaking the riskier demolition activities first and in isolation	
	• Ensuring there is security in and around the site to control the movement of people. Providing safe and secures to rage for the waste and materials in the site.	
	• Placing visible and readable signs to control the movement of vehicles and notify motorists and pedestrians around the, and workers in the site.	

	• Providing firefighting equipment and in easily accessible areas as well as ensuring site personnel are well trained to use them as well as maintaining them regularly.	
	• Labelling chemicals and materials according to the risks they possess.	
	• Creating safe and adequate fire and emergency assembly points and making sure they are well labelled.	
	• Establishing emergency procedures against hazards and ensuring the workers stay aware/educated on following them and commensurate to the magnitude and type of emergency, by conducting regular drills and involving the neighbours.	
Emission of Air Pollutants	• Using efficient equipment and machines with efficient engines meaning low emission. Using clean fuels such de-sulphurized diesel and unleaded fuels.	Low
	• Using Dust screens.	
	• Removing components with potential of emitting hazardous gases or particulates separately and under caution to prevent emissions.	

6.3 Mitigation Measures for Traffic Impact

6.3.1 Mitigation Measures during Construction Phase

The significant traffic impact of the proposed development will occur during the construction phase. This is due to the trip generation of the expected 350 construction workers on site.

The contractor will be required to prepare a construction traffic management plan that will specify haulage routes to and from the site, keeping heavy goods vehicles (HGV) traffic to designated suitable roads in the area.

6.3.2 Mitigation Measures during Operational Phase

The impact of the traffic generated by the operational phase on the surrounding road network will not be significant and no mitigation measures are required. Nevertheless, AFREXIMBANK plans to implement a mobility management plan for the site with the focus of promoting more sustainable modes of transportation, other than the car, amongst its employees. Such a Plan would entail the following:

- Review of the existing and future transportation framework within the vicinity of the development;
- Review of the existing travel patterns of staff that will be employed at AFREXIMBANK;
- Development of a sustainable travel strategy which may include the promotion of public transport, establishment of a car share scheme, ensure footpaths are safe and well lit, and the appointment of a mobility management coordinator amongst others; and
- Setting of realistic mode share targets based on the findings of the previous steps outlined above

CHAPTER SEVEN

7.0 ENVIRONMENTAL MANAGEMENT PLAN

7.1 Introduction

AFREXIM Bank acknowledges the fact that the proposed project activities will have some impacts on the biophysical environment, health and safety of its employees, stakeholders, interested parties and socio economic well-being of the public. Thus, the main focus will be on reducing the negative impacts and maximizing the positive impacts associated with the project activities through a programme of continuous improvement.

An Environmental Management Plan (EMP) has been developed to assist the proponent in mitigating and managing environmental impacts associated with the life cycle of the project. The EMP has been developed to provide a basis for an Environmental Management System (EMS; ISO 14001 principles) for the project. It is noteworthy that key factors and processes may change through the life of the project and considerable provisions have been made for dynamism and flexibility of the EMP; therefore, the EMP will be subject to a regular regime of periodic review. Table 9.1 forms the core of this EMP for the construction, operational and decommissioning phases of the proposed AATC respectively. The Table generally outlines the potential safety, health and environmental risks associated with the project and the necessary mitigation measures as well as the persons responsible for their implementation. The EMP will be used as checklist in future environmental audits. The effectiveness of an EMP of any organization however rests on the composition, efficiency and management commitment to the following three other ISO standards namely:

Environmental Management System (ISO 14001)

This is a structured control method employed by organizations to attend to the environmental effects of their actions and also improve their environmental performance.

Environmental Auditing (EA)

According to ISO, there are three environmental auditing guidelines namely: ISO 14010, ISO 14011 and ISO 14012. These guidelines work along with Life Cycle Assessment (LSA) standards ISO 14040, ISO 14041, ISO 14042 and ISO 14043 to ensure effective implementation of any environmental management system.

Environmental Performance Evaluation (EPE)

Environmental Performance Evaluation otherwise code named ISO 14031 provides a management framework for monitoring and measuring performance against set targets.

Environmental Management Plan

The necessary objectives, activities, mitigation measures, and responsibilities pertaining to prevention, minimization and monitoring of significant negative impacts and maximization of positive impacts associated with all phases of the proposed project are outlined in **Table 7.1** below.

Table 7. 1: Project EMP

CONSTRUCTION PHASE					
LIKELY IMPACT	**MITIGATION MEASURES**	**RESPONSIBLITY**	**COSTS(USSD)**	**INDICATOR**	**FREQUENCY**
Loss of Flora and Fauna Habitats	• Landscaping with indigenous species on completion of construction. • Maintaining of landscaped gardens, terraces, conservation and management of the vegetation and gardens. • Clearing vegetation only in construction areas and demarcating areas where no clearing will happen.	Project Proponent AMAC, Project Contractors	Within project costs	% of paved area to vegetated area	Once
Changes in surface and sub-surface hydrology	• During construction, the drainage system design should ensure that surface flow is drained suitably into the public drains provided to control flooding within the site • Drainage channels should be installed in all areas that generate or receive surface water such as car parking, driveways and along the building block-edges of the roofs. The channels should be covered with gratings or other suitable approved materials to prevent occurrence of accidents and entry dirt that would compromise flow of run-off. • The channels should be designed with regards to the peak volumes such as periods or seasons when there is high intensity of rainfall which is also not common in the project area but just in case such an event occurs. • The drainage channels should ensure the safe final disposal of run-off/surface water and should be self-cleaning which means it should have a suitable gradient. • Storm water generated from roof catchments should be harvested, stored and made use in various household activities such as general cleaning. This will reduce run-off reaching the drainage channels. • Paving of the side walkways, driveways and other open areas should be done using pervious materials such as cabro to encourage water recharge and reduce run-off volume	Project Proponent and AEPB	Within project costs	Presence of drainage channels	Once
Changes in soil characteristics	• Sprinkling water on the soil to prevent dust from rising and creating specific paths for the trucks • Ensuring there is enough space for normal percolation of water. • Preventing pollution from construction wastes by having specific sites for collection, sorting and transport of wastes. Proper installation and configuration of drainage structures to ensure their efficiency. • Providing soil erosion control structures on the steeper areas of the site & controlling activities during the rainy season.	Project Proponent, Contractors and AEPB	Within project costs	Amount of dust per volume of air. % of paved area to vegetated area. Amount of run-off i.e. flow rate of run-off in m3/s Amount of soil in run-off or drained water–kg/m3	Daily as per operation Once Quarterly

	• Controlling the earthworks and ensuring the management of excavation activities.				
Emissions of Air pollutants	• Sprinkling water on soil before excavation and periodically when operations	Project Proponent and Contractors		Amount of gaseous emissions per day: ppm in air per day	Monthly
	• Enclosing the structures under construction with dust proof nets.				
	• Using efficient machines with low emission technologies for the ones that burn fossil fuels.				
	• Controlling the speed and operation of construction vehicles.			Amount of particulate emission per day: ppm in air per day	Monthly
	• Regular maintenance and services of machines and engines.				
	• Use of clean fuels e.g. unleaded and de-sulphurized fuels.				
	• Educate and raise awareness of construction workers on emission reduction techniques.				
Generation of Noise	• Using equipment with noise suppressing technologies.	Project Proponent Contractor		Quality of PPEs (earmuffs, earplugs)	Daily
	• Providing workers with PPEs against noise e.g. ear plugs.	Workers working in noisy conditions or with noise generating equipment		Amount of noise generated in dB	Monthly
	• Placing signs around the site to notify people about the noisy conditions.	Contractors and Members of the public			
	• Regular maintenance of equipment to ensure they remain efficient and effective.				
	• Complying with the FMEnv/NESREA noise regulations				
	• Construction works should be carried out only during the specified time which is usually as from 0800hrs to 1700hrs.				
	• There should not be unnecessary horning of the involved machinery.				
	• Provision of bill boards at the construction site gates notifying of the construction activity and timings				
Increased Pressure on Utilities	• Employing water conservation techniques and only using the required amounts of water to prevent wastage.	Project Proponent, Contractor and AMAC	Within project costs	Amount of water consumed per day: m3/day	Daily
	• Inspecting the drainage facilities regularly to ensure they are free of debris that may reduce their efficiency.			Number of drainage blockages per month	Monthly
	• Providing proper sanitary facilities for construction workers.	Project Proponent and Contractor		Number of facilities serviced per month	Monthly
		Members of the Public		Amount of fuel consumed per day: m3/day	Daily

	• Employing power saving techniques such as switching off equipment when not in use, using natural light whenever possible. Using machines with power saving technologies i.e. high efficiency equipment.			Amount of electricity consumed per day: Kwh	
Increased Heavy Traffic	• Placing signs around the site notifying other vehicles about the heavy traffic and to set the speed limit around the site. Ensuring all drivers for the project comply to speed regulations	Project Proponent	Within project costs	Quality of the signs	Daily
	• Making sure the construction doesn't occupy the road reserves and complying to traffic and land demarcation obligations. Ensuring all vehicles used for the project are in good working condition both legally and commensurate to their intended use.	Contractor Truck drivers Members of the Public FRSC/Traffic Police AMAC		Number of incidents / complaints per month	Monthly
Population Influx	• Workers to be issued with jobs cards to monitor their movements in the site area only authorized personnel should be allowed entrance to the site	Project manager, Project proponent	Within project cost	Presence of a work registry book	Once
	• Presence of a work registry book where workers sign in and out.	Project Proponent			Daily
	• Educating the workers on proper hygiene and sanitation methods.			Issuing of job cards	Daily and as often as possible
	• Sensitizing the worker on HIV/AIDS, COVID-19 and other communicable diseases that maybe prevalent			ToolBox meetings	
	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes			Amount of waste generated per day i.e. Kg/day per specific waste type	
	• Ensuring all waste is dumped in their designated areas and legally acceptable methods				
Generation of Construction waste	• Following FMEnv, NESREA and AEPB regulations on Waste Management.	Project Proponent	Within project costs	Amount of wastes generated per day i.e. kg/day per specific waste type.	Once
	• Employing a waste management plan.	Contractor, AEPB			
	• Using waste minimization techniques such as buying in bulk.				
	• Allocating responsibilities for waste management and identifying all sources of wastes, and ensuring wastes are handled by personnel licensed to do so.			Quality and capacity of waste management equipment (bins, signs, PPEs, etc.)	Daily and often as possible
	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes.				
	• Creating waste collection areas with clearly marked facilities such as colour coded bins and providing equipment for handling the wastes. The bins should be coded for plastics, rubber, organics, glass, timber, metals, etc.				
	• Assessing and creating opportunities for Regulation, Reducing, Reusing, Recycling, Recovering, Rethinking and Renovation.				
	• Ensuring all wastes are dumped in their designated areas and through legally acceptable methods and that the bins are regularly cleaned and disinfected.	Members of the public			

	• Ensuring bins are protected from rain and animals.				
	• Creating adequate facilities for the storage of building materials and chemicals and controlling access to these facilities.				
OSH Risks	• Employing an OSH plan that will outline all OSH risks and provide a strategy for their management.	Project Proponent Site personnel Contractor	Within Project Cost	Number of incidents / accidents per monthly	Once
	• Ensuring there is security in and around the site to control the movement of people. Providing safe and secure storage for equipment and materials in the site and maintaining MSDSs.			Level of awareness of workers	Daily and spot checks
	• Placing visible and readable signs to control the movement of vehicles and notify motorists and pedestrians around the, and workers in the site.			Number of drills per quarter	Quarterly
	• Providing firefighting equipment and in easily accessible areas as well as ensuring site personnel are well trained to use them as well as maintaining them regularly.			Efficiency of equipment such as firefighting equipment	Daily and spot checks
	• Labeling chemicals and material according to the risks they possess.			Quality and efficacy of storage	Weekly and spot checks
	• Creating safe and adequate fire and emergency assembly points and making sure they are well labelled.			Number of assembly points	Quarterly and spot checks
	• Establishing emergency procedures against hazards and ensuring the workers stay aware/educated on following them and commensurate to the magnitude and type of emergency, by conducting regular drills and involving the neighbours..			Effectiveness of drills	After every drill
	• Ensuring all potential hazards such as movable machine parts are labelled.	OSH Officer		Visibility and clarity of signs and alerts	Weekly
	• Raising awareness and educating workers on risks from equipment and ensuring they receive adequate training on the use of the equipment.	AEPB			
	• Providing the workers with adequate PPEs and monitoring regularly to ensure they are replaced on time when they wear out. Placing visible and readable signs around where there are risks.	Project Proponent Site Personnel Contractor		Quality of all PPEs	Daily and as often as possible
OPERATIONAL PHASE					
LIKELY IMPACT	**MITIGATION MEASURES**	**RESPONSIBILITY**	**COSTS(USSD)**	**INDICATOR**	**FREQUENCY**

Increased Pressure on available utilities	• Implementing water conservation techniques such as having faucets with dead man tap openers.	Proponent	Within Project cost	Amount of water consumed per day: m3/day	Daily
		Project Staff			
	• Using only the required amounts of water during normal operations.	Project Occupiers (Residents and Business people)		Amount of electricity consumed per day: Kwh	
	• Creating awareness through signs of conservation of water and electricity.			Amount of fuel consumed per day: m3/day	
	• Using natural light during the day for lighting purposes.				
	• Using machines and equipment with a high level of power efficiency in the offices and residential houses and servicing them as often as required to maintain their efficiency.			Number of machines and equipment serviced per month	Monthly
Increase Land Values and Land Use Changes	• Complying to zoning by laws	Proponent	Within project costs	Ratio of new settlers to host community	Half-yearly
	• Collaborating with public and planning officials on the development and future developments.	FCDA			
	• Aligning the project's objectives with those of national, and FCT development policies			Land use balance trend	
Micro-climate modification	• Advocating for the use of other renewable sources of energy such as solar energy.	Project proponent	Within the project cost	Numbers of trees planted	Yearly
	• Use of clean fuels e.g. unleaded and de-sulphurized fuels in vehicles.	Contractors			
	• Paving should only be carried out where necessary to reduce the reflection of the solar radiations.	Project Occupiers (Residents and Business people) AEPB		Ratio of paved surface to unpaved surfaces	Once
	• Landscaping the site with indigenous species of plants.	Project proponent			Half-yearly
	• Using sustainable drainage systems that mimic the natural percolation of water into the soil, and green roofs where possible. Using efficient equipment that emit little or no waste heat				
Security Threats	• Employing of security guards/competent security firm at the site and searching all vehicles and people entering the project.	Project proponent	Within the project cost	Presence of a security personnel	Daily Weekly Monthly
	• Use of CCTV cameras to monitor security within the site.	Project staff		Number of security incidences	
	• Collaborating with the police on security matters	FCT Police			

	• Placing alarms around the project and establishing emergency preparedness and response procedures	Project Occupiers (Residents and Business people)		Number of security drills and emergency response drills	
		Members of the public			
Socio-cultural	• Integrating Equal Opportunity Principles in Procurement and human resource policies. Promoting social cohesion and integration among people in the area.	Proponent Project	Within the project cost	Staff Diversity ratios	Quarterly
Impacts	• Creating awareness towards the diversity of cultures and different economic background of the people in the project.	Project Occupiers (Residents and Business people)		Number of discrimination incidences and reports	Quarterly
	• Staff and residents through sensitization.	Members of the public		Number of social groups	Yearly
	• Allowing the residents and businesses to form social groups and networks that build social capital.			Number of social investment strategies targeted at the local community	Yearly
	• Targeting social investment programs.	Proponent		Level of integration of cultural appreciation into staff training programs	Every time training is held and reviewed.
Increased Air pollution	• Install scrubbers in the exhausts of motor vehicles to filter the toxic fumes.	Proponent		Efficacy of equipment and machinery	Weekly and on procurement
	• Use of clean fuels such as solar energy source	Contractors		Amount of gaseous emissions per day: ppm in air per day	
	• Use of de-sulphurized and unleaded fuels in vehicles	Project Staff			
	• Banning the burning of wastes and other materials at the site.	Project Occupiers (Residents and Business people)Member of the Public		Amount of particulate emission per day: ppm in air per day	
	• Using efficient equipment, machines and engines that emit less pollutants				
Increased surface runoff	• Using materials that mimic natural percolation of water.	Proponent Contractor	Within project costs	Drainage flow rate:	Daily Quarterly
	• Landscaping to ensure there are areas where water will percolate underground.	AEPB		Ratio of paved areas to vegetated areas	
	• Constructing proper drains and monitoring them to ensure there are no blockages. This also includes ensuring the size of the drains can accommodate storm flows during the rainy season.	Project Occupiers (Residents and Business people) and Members of the public		Number of drainage blockages	

Increased traffic	• Erecting visible and clear signs to control the movement of vehicles in and out of the site.	Proponent	Within project costs	Number of traffic jams per day	Daily Monthly
	• Having alternative entrances and exits for emergency operations.	FRSC/Traffic Police		Duration of traffic jams:hours	
	• Placing signs around the site notifying other vehicles about the heavy traffic and to set the speed limit around the site. Ensuring all drivers for the project comply to traffic regulations.	Project Staff and Office staff as well as hotel residents			
	• Making sure the construction doesn't occupy the road reserves and complying to traffic and land demarcation obligations. Ensuring all vehicles used for the project are in good working condition both legally and commensurate to their intended use.	Members of the Public, Project Occupiers (Residents and Business people)		Number of traffic incidents and accidents per month	
Generation of waste	• Developing and implementing a waste management plan.	Proponent Project Maintenance Staff	Within the project cost	Amount of waste generated per day per waste type: Kg/day	Daily
	• Following FMEnv, NESREA, and AEPB regulations on Waste Management.	Proponent		Adequacy/quality of waste management equipment (bins, PPEs such as gloves, boots, etc.)	
	• Using waste minimization techniques such as buying in bulk, buying pre-processed foods in the restaurants, etc.				
	• Allocating responsibilities for waste management and identifying all sources of wastes, and ensuring wastes are handled by personnel licensed to do so.	Project Occupiers (Residents and Business people)		Visibility and clarity of notices and signs	Weekly
	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes.				
	• Creating waste collection areas with clearly marked facilities such as colour coded bins and providing equipment for handling the wastes. The bins should be coded for plastics, rubber, organics, glass, paper, electrical equipment, etc.				
	• Ensuring all wastes are dumped in their designated areas and through legally acceptable methods and that the bins are regularly cleaned and disinfected. Assessing and creating opportunities for Regulation, Reducing, Reusing, Recycling, Recovering, Rethinking and Renovation. Creating adequate facilities for the storage of materials and chemicals and controlling access to these facilities.				Daily
	• Ensuring bins are protected from rain and animals.				

OSH Risks	• Employing an EHS/OSH plan.	Proponent	Within project costs	Number of incidents/accidents per monthly	Weekly
	• Provision of PPEs to all personnel working in potentially hazardous areas or with potentially hazardous equipment, and replacing the PPEs on wear and tear. Placing readable signs alerting people of hazardous such as for slippery floors. Servicing equipment and machine to ensure efficiency.	AMAC FRSC /Traffic Police AEPB Project Staff Project Occupiers (Residents and Businesses)		Quality of all PPEs	Daily and as often as possible
	• Providing firefighting equipment and maintaining them to ensure they are fully functional.	Proponent		Number of drills per quarter	Quarterly
	• Delineating fire and emergency assembly points and creating awareness to ensure all people at site are aware of them, e.g. through the use maps on elevators, stair cases, etc.	Project Occupiers (Residents and Businesses)			
	• Putting in place and ERP and ensuring all people in the project are aware of it and the procedures to follow commensurate to the level of emergency.			Effectiveness of drills	
	• Providing adequate storage for hazardous and flammable substances and controlling access to them.				After every drill
	• Monitoring the movement, handling and management of wastes to ensure they safely managed and don't present any EHS risks.			Visibility and clarity of signs and alerts	
	• Agencies in the management of emergencies and disasters to ensure multilateral and inter-sectoral approaches to this management. Performing emergency drills on a frequent basis, setting benchmarks for response and evaluating performance to ensure continuous improvement of response and preparedness.	NEMA and FCT Fire Service		Efficiency of equipment such as firefighting equipment	Daily and spot checks
				Quality and efficiency of storage	Weekly
				Level of awareness of workers	Daily and spot check
				Number of assembly points	Quarterly
Generation of Noise	• Erecting signs and notifying other users of noisy activities.	Proponent		Visibility and Clarity of	Daily
	• Conducting all noisy activities during the day when permissible levels are higher. Provision of PPEs such as ear plugs for employees working in noisy conditions or with noisy equipment.	Project Maintenance Staff Office and Hotel Staff		Amount of noise generated per day: dB	Daily

	• Using equipment with low noise ratings or noise reduction technologies such as for the generators.	Workers working in noisy conditions or with noisy equipment / machines Project Occupiers (Residents and Businesses)		Adequacy and quality of noise PPEs (earmuff, ear plugs)	Daily or as often as necessary
DECOMMISSIONING PHASE					
LIKELY IMPACT	**MITIGATION MEASURES**	**RESPONSIBILITY**	**COSTS(USSD)**	**INDICATOR**	**FREQUENCY**
Generation of Noise	• Carrying out the decommissioning works only during the specified time from 0800hrs to 1700hrs where permissible levels of noise are high and acceptable.	Proponent, AEPB	Within project costs	Quality of PPEs (earmuffs, earplugs)	Daily and as often as possible
	• Machineries should be maintained regularly to reduce noise resulting from friction.				
	• Providing workers with Personal Protective Equipment such as earmuffs when operating noisy machinery and when in a noisy environment.	Members of the Public		Amount of noise generated: dB	Daily
	• Provision of billboards at the site gates notifying people of the activities and timings.	Workers working in noisy conditions or with noisy equipment / machines			
	• Shielding the area to reduce noise propagation				
Generation of demolition waste	• Following AEPB, NESREA and FMEnv regulations on Waste Management.	Demolition Contractor Project Proponent		Amount of wastes generated per day i.e. kg/day per specific waste type.	Daily
	• Employing a waste management plan, which will involve assessing and creating opportunities for Regulation, Reducing, Reusing, Recycling, Recovering, Rethinking and Renovation.	AEPB			
	• Removing reusable and recyclable material from the building before demolition to minimize the amount of waste.	Proponent, Members of the Public		Quality of PPEs	
	• Allocating responsibilities for waste management and identifying all sources of wastes, and ensuring wastes are handled by personnel licensed to do so.			Quality and capacity of waste management equipment (bins, signs, PPEs, etc.)	Daily and as often as possible
	• Ensuring all wastes are dumped in their designated areas and through legally acceptable methods.				

	• Making available suitable facilities for the collection, segregation and safe disposal of the wastes.				Daily
Increased Heavy Traffic	• Placing signs around the site notifying other vehicles about the heavy traffic and to set the speed limit around the site. Ensuring all drivers for the project comply to speed regulations.	Proponent	800	Quality of the signs	Daily and as often as possible.
	• Making sure the construction doesn't occupy the road reserves and complying to traffic and land demarcation obligations. Ensuring all vehicles used for the project are in good working condition both legally and commensurate to their intended use.	FRSC/Traffic Police		Number of incidents per month	Monthly
		Members of the Public		Complaints per month	Monthly
OSH Risks	• Employing an OSH plan that will outline all OSH risks and provide a strategy for their management. Ensuring all hazards such as movable parts are labelled.	Demolition Contractor Project Proponent		Number of incidents / accidents per monthly	Monthly
	• Raising awareness and educating workers on risks from equipment and ensuring they receive adequate training on the use of the equipment.	Project Security Firm, Members of the Public		Level of awareness of workers	Weekly and spot checks
	• Providing the workers with adequate PPEs and monitoring regularly to ensure they are replaced on time when they wear out.	Proponent		Quality of all PPEs	Daily and as often as possible
	• Ensuring there is security in and around the site to control the movement of people.				Bi-weekly and spot checks
	• Placing visible and readable signs around where there are risks and undertaking the riskier demolition activities first and in isolation.			Visibility and clarity of signs and alerts	Weekly and as often as possible
	• Providing firefighting equipment and in easily accessible areas as well as ensuring site personnel are well trained to use them as well as maintaining them regularly. Labelling chemicals and materials according to the risks they possess. Creating safe and adequate fire and emergency assembly points and making sure they are well labelled.	Proponent, FCT Fire Service		Efficiency of equipment such as firefighting equipment	
	• Providing safe and secure storage for the waste and materials in the site.	Proponent		Quality and efficiency of storage	
	• Establishing emergency procedures against hazards and ensuring the workers stay aware / educated on following them and commensurate to the magnitude and type of emergency, by conducting regular drills and involving the neighbours.				
Emission of Air Pollutants	• Using efficient equipment and machines with efficient engines meaning low emission.	Demolition Contractor Project Proponent, AEPB		Amount of gaseous emissions per day:ppm in air per day	Daily
	• Using clean fuels such de-sulphurized diesel and unleaded fuels.				

	• Using Dust screens.			Amount of particulate emission per day:ppm in air per day	Daily
	• Removing components with potential of emitting hazardous gases or particulates separately and under caution to prevent emissions.				

7.2 Management Organization

The Proponent shall retain the primary responsibility of ensuring that environmental commitments are met throughout the life cycle of this project. The proponent shall establish a schedule for responsibility and training on matters relating to the environment. Environmental issues shall be a line responsibility for which all levels of personnel are accountable. Top management shall ensure that all environmental considerations are integrated into project execution. The Environment Unit shall offer expert advice on protection measures and shall assist to monitor performance.

The proponent shall appoint an Environmental Monitoring Team (EMT) to ensure effective implementation of the recommendations of the EIA and its management plan in close liaison with FMEnv. This team shall be made up of representatives of the project team, HSE and other Departments. The project HSE Team Leader shall additionally provide leadership to the EMT. However, final environmental responsibility lies with the Project Manager. The EMT shall liaise at a predetermined interval with contractors, engineers, quality assurance officers, supervisors and relevant departments of the project on all environmental matters. The HSE Team Leader within the project, assisted by the EMT shall be the focal point for all environmental matters relating to detailed design and monitoring of construction, operation, and handover of facilities to the operating and maintenance teams. The EM Team shall verify the effectiveness of the EMP implementation in liaison with Regulators and other stakeholders as appropriate.

Notwithstanding, all action parties within the project team shall demonstrate compliance directly from their line through to the Project Manager. In this way, the proponent shall take responsibility for all environmental matters and ensure that the contractors comply with all applicable environmental laws, regulations and policies as they apply to this project. In principle, the proponent and the contractors shall be responsible for implementing those aspects of the EIA recommendations that pertain to the engineering, procurement and construction phase of the project.

Similarly, the proponent and the contractor shall be responsible for the implementation of the recommendations of those aspects of the EIA that are relevant to them during the operations and maintenance phases of the project. The contractors shall be required to submit, for approval, their proposal to manage HSE inherent in their contract execution. The EM Team through the HSE- Team Leader will operate in an advisory capacity in all matters; the approval responsibility lies with the Project Manager.

7.3 Use and Maintenance of the EMP

The EMP shall remain a dynamic working tool and will be owned by the Project team. The project Manager is however the custodian of the document and may exercise auditing role to verify compliance by the project. The EMP shall be updated and revised periodically, throughout the project's life span to incorporate improved technologies, better environmental regulations, management systems, guidelines and policies. Constructive suggestions by users (contractors, management, line and operating personnel) shall be assessed by the EM Team and integrated into the EMP.

7.4 Regulatory Compliance

All environment-related regulations as they apply to this Project have been documented and described in this EIA. The project management shall ensure compliance with these regulations throughout the project's lifecycle.

7.5 Transport Operations

The project shall manage all transportation operations in line with the following guidelines in order to forestall accidents/incidents.

7.5.1 Pre-mobilization of Vehicles

All vehicles to be used for transportation of equipment, materials and personnel shall be pre-mobilized. The pre-mobilization shall be conducted to confirm that the vehicles are fit for purpose and that the drivers of the vehicles as well as their assistant(s) have the necessary competencies needed for the journey. It shall also be confirmed during the pre-mobilization exercise that a Job Hazard Analysis (JHA) has been conducted for the trip and that all recommended precautions (mitigation measures) have been adopted.

Journey Management Plan: In liaison with the HSE Team Leader, the contractors for this project shall manage their day-to-day transportation needs within a framework of controls that ensures compliance with client 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; and
- The safest times and routes are selected.

7.6 Prevention of Accident Incidents

Prevention of workplace accidents and incidents during the proposed project shall be achieved using the JHA tool and Written Work Instructions (WIS). Consequently, the HSE Team Leader shall arrange for JHA to be conducted for all HSE 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 HSE 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 client and contractors, shall address the following emergency situations.

- Fires and Explosions;
- Electrocution
- Serious injury or illness;
- Lubricant/chemical spills;
- Weather related disasters; and
- Land vehicle mishaps.

- Terrorist attack

The HSE Team Leader shall ensure that adequate security arrangements are put in place. Such plan shall have inputs from host community. 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 the client's security guidelines. In addition, each contractor shall be required to prepare a project security plan and community involvement strategy and summit to client for a review and approval. As part of the Environmental Management Plan and with the approval of the Project Manager, the HSE Team Leader shall organize security workshops to identify, evaluate and recommend contingency plans for all security risks associated with the proposed project.

7.7 Training and Awareness

In order to assure competence and awareness as well as Operation & Maintenance (O&M) staff and contractors, the project management shall establish, maintain and operate a training and awareness programme on health, safety and environmental issues. A great deal of attention shall be devoted to the locals in the contractors' teams. The training shall include accident emergency practices, basic First Aid, the use of Personnel Protective Equipment etc. Environmental Induction Course and subsequent refresher course relating to the project shall be organized for all work forces.

The objective of the courses would be to develop environmental awareness and sensitivity amongst the personnel. The training and awareness programme shall be reviewed periodically by top management and shall include but not restricted to the following aspects;

- HSE induction course,
- Emergency response drill,
- Community interaction and relations management,
- Basic First aid for all and more in depth training for selected personnel, (numbers as required by client policy),
- Defensive driving,
- Permit to Work System, and
- HSE on site Certificates of attendance shall be issued to successful participants.

The client shall also conduct HSE awareness campaigns for the host communities and general public with the aim of sensitizing them to the potential impacts and hazards associated with its operations and the appropriate response to accidents/incidents. The public awareness campaigns shall be conducted periodically and the proceedings documented for subsequent audit.

7.8 Maintenance Programme

The maintenance officer to be employed by the contractors for the project shall develop a comprehensive maintenance programme. The maintenance schedule contained in the programme shall be designed in line with manufacturer's specifications for each of the equipment. A maintenance logbook shall also be operated and it shall be regularly audited by the HSE 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.

7.9 Construction Guidelines

7.9.1 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 shall be fenced off and left fallow until use for the land is required. 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.

7.9.2 Use of Public Rights of Way

All transportation and construction works shall be executed in such a manner that will ensure that interference with the use of public highways and access roads is minimal. However, if operational safety demands that public highways or roads be blocked, then the 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 highways and roads shall be prohibited. The proponent shall develop highway and road clearing strategies to ensure that public roads and highways are kept clear, safe and passable.

7.9.3 Health and Safety of Workers

Throughout the project development HEMP *(Hazards and Effects Management Process)* shall be applied and shall consist of identifying, assessing and controlling hazards, and putting in measures to recover from the consequences of hazards if the controls fail. An early part of this is the HAZID (Hazard identification) exercise conducted within the communities during the consultation exercise. The combined HAZID Study, which identified the potential hazards associated with the health, safety and environmental aspects of the project and the HSE Premises for this project, which sets out the minimum standards and guidelines that should be met by the project, have set the stage for project execution which aim to design, construct and operate the project in a sustainable manner. Operations at all work sites shall be subject to government, industry and client HSE policies and guidelines. All client and contractor staff shall be well informed and trained on the HSE policies and guidelines. All facilities shall also be designed to enhance safety planning and activities shall be executed within the confines of relevant legislation and stakeholders' interests. The proponent shall provide adequate health services as well as site first aid services for its workforce. The first aid services shall be extended to visiting personnel and casual workers. All construction activities shall be properly managed through careful planning and the application of relevant HSE policies including the following:

- Use of Permit to Work (PTW);
- Job Hazard Analysis and toolbox meetings;
- Use of PPE in designated hazard areas;
- Prohibition of alcohol during work hours and at work sites and facilities;
- Prohibition of use of petrol engines for operations;
- Regular emergency drills;
- Prohibition of smoking in fire hazard areas.

7.9.4 Emergency Response

The following equipment shall be provided as minimum requirements for emergency response action.

- Safety showers at locations in the project where accidental spillage of chemicals could occur. Supply shall be taken from the firewater system;
- Self-contained (storage type) eye wash units shall be provided at all the operating rooms;
- Safety signs and notices shall be provided throughout the site in accordance with the client requirements and standards;
- Walkways across pipes and working platforms on vessels and equipment shall be provided with non-slip surfaces;
- Hot surfaces (>70°C) likely to be accessible by personnel, shall be lagged or caged;
- A general alarm system shall be provided, capable of giving an audible alarm in all areas of the project and visual display in areas of high background noise;
- Two sets of personnel breathing apparatus shall be provided in each control building to allow rescue activities to be performed in smoke conditions.
- Safety mats in areas where there is the possibility of electrocution
- Emergency response procedures shall be put in place for snakebites, electrocution, road traffic accidents, medevac/medial rescue and gas leaks.

7.9.5 Pollution Control

i) Air Pollution

In operating any equipment, client shall utilize all practical methods and devices available to control, prevent and otherwise minimize atmospheric emissions or the discharge of air contaminants. Good engine efficiency of equipment and vehicles shall be maintained. Indiscriminate burning of materials resulting from clearance of trees, bushes and combustible materials shall not be permitted.

Field measurements of air pollutants to determine the air quality in the areas around the proposed project was undertaken as part of the baseline surveys.

ii) Water and Soil Pollution

a) Wastewaters: Pollution of surface water by project-related waste including waste water shall be prevented by proper management practices. Contaminated or potentially contaminated area run-offs shall be collected and treated by the proponent to meet regulatory requirements before discharge.

b) Soil: the client shall ensure that all construction activities are performed by methods that will prevent pollution of the soil media by accidental spills of contaminants, debris, and other objectionable pollutants. In the event of a significant spill, relevant spill control measures shall be applied and contaminated soil shall be cleaned as appropriate. Regular checks shall be conducted on equipment to minimize minor lube oil and combustible leaks from engines.

iii) Noise Pollution: the client shall comply with all requirements for noise control and with regulatory standards. For example, client shall ensure that contractor plans activities such that World Bank Guidelines

shall not be exceeded at the nearest communities especially at nights. All equipment shall be maintained at optimal working conditions and recommended work practices shall be employed to minimize noise. Night operations shall be avoided except when absolutely necessary. In such instances, adequate measures shall be taken to reduce the noise involved and keep working hours to a minimum. Earmuffs shall be provided for all workers and any other person present in the vicinity of high noise generating equipment. If noise levels at any time give rise to public complaint, the issue shall be treated as public nuisance and client shall take appropriate measures to resolve the problem with the appropriate authorities. In any case, communities shall be consulted prior to periods of expected peak noise levels. Safe separation distances and buffer zones shall be established between facilities, work sites and adjoining facilities to reduce the impact of high noise levels from the facilities. The possibility of encroachment up to the fence line is taken into account in the design of noise reduction measures.

7.9.6 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 client approved waste management guidelines. These guidelines are 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 surface water, swamp or land.
- Discharge of solid wastes (including domestic waste) into surface water, swamp or land.
- Generation of noise and vibration.

A detailed waste management plan shall be developed for the wastes generated during the site preparation and construction activities. This waste management plan shall be subject to approval by the regulatory authorities prior to demolition. In the design of this plan the focus shall be on optimal recycling and reuse of materials.

i) 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. The proponent 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 includes:

- Waste type identification
- Proper waste categorization
- Waste segregation information
- Recommended Management practices.

ii) Waste Minimization

Waste minimization implies reduction to the greatest extent possible of the volume or toxicity 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. A large proportion of excavated materials shall be used for landscaping or other remedial works on site.

iii) 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. Particular attention shall be given to work areas where a variety of wastes are generated such as in kitchens and residential areas.

iv) Waste Disposal

All waste, except excavated soil and rock, shall be cleared regularly from the site and disposed off at designated areas and facilities owned by the AEPB. Instructions on material safety handling sheet shall be strictly adhered to and shall form basis for the disposal of wastes related to such products. 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).

7.10 Operational Guidelines

A set of minimum standards and guidelines would be developed and agreed upon by the project managers. This is the HSE Premises document which should include numerical limits (e.g. for noise, air emissions) as well as commitment to certain policies, systems and actions. The relevant sections and commitments from the project HSE Premises document shall be translated to contractual requirements of the contractor (s).

For this reason, a manual of permitted operations (MOPO) shall be developed and implemented for the project. This (MOPO) shall establish:

(i) The limits within which the project will be allowed to operate and

(ii) The required level of supervisory intervention when operating outside the optimal design envelope

Other than during start-up and rectification of system upset periods, the facilities shall be operated in compliance with project environmental standards.

To assist in maintaining the technical integrity of the facilities, a well-defined maintenance management system, which shall be approved by the HSE Team Leader, shall be used to ensure compliance with the client's maintenance policies. The maintenance system shall include plans and procedures for

- Normal maintenance (routine and breakdown maintenance performed by the various disciplines will be judiciously adhered to;
- Preventive maintenance (activities carried out at pre-determined intervals);
- Predictive maintenance (as initiated by facility condition monitoring and assessment);
- Inspection (in accordance with a pre-defined programme and based on statutory and company requirements);
- Production and maintenance personnel shall be properly selected and trained to ensure safe and effective job performance. Ongoing competence training shall be undertaken.

Inspections shall be carried out to comply with statutory and company requirements and shall be based on "Risk Avoidance" rather than "Risk Management". The principle of risk-based inspection shall be adopted. Routine maintenance and inspection activities shall also be carried out for all project facilities and on-line condition based performance monitoring shall be applied.

7.10.1 Operational Wastes and Disposal Methods

7.10.1.1 Solid wastes

Provision shall be made for the proper storage and subsequent disposal of all sludge/solid/sewage wastes generated at the facilities in accordance with the client and waste management guidelines in Nigeria. In addition, organic wastes, generated during construction shall be collected, segregated and transported to an approved disposal facility. No dumping of wastes in swamps, land and rivers shall be permitted. All operational solid wastes shall be segregated prior to disposal and concrete arrangement shall be worked out with the AEPB to use their waste dump facilities for the disposal of non-hazardous wastes, while hazardous wastes shall be channeled for effective management to an approved Landfills or Incinerators or even in approved Thermal Desorption Units. Generally, the waste management principle to be adopted by this project shall capture the 3Rs-Recycling, Reusing and Reducing.

7.10.1.2 Liquid wastes

A policy for the discharge of all site water in accordance with all environmental and process requirements has been adapted in designing the discharge of water from the project. The discharge pipe is capable of discharging the total combined wastewater from the site. This total combined wastewater includes all process water subject to contamination. For this project, these shall be treated and combined into a single discharge waste treatment plant.

- **Industrial Wastewaters:** Industrial wastewaters generated from the project activities and facilities shall not be disposed into the environment unless treated, such that they comply with environmental and process requirement in a coherent manner. These wastes include chemically contaminated water from the chemical unloading area, effluents which are likely to be contaminated by oils and potentially contaminated storm water.
- **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.

- **Lubricant** Spills: Minor lubricant spills shall be cleaned immediately using appropriate absorbent granules and powders. Direct flushing into the river shall not be permitted until such measures are taken and the majority of the spill absorbed.

7.10.1.3 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.

9.10.2 Noise Minimization Guidelines

Noise and vibration generated by facilities and equipment shall meet the ergonomic requirements of client 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. The following noise limits shall be used in the design as specified by FMEnv guidelines for not more than 8 hours operation:

- Workshops for light maintenance 70 dB (A)
- Workshop offices, plant offices and computer rooms 60 dB (A)
- Open plan offices and control rooms 50 dB (A)
- Social rooms, changing rooms, wash places and toilets 50 dB (A)
- Offices and conference rooms 45 dB (A)
- Sleeping areas 40 dB (A)

7.11 Site Inspection Procedures

The EM Team and representatives of regulatory bodies throughout the project life shall carry out regular inspection of sites and facilities. The main objective of such inspections shall be to assess compliance level with mitigation measures and recommendations of the EIA. When the HSE Team Leader requests such inspection, the site shall therefore be made accessible to such inspectors upon authentication of identity to:

- Examine and inspect all equipment that could cause pollution;
- Collect samples of any atmospheric emissions, effluent discharges or solid waste deposition for analyses and interpretation;
- Examine all construction and operation logbooks for environmentally related issues.

After each inspection, the Team shall compile a site inspection report detailing the:

- Specific facilities or areas inspected,
- Details of project activities, and
- Highlights of any observed non-compliance/persistent negligence.

In case of non-compliance the O&M contractor shall be requested to take appropriate measures. The inspection procedure shall be repeated after implementation.

7.12 Monitoring and Auditing Plans

7.12.1 Environmental Monitoring Plans

The proponent shall monitor the proposed development from pre-construction all through operation stages to keep track of the entire project development life cycle. The monitoring plans for the project including the environmental components, parameters and frequency of monitoring as well as responsibilities are presented in Table 9.1. The objective of this monitoring plan is to:

- Ensure compliance with regulatory standard limits.
- Monitor changes in the existing physic-chemical, biological and Socio-Economic characteristics of the environment comparing changes with the baseline data acquired.
- Ascertain the effectiveness of the mitigation measures proffered.

Monitoring will be aimed at maintaining an optimal performance as consistently as possible by maintaining the combustion temperature. Surrogate performance monitoring will be done on the basis of initial calibration, using the following surrogate parameters, relevant for assessing environmental performance. They require no changes in project design but do call for appropriate training of operating personnel.

Table 7. 2: Environmental Monitoring Plan for the Proposed AATC

Environmental Components	Parameters for Monitoring	Frequency	Location	Action Party
Air Quality	NO_x, SO_x, CO_2, SPM, SPM levels in the atmosphere.	Bi-weekly during construction and 3 monthly afterwards	Project Site and specific areas outside its boundary.	AFREXIM Bank's Safety and Environment Unit in conjunction with relevant regulators (AEPB, FMEnv).
Water Quality	pH, DO, BOD,COD,Turbidity, Conductivity, Salinity, TDS, Heavy Metals	Weekly during construction and 3 months after construction	Waterbodies within the Site and specific areas outside its boundary.	Churchgate's Safety and Environment Unit in conjunction with relevant regulators.
Vegetation	Species diversity and abundance	Once during site clearing and yearly at operation stage	Project site and immediate surrounding	AFREXIM Bank's Safety and Environment Unit in conjunction with relevant regulators.
Soil Quality	• pH • Soil structure • Colour • Soil texture • Heavy metals and other pollutants	Weekly during construction and 3 months after construction	Project Site	AFREXIM Bank's Safety and Environment Unit in conjunction with relevant regulators.
Waste Handling/ Disposal	Sanitary condition and aesthetic of the project area and its surrounding. Waste Consignment Note (WCN)	Daily at close of work during construction and weekly at operation stage.	Project and its immediate surrounding	AFREXIM Bank's Safety and Environment Unit conjunction with relevant regulators.
Socio-economics	Population Health status Infrastructure Community attitude	Annually	Abuja Municipal Area Council	AFREXIM Bank's Safety and Environment Unit
Health and safety	Health status of employées	Weekly during construction and		Health and safety officer

	Accident frequencies and near misses.	Quarterly at operation stage	Company employees and contractor staff attached to the facility	

7.12.2 Environmental Auditing Plans

AFREXIM Bank shall set up a QA/QC function to monitor through regular auditing the quality management system of the project to ensure compliance with the project design concepts. This audit shall check the prediction of the EIA and assess the general performance of the project to ensure that environmental standards are maintained and that the facility policies and environmental management guidelines are strictly maintained.

Each environmental audit shall be geared towards achieving the following:

- Compliance with all necessary codes, standards and procedures;
- Examine compliance with regulatory requirements;
- Identify current and potential environmental problems;
- Examine line management systems, operations, monitoring practices and data, procedures and plans;
- Check the predictions in the Environmental Impact Assessment and ensure that recommendations are being implemented; and
- Recommend areas of improvement in operations management.

During the operational phase of the project and at conclusion of every environmental audit exercise, the environmental auditor shall produce an Environmental Audit Report (EAR), which shall be submitted to the project management for onward submission to relevant regulators.

7.13 Remediation plans after Decommissioning/Closure

The proposed project initiative is not expected to be entirely decommissioned. This is in consideration that human activities will continue to require this kind of project especially within FCT. In event of unlikely need to decommission the project, a well-articulated plan shall be developed in consultation with all relevant regulators and institutions to ensure that the site is restored and improved if possible, beyond its current level. It will involve removal of all metal panel pillars and frames which would be sold off to recyclers who will melt it and put it to other uses.

All components of the project which are considered to be potentially toxic with tendencies of polluting the environment will either be sent back to manufacturers through vendors or if technological level of the country improves, destroyed through appropriate means locally. Should there be need to put these cells to other uses, such opportunity would be exploited at the time.

The proposed project site will at the close of the project and removal of all metal scraps, plastics and wires be audited for possible pollution. However, civil structures that are found to be of significance will be converted to suitable uses.

CHAPTER EIGHT

8.0 DECOMMISSIONING AND CLOSURE

8.1 Introduction

Projects are normally designed to serve a planned lifespan, after which they shall be decommissioned, replaced or phased out. The decommissioning and phase out plan is based on what will happen to the structures at closure. This involves activities that result in the stabilization and restoration of unneeded site to a more natural state. For this project, AFREXIM Bank will 'return' the project site to its initial and unblemished natural state, through rehabilitation and enhancement, as prescribed by the environmental statutes and in recognition of multi-stakeholders' decision.

Decommissioning of the project will be given utmost priority as the project proponent believes in leaving the environment in its project sites as close to how it was before operations began. To this end, all activities related to decommissioning shall be initiated ahead of time, before the cessation of project activities. Considerations will be given to ensuring the safety of navigation taking into cognizance all appropriate regulatory and company requirements. In addition, removal of all structures will be carried out with due regard for the protection of the environment and the rights and duties of the government.

Prior to the actual decommissioning activities, a plan shall be drawn. The plan will discuss the effects of the closure and decommissioning on other stakeholders of the project and the economy of Nigeria in general. Decommissioning of the structures and abandonment is the reverse of construction and commissioning. Therefore, detailed HSE studies, engineering and decommissioning plan must be carried out before implementation. Consultations and negotiations with stakeholders, particularly the host communities, employees and regulatory agencies must commence early and be concluded before commencement of the execution of the decommissioning plan. The Federal Ministry of Environment EIA Division, NESREA and the Abuja Environmental Protection Board (AEPB) shall be informed about the plan. Furthermore, guideline for site restoration and remediation prevailing at time shall be used.

Before decommissioning, AFREXIM Bank will develop plans that include the following:

- Identification of components of the project that will be removed;
- The choice of environmentally sound methods for removal, re-use, recycling or disposal of special wastes that may arise from the decommissioning process e.g. Asphalt, liaison with FMEnv;
- Expressly outline the time frame/schedule for the decommissioning and post-decommissioning process, and communicate the same to FMEnv and other relevant regulatory agencies as well as the affected or concerned persons and groups;
- Proper rehabilitation, decommissioning process;
- Appropriate site rehabilitation, remediation and enhancement techniques and technologies; and
- There shall be post-decommissioning assessments to compare ameliorated project-related impacts, relative to the baseline conditions.

The content of the plan will take into consideration the extent of the decommissioning (temporary or permanent, partial or complete shutdown), plans for future use of the site, and the condition of the site and environment at the time of decommissioning. A detailed post-operational study of the impact of the project on the environment will be conducted to determine an appropriate restoration and remedial measures. In general, however, decommissioning activities will be conducted in compliance with applicable regulations and guidelines, including FMEnv or any other regulations that are in force at the time of decommissioning. The plans will also include regulations and a risk and cost analysis of the various options.

8.2 Consultation

The project decommissioning and abandonment plan will include consultation with various stakeholders including employees from various departments. The decommissioning team will include competent personnel from various departments as well as the regulatory authorities.

8.3 Decommissioning of Project and Ancillary Facilities/ Equipment Re-Use

At the end of this project lifespan, the project and all ancillary facilities will be decommissioned. All installed facilities on project site will be adequately dismantled and remove to allow for proper remediation of the project site. FCP Health Safety and Environment Management Systems will be implemented to assure safety of personnel and the public during decommissioning as well as minimize negative environmental impacts. Particular attention will be paid to the following:

- Protection from air pollutant emissions;
- Protection from noise; and
- Waste handling

The process of decommissioning will involve:

- Blockage of entrance to site
- Decontamination of contaminated spots
- Revegetation and Watering
- Establish drainage ways
- Full obliteration, re-contouring and restoring natural slopes.

All the components that can be used or recycle will be identified and quantified. Cleared locations will be re-vegetated using fast growing native plant species, which can either be purchased from a nursery plantations/farms or nursery of these seedlings will be developed by capable agronomists contracted by the proponent. Disturbed areas on the facility will be identified and restored using native species.

8.4 Reporting

As required by regulations, a post-decommissioning report will be prepared and submitted to the FMEnv. The report will include the following details:

- Overview of decommissioned facilities
- Details of methods used for decommissioning
- Nature of decommissioning (partial or whole)

- Record of consultation meetings
- Details of recyclable / reusable materials / facility components
- Decontaminated facilities
- State of the surrounding environment
- Waste Management Plan
- Plans for restoration/ remediation where necessary.

Recommended Mitigation Measures for Decommissioning Phase

Some basic mitigation measures that will be required to be undertaken once all operational activities of the project have ceased. The necessary objectives, mitigation measures, allocation of responsibilities, time frames, prevention, minimization and monitoring of all potential impacts associated with the decommissioning and closure phase of the project

8.5 Decommissioning And Abandonment Plans

8.5.1 Decommissioning of Existing Facilities

Decommissioning of the World Trade Centre is not foreseen, however, decommissioning of related facilities especially project site offices and workshops are inevitable. Further, decommissioning of quarries and borrow sites will be done upon completion of construction works. The proponent will prepare a written abandonment plan within 30 days of determining decommissioning. The Plan will detail how the decommissioning will be carried out.

The abandonment plan will be subject to approval by FMEnv/NESREA. An Environmental Protection and Rehabilitation Plan (EPRP) will be prepared prior to implementation of this plan, to assess and minimize potential environmental and social impacts arising from the abandonment operations. This abandonment EPRP Study will be submitted to FMEnv/NESREA for consideration. Upon completion of the abandonment operations, an assessment of contaminated land will be prepared recording the final contamination status of the location of the project facilities. This assessment will be subjected to AEPB/NESREA for approval.

8.5.2 Products, By-Products and Waste

The construction of the project will generate inert, non-hazardous and hazardous waste over the period of construction. Operation of the world trade center will result in relatively small volumes of routine waste generation for the life of the Project. Maintenance and repair activities conducted during the operational lifetime of the project may generate limited volume of waste.

CHAPTER NINE

9.0 CONCLUSION

This EIA study has established that the proposed development project by AFREXIM Bank will contribute significantly to the improvement of living standard and by extension spur economic development. This will be achieved through the prior discussed positive impacts namely; attraction of foreign investment, increasing foreign exchange inflow, Increasing Foreign Direct Investment, growth of the economy, boosting of the informal sector during the construction phase, provision of market for supply of building materials, employment generation and increase in government revenue. However, the EIA study has established that the proposed project will also come along with some negative impacts which include pressure on the existing traffic and utilities, noise pollution, dust emissions, solid waste generation, increased water demand, increased energy consumption, generation of exhaust emissions, workers accidents and hazards during construction, possible exposure of workers to diseases, possible attraction of terrorist, increased storm water among others can however be sufficiently mitigated.

The proponent of the proposed project shall be committed to putting in place several measures to mitigate the negative environmental, safety, health and social impacts associated with the life cycle of the project. It is recommended that in addition to this commitment, the proponent shall focus on implementing the measures outlined in the EMP as well as adhering to all relevant national and international environmental, health and safety standards, policies and regulations that govern establishment and operation of such projects. It is expected that the positive impacts that emanate from such activities shall be maximized as much as possible as exhaustively outlined within the report. These measures will go a long way in ensuring the best possible environmental compliance and performance standards.

It is our recommendation that the project be allowed to go on provided the mitigation measures outlined in the report are adhered to, Environmental Management Plan (EMP) is implemented and the developer adhere to the conditions of approval of the project.

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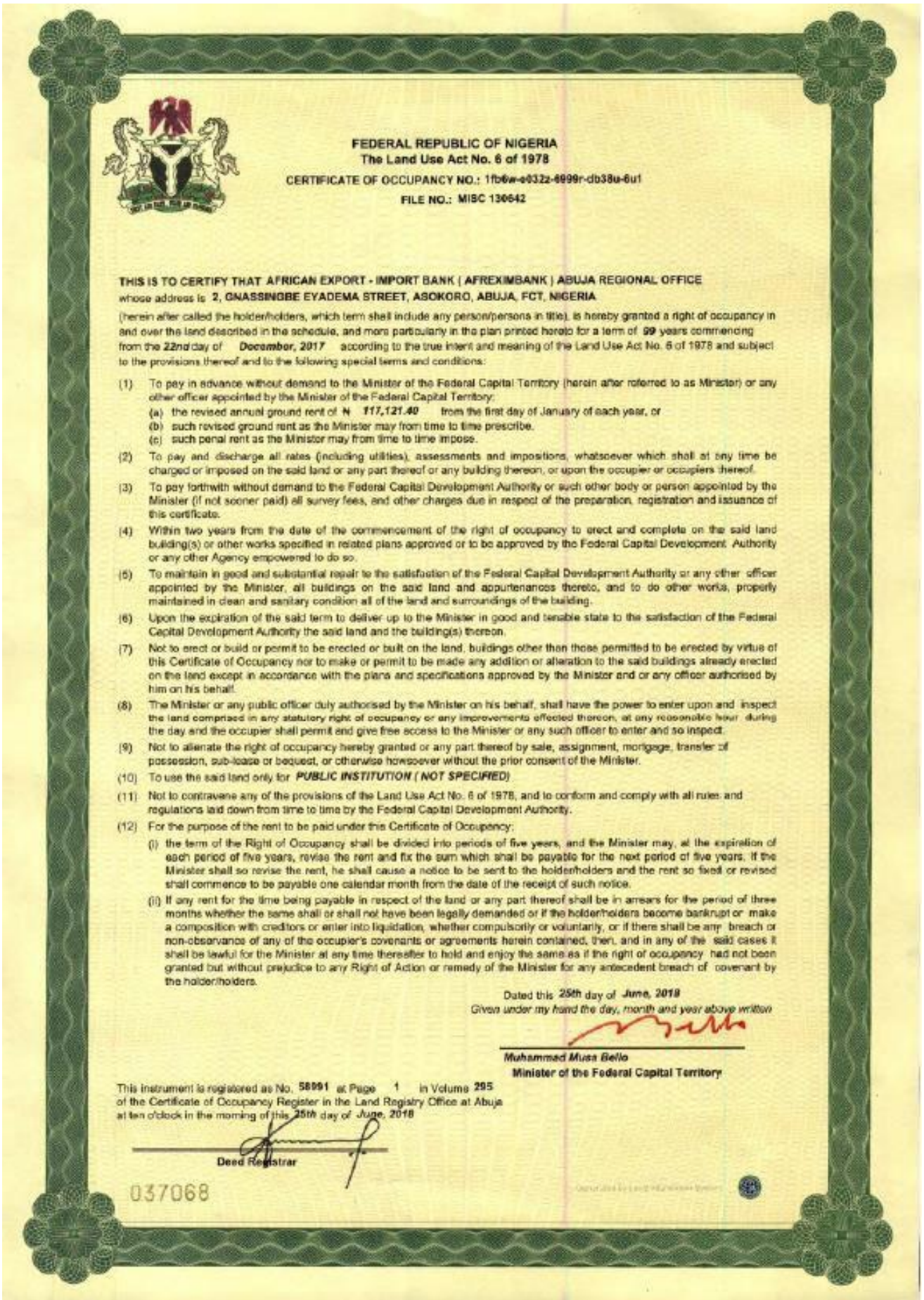
APPENDIX

APPENDIX A



FEDERAL REPUBLIC OF NIGERIA
The Land Use Act No. 6 of 1978

CERTIFICATE OF OCCUPANCY NO.: 1fb6w-e032z-6999r-db38u-6u1

FILE NO.: MISC 130642

THIS IS TO CERTIFY THAT AFRICAN EXPORT - IMPORT BANK (AFREXIMBANK) ABUJA REGIONAL OFFICE
whose address is **2, GNASSINGBE EYADEMA STREET, ASOKORO, ABUJA, FCT, NIGERIA**
(herein after called the holder/holders, which term shall include any person/persons in title), is hereby granted a right of occupancy in and over the land described in the schedule, and more particularly in the plan printed hereto for a term of **99** years commencing from the **22nd** day of **December, 2017** according to the true intent and meaning of the Land Use Act No. 6 of 1978 and subject to the provisions thereof and to the following special terms and conditions:

(1) To pay in advance without demand to the Minister of the Federal Capital Territory (herein after referred to as Minister) or any other officer appointed by the Minister of the Federal Capital Territory:
- (a) the revised annual ground rent of ₦ ***117,121.40*** from the first day of January of each year, or
- (b) such revised ground rent as the Minister may from time to time prescribe.
- (c) such penal rent as the Minister may from time to time impose.

(2) To pay and discharge all rates (including utilities), assessments and impositions, whatsoever which shall at any time be charged or imposed on the said land or any part thereof or any building thereon, or upon the occupier or occupiers thereof.

(3) To pay forthwith without demand to the Federal Capital Development Authority or such other body or person appointed by the Minister (if not sooner paid) all survey fees, and other charges due in respect of the preparation, registration and issuance of this certificate.

(4) Within two years from the date of the commencement of the right of occupancy to erect and complete on the said land building(s) or other works specified in related plans approved or to be approved by the Federal Capital Development Authority or any other Agency empowered to do so.

(5) To maintain in good and substantial repair to the satisfaction of the Federal Capital Development Authority or any other officer appointed by the Minister, all buildings on the said land and appurtenances thereto, and to do other works, properly maintained in clean and sanitary condition all of the land and surroundings of the building.

(6) Upon the expiration of the said term to deliver up to the Minister in good and tenable state to the satisfaction of the Federal Capital Development Authority the said land and the building(s) thereon.

(7) Not to erect or build or permit to be erected or built on the land, buildings other than those permitted to be erected by virtue of this Certificate of Occupancy nor to make or permit to be made any addition or alteration to the said buildings already erected on the land except in accordance with the plans and specifications approved by the Minister and or any officer authorised by him on his behalf.

(8) The Minister or any public officer duly authorised by the Minister on his behalf, shall have the power to enter upon and inspect the land comprised in any statutory right of occupancy or any improvements effected thereon, at any reasonable hour during the day and the occupier shall permit and give free access to the Minister or any such officer to enter and so inspect.

(9) Not to alienate the right of occupancy hereby granted or any part thereof by sale, assignment, mortgage, transfer of possession, sub-lease or bequest, or otherwise howsoever without the prior consent of the Minister.

(10) To use the said land only for ***PUBLIC INSTITUTION (NOT SPECIFIED)***

(11) Not to contravene any of the provisions of the Land Use Act No. 6 of 1978, and to conform and comply with all rules and regulations laid down from time to time by the Federal Capital Development Authority.

(12) For the purpose of the rent to be paid under this Certificate of Occupancy:
- (i) the term of the Right of Occupancy shall be divided into periods of **five years**, and the Minister may, at the expiration of each period of five years, revise the rent and fix the sum which shall be payable for the next period of five years. If the Minister shall so revise the rent, he shall cause a notice to be sent to the holder/holders and the rent so fixed or revised shall commence to be payable one calendar month from the date of the receipt of such notice.
- (ii) If any rent for the time being payable in respect of the land or any part thereof shall be in arrears for the period of three months whether the same shall or shall not have been legally demanded or if the holder/holders become bankrupt or make a composition with creditors or enter into liquidation, whether compulsorily or voluntarily, or if there shall be any breach or non-observance of any of the occupier's covenants or agreements herein contained, then, and in any of the said cases it shall be lawful for the Minister at any time thereafter to hold and enjoy the same as if the right of occupancy had not been granted but without prejudice to any Right of Action or remedy of the Minister for any antecedent breach of covenant by the holder/holders.

Dated this **25th** day of ***June, 2018***
Given under my hand the day, month and year above written

Muhammad Musa Bello
Minister of the Federal Capital Territory

This instrument is registered as No. **58991** at Page **1** in Volume **295** of the Certificate of Occupancy Register in the Land Registry Office at Abuja at ten o'clock in the morning of this **25th** day of ***June, 2018***

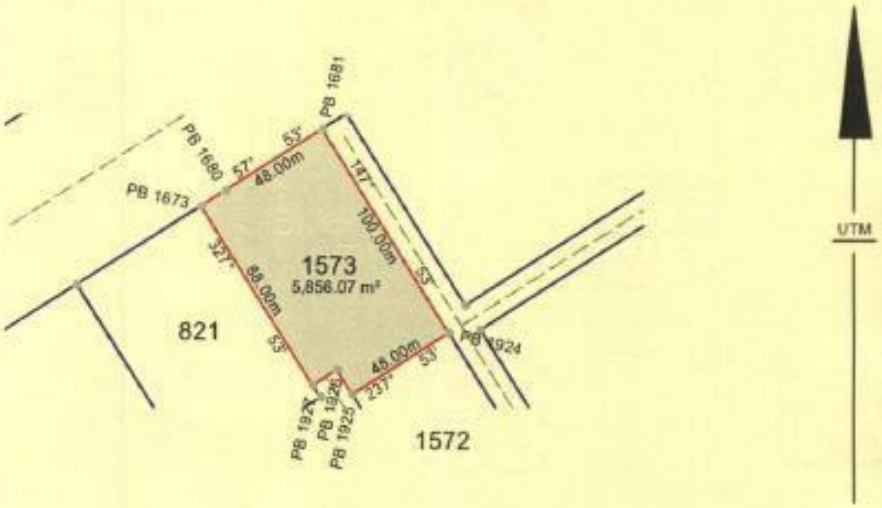
Deed Registrar

037068

APPENDIX B

LAND GRANTED TO AFRICAN EXPORT - IMPORT BANK (AFREXIMBANK) ABUJA REGIONAL OFFICE
FILE NO: MISC 130642
DISTRICT: CENTRAL AREA
CADASTRAL ZONE: A00
PLOT NO: 1573

DIRECTOR OF SURVEYING AND MAPPING



SCALE: 1:2500

SCHEDULE: AS DESCRIBED IN GRAPHICS ABOVE

BEACON No.			DIST	BEARING
FROM PB1673	TO PB1680	=	12.00m AT	57° 53'
FROM PB1925	TO PB1926	=	12.00m AT	327° 53'
FROM PB1926	TO PB1927	=	12.00m AT	237° 53'

NOTE:
FULL BEACON NUMBER FCT A00 PB 1673
COORDINATES OF PB 1673
N. 1,001,093.06
E. 334,854.63
COORDINATE SYSTEM UTM ZONE 32N

CADASTRAL MAP 1:5000

334/999	---
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SURVEYED BY: Surveying & Mapping Department FCT Aug 2017

PREPARED BY: Abuja Geographic Information Systems 25th June 2018

APPENDIX C

AMMC
ABUJA METROPOLITAN MANAGEMENT COUNCIL
...the City Managers

DEPARTMENT OF DEVELOPMENT CONTROL
No. 2, Juba Street, Zone 6, Wuse Abuja

Our Ref: AMMC/DC/DP/2016/6767 Date: June 15, 2017
Your Ref:

The Regional Manager,
Anglophone West Africa
African Export- Import Bank
No. 2 Gnassingbe Eyadema Street Asokoro

RE: DESIGN CONTROL FOR PLOT NO. CADASTRAL ZONE A00, CENTRAL BUSINESS DISTRICT, ABUJA

Your letter on above subject refers.

2. Please find below the design control information regarding your plot.

i)	Land use	-	To be Confirmed
ii)	Plot Size	-	To be Confirmed
iii)	Building Type	-	Office Complex
iv)	Building Height	-	6- 8 Suspended floors
iii)	Setbacks	-	Front 6m, sides 4m min. & rear 4m minimum
v)	Building coverage	-	25% min. 50%max.
vi)	Vehicular Access	-	Ralph Sodehinde Street
vii)	Inter Building Setbacks	-	6m minimum
viii)	Parking requirements	-	1car per 50m² floor space
ix)	Complimentary Requirement		Design should adopt Green Building Principles as much as possible and be energy efficient. Super impose contour map on site plan.
x)	Supportive Documents	-	Copy of C of O, Environmental Impact Assessment Report, Site Analysis Report, Soil Test Report, Structural Calculation Sheets and complete set of working drawings (softcopy in dwf and pdf) and any other relevant title document.

African Export - Import Bank
Abuja - Nigeria
20 JUN 2017
RECEIVED

APPENDIX D: **Dry Season Results**

A: Water Quality Results

Physico-Chemistry Results for Analysis of Water Samples

S/N	Sample ID	PH	TEMP.OC	COND.µS/cm	TDS mg/l	Turb. NTU	COD mg/l
1	AFR/EIA/W/P1	9.3	28.1	69.4	34.7	2.3	2
2	AFR/EIA/W/P2	8.4	26.2	104.2	51.7	1.8	2
3	AFR/EIA/W/P3	8.4	30.7	61.4	30.7	2.4	3
4	AFR/EIA/W/C1	7.2	30.1	143.1	71.7	2.7	1
5	AFR/EIA/W/C2	6.7	33.3	96.9	48.5	1.9	2
MIN		6.7	26.2	61.4	30.7	1.8	1
MAX		9.3	33.3	143.1	71.7	2.7	3
MEAN		8	29.68	95	47.46	2.22	2
Highest Desirable Level by NESREA		7.0 - 8.5	NA	NA	NA	NA	NA
Maximum permissible Level by NESREA		6.5 - 9.2	NA	NA	NA	NA	NA

Metal Results for Analysis of Water Samples

S/N	Sample ID.	Ni (mg/l)	Cd (mg/l)	Cu (mg/l)	Fe (mg/l)	Zn (mg/l)	Mn (mg/l)	Cr (mg/l)	Pb (mg/l)	Co (mg/l)	Ag (mg/l)	V (mg/l)
1	AFR/EIA/W/P1	0.001	0.019	0.001	0.001	0.001	0.023	0.001	0.001	0.001	0.001	0.001
2	AFR/EIA/W/P2	0.36	0.001	0.001	0.187	0.001	0.062	0.001	0.001	0.001	0.001	0.001
3	AFR/EIA/W/P3	0.001	0.001	0.001	0.087	0.001	0.001	0.001	0.001	0.001	0.001	0.001
4	AFR/EIA/W/C1	0.084	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
5	AFR/EIA/W/C2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MIN		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MAX		0.36	0.019	0.001	0.187	0.001	0.062	0.001	0.001	0.001	0.001	0.001
MEAN		0.09	0.00	0.00	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Highest Desirable Level by NESREA		0.075	0.006	1.5	1	15	NA	0.03	0.08	0.10	NA	NA

Metal Results for Analysis of Plant Samples

S/N	Sample ID.	Ni (mg/l)	Cd (mg/l)	Cu (mg/l)	Fe (mg/l)	Zn (mg/l)
1	P19	0.001	5.93	3.2	280.259	8.686
2	P20	8.703	13.89	7.947	0.001	23.2
3	CTRL 1	258.5	0.001	13.36	634.056	340.5
4	CTRL 3	0.001	0.001	14.38	650.612	78.09
MIN		0.001	0.001	0.001	0.001	0.001
MAX		258.5	13.89	14.38	650.612	340.5
MEAN		38.35	2.84	5.77	223.74	66.50

Organic/ Microbiology Results for Analysis of Water Samples

S/N	Sample ID	O/G mg/l	THC mg/l	THB Cfu/ml	HUB Cfu/ml	THF Cfu/ml	HUF Cfu/ml	Coliform (MPN/100 ml)
1	AFR/EIA/W/P1	0.001	0.001	$2.24x10^2$	$2.20X10^1$	$1.36x10^2$	$0.30X10^1$	18+
2	AFR/EIA/W/P2	0.001	0.001	$2.28x10^2$	$1.80X10^1$	$1.12x10^2$	$1.30X10^1$	18+
3	AFR/EIA/W/P3	0.001	0.001	$2.95x10^2$	$0.20x10^1$	$1.02x10^2$	$4.70X10^1$	18+
4	AFR/EIA/W/C1	0.001	0.001	$2.15x10^2$	$2.10X10^1$	$1.38x10^2$	$0.50X10^1$	18+
5	AFR/EIA/W/C2	0.001	0.001	$2.03x10^2$	$4.00X10^1$	$1.41x10^2$	$0.40X10^1$	18+
MIN		0.001	0.001	2.03E+02	2.00E+00	1.02E+02	3.00E+00	18+
MAX		0.001	0.001	2.95E+02	4.00E+01	1.41E+02	4.70E+01	18+
MEAN		0.001	0.001	2.33E+02	2.06E+01	1.26E+02	1.44E+01	18+
Highest Desirable Level by NESREA		0.3	0.3	NA	NA	NA	NA	NA

B: Soil Quality Results

Physico-Chemistry Results for Analysis of Soil Samples (Top)

S/N	Sample ID	pH	TEMP.OC	COND µS/cm	SO_4 mg/kg	NO_3 mg/kg	CO_3^{2-} mg/kg	Moisture content (%)
1	S 1 Top	7.42	26.4	202	<1	0.3	0.12	1.85
2	S 2 Top	7.68	26.8	228	<1	0.3	0.11	2.85
3	S 3 Top	7.75	26.4	240	6	0.2	0.92	2.38
4	S 4 Top	7.52	26.3	182	<1	0.6	0.88	2.33
5	S 5 Top	7.68	26.5	156	13	0.2	0.47	1.86
6	S 6 Top	7.55	26.2	156	65	1.3	0.14	2.94
7	S 7 Top	7.6	26.7	172	3	0.6	0.53	0
8	S 8 Top	7.94	26.8	202	9	0.7	0.13	5.4
9	S 9 Top	7.55	26.9	130	<1	3.1	0.8	4.65
10	S 10 Top	7.69	26.4	120	4	0.6	0.89	0

11	S 11 Top	7.89	25.1	224	<1	0.4	0.46	0
12	S 12 Top	7.6	26.6	230	23	0.1	0.15	2.22
13	S 13 Top	7.72	24.6	44	11	0.7	0.8	3.03
14	S 14 Top	7.42	26.3	120	6	0.1	0.84	2.38
15	S 15 Top	7.35	25.4	122	<1	0.4	0.16	0
16	S 16 Top	7.4	25.8	44	<1	20.9	0.04	0
17	S 17 Top	7.52	25.9	210	<1	0.3	0.13	17.02
18	S 18 Top	7.77	24.8	274	<1	0.1	0.25	22
19	S 19 Top	7.65	25.2	300	<1	0.5	0.17	2.21
20	S 20 Top	7.7	24.3	254	5	0.2	0.1	1.72
21	S 21 Top	7.83	25.5	260	1	0.1	0.21	17.54
22	S 22 Top	7.62	24.9	282	1	0.3	0.26	18.75
23	S 23 Top	7.49	24.6	185	10	1	0.27	11.11
24	S 24 Top	7.55	25.1	208	<1	0.3	0.32	17.25
25	S 25 Top	7.73	24.9	284	7	0.3	0.18	22.07
26	S 26 Top	7.63	25.3	300	<1	0.6	0.2	46.61
27	S 27 Top	7.6	24.9	286	3	0.3	0.29	24.1
28	CTRL 1 Top	7.15	27.5	22	2	0.6	0.3	10
29	CTRL 2 Top	7.5	25.8	148	5	0.3	0.15	30.05
30	CTRL 3 Top	7.53	27.1	152	<1	0.3	0.96	16.98
	MIN	7.15	24.3	22	1	0.1	0.04	0
	MAX	7.94	27.5	300	65	20.9	0.96	46.61
	MEAN	7.60	25.83	191.23	6.23	1.19	0.37	9.64

Physico-Chemistry Results for Analysis of Soil Samples (Bottom)

Sample ID	pH	TEMP.OC	COND µS/cm	SO_4 mg/kg	NO_3 mg/kg	CO_3^{2-} mg/kg	Moisture content (%)
S 1 Bot	7.64	24.9	198	<1	<0.1	0.11	2.25
S 2 Bot	7.62	25.8	240	<1	0.8	0.96	2.24
S 3 Bot	7.7	24.2	218	7	<0.1	0.13	2.08
S 4 Bot	7.65	25.8	240	5	0.5	<0.01	2.15
S 5 Bot	7.5	24.2	172	3	0.3	0.85	1.92
S 6 Bot	7.6	25.5	175	<1	0.3	0.13	4.76
S 7 Bot	7.66	24.3	182	6	0.4	0.97	0
S 8 Bot	7.78	25.7	216	7	5.1	0.14	3.33
S 9 Bot	7.4	24.7	172	1	0.7	0.85	3.98
S 10 Bot	7.62	25.3	124	6	0.7	0.65	0

S 11 Bot	7.85	24.7	218	4	0.1	0.36	0
S 12 Bot	7.83	25.8	158	11	0.6	0.86	2.74
S 13 Bot	7.7	28.1	74	8	0.5	0.53	2.56
S 14 Bot	7.78	25.8	70	<1	0.6	0.13	2.08
S 15 Bot	7.82	24.6	72	<1	0.5	0.19	1.5
S 16 Bot	7.4	26.3	228	1	0.1	0.63	
S 17 Bot	7.55	26.1	205	<1	0.4	0.13	16.18
S 18 Bot	7.48	26.4	282	<1	0.2	0.23	22
S 19 Bot	7.68	26.9	228	6	0.2	0.51	1.85
S 20 Bot	7.89	26.7	226	1	0.3	0.14	1.54
S 21 Bot	7.68	28.1	306	3	0.1	0.22	20.24
S 22 Bot	7.74	26.2	240	7	0.4	0.19	17.14
S 23 Bot	7.51	26.2	188	8	0.6	0.27	12.5
S 24 Bot	7.53	26.3	224	<1	0.4	0.31	16.51
S 25 Bot	7.8	26.5	282	7	0.7	0.23	20.54
S 26 Bot	7.75	26.2	284	<1	0.2	0.21	45.3
S 27 Bot	7.6	26.4	292	15	0.3	0.33	22.92
CTRL 1 Bot	7.09	24.9	20	1	0.3	0.31	8.69
CTRL 2 Bot	7.51	26.3	128	6	0.1	0.19	27.91
CTRL 3 Bot	7.42	25.9	155	<1	0.2	0.15	18.37
MIN	7.09	24.2	20	1	0.1	0.11	0
MAX	7.89	28.1	306	65	5.1	0.97	45.3
MEAN	7.63	25.83	193.90	6.23	0.56	0.38	9.77

Metal Results for soil samples (Top)

S/N	Sample ID	Ni mg/kg	Cd mg/kg	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Cr (mg/kg)	Pb (mg/kg)	Co (mg/kg)	Ag (mg/kg)	V (mg/kg)	K (mg/kg)	Na (mg/kg)	Ca (mg/kg)
1	S 1 Top	147.3	49.58	25.68	314.5	36.64	230.9	62.64	<0.001	<0.001	<0.001	<0.001	5525	3819	1571
2	S 2 Top	8.448	3.99	20.68	468.6	67.26	390.6	250.7	<0.001	8.555	<0.001	<0.001	25197	5515	2120
3	S 3 Top	<0.001	2.96	16.72	393.2	27.99	219.4	116.8	3.232	28.59	<0.001	<0.001	14470	1977	627.3
4	S 4 Top	102.8	14.96	22.77	415.6	58.2	289.4	24.15	1.593	9.507	<0.001	<0.001	9777	3795	1278
5	S 5 Top	99.57	48.06	44.03	590.5	71.55	409.4	169	233	15.87	<0.001	<0.001	4736	2982	1254
6	S 6 Top	<0.001	3.03	9.812	287.6	46.52	202.8	202.2	36.55	10.3	<0.001	<0.001	18645	2765	5179
7	S 7 Top	121.3	<0.001	43.46	515	104.6	386.4	273.3	5.201	3.515	<0.001	<0.001	5418	2696	1127
8	S 8 Top	<0.001	40.51	<0.001	240.7	37.74	179.2	15.27	52.68	31.8	<0.001	<0.001	2723	253.3	614.1
9	S 9 Top	48.36	13.81	26.39	245.3	63.65	230.4	143.2	80.91	<0.001	<0.001	<0.001	3184	1605	654
10	S 10 Top	<0.001	6.732	20.24	378.8	60.24	300.1	215.2	32.53	6.223	<0.001	<0.001	3193	2776	712
11	S 11 Top	<0.001	37.96	34.09	353.4	57	334.5	42.06	<0.001	50.41	<0.001	<0.001	5658	3630	640
12	S 12 Top	2.851	56.31	45.21	463.4	78.8	327.3	55.91	16.98	4.589	<0.001	<0.001	3565	1784	502
13	S 13 Top	30.87	45.87	30.82	459.6	12.54	324.3	4.566	28.1	24.48	<0.001	<0.001	4517	2890	828

14	S 14 Top	33.83	54.7	5.876	471.2	19.63	346.1	223.2	<0.001	<0.001	<0.001	<0.001	8960	2383	900.2
15	S 15 Top	<0.001	36.98	21.29	263.4	3.969	131.4	151.5	22.85	192.4	<0.001	<0.001	6085	1882	854.1
16	S 16 Top	<0.001	35.69	27.3	389.9	20.79	143.3	78.88	83.75	<0.001	<0.001	<0.001	4256	3537	758.5
17	S 17 Top	<0.001	8.03	29.38	390.7	56.49	318.4	301.9	<0.001	<0.001	<0.001	<0.001	3690	210.8	455.6
18	S 18 Top	39.1	27.71	9.061	160.6	13.78	168	23.83	20.66	48.02	<0.001	<0.001	2486	1739	123.6
19	S 19 Top	20.91	42.63	36.21	395	56.15	387.9	50.87	17.91	74.94	<0.001	<0.001	5749	2196	485.7
20	S 20 Top	<0.001	27.96	20.65	289	51.51	274.5	12.49	13.65	6.889	<0.001	<0.001	5459	3343	408.5
21	S 21 Top	79.91	39.28	12.17	251	30.42	163.7	159.2	103.4	<0.001	<0.001	<0.001	3573	1354	364
22	S 22 Top	8.225	20.96	13.53	359.4	53.6	218.6	357.5	38.53	43.62	<0.001	<0.001	5241	2919	862.3
23	S 23 Top	14.56	39.28	29.96	140	35.68	133.6	32.47	92.23	36.04	<0.001	<0.001	5238	2529	799.4
24	S 24 Top	22.1	38.33	31.42	291	45.47	319.4	<0.001	8.213	29.06	<0.001	<0.001	3529	1556	427
25	S 25 Top	<0.001	52.68	10.29	288.5	9.77	170.4	39.15	0.771	3.032	<0.001	<0.001	4611	2351	1625
26	S 26 Top	116.7	34.43	10.38	274	56.39	182.6	182.3	13.81	<0.001	<0.001	<0.001	5145	3047	1427
27	S 27 Top	40.9	2.27	34.09	390	116.9	274.3	54.08	3.003	15.7	<0.001	<0.001	5035	3914	1908
28	CTRL 1 Top	<0.001	22.99	13.81	240	28.01	185.1	26.62	<0.001	47.52	<0.001	<0.001	5241	3696	1326
29	CTRL 2 Top	<0.001	20.73	8.889	169.5	2.401	122	52.49	1.253	4.839	<0.001	<0.001	4548	2075	1853
30	CTRL 3 Top	1.841	7.913	15.11	75.18	21.47	148.9	112	46.87	9.81	<0.001	<0.001	3812	1459	631.9
	MIN	0.001	0.001	0.001	75.18	2.401	122	0.001	0.001	0.001	0.001	0.001	2486	210.8	123.6
	MAX	147.3	56.31	45.21	590.5	116.9	409.4	357.5	233	192.4	0.001	0.001	25197	5515	5179
	MEAN	31.32	27.88	22.31	332.15	44.84	250.43	114.45	31.92	23.52	0.00	0.00	6308.87	2555.94	1077.21

Metal Results for soil samples (Bottom)

Sample ID	Ni mg/kg	Cd mg/kg	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Cr (mg/kg)	Pb (mg/kg)	Co (mg/kg)	Ag (mg/kg)	V (mg/kg)	K (mg/kg)	Na (mg/kg)	Ca (mg/kg)
S 1 Bot	69.17	54.97	27.12	401.6	46.73	271.8	108.8	<0.001	2.01	<0.001	<0.001	11880	3876	1614
S 2 Bot	4.253	<0.001	27.96	434.6	24.98	379.1	127.5	<0.001	2.117	<0.001	<0.001	20952	3406	1728
S 3 Bot	<0.001	64.1	39.3	406.9	82.91	259.9	373.8	7.514	64.45	<0.001	<0.001	15302	1725	681.6
S 4 Bot	82.51	4.9	20.82	408.4	45.42	274.2	21.23	0.583	5.461	<0.001	<0.001	9579	3261	1215
S 5 Bot	<0.001	37.24	22.64	445.6	67.73	400.9	70.93	98.58	<0.001	<0.001	<0.001	2647	2022	1194
S 6 Bot	<0.001	10.81	16.21	405.8	47.8	263.5	238.4	40.55	15.27	<0.001	<0.001	20042	3577	5613
S 7 Bot	<0.001	76.63	28.15	458.6	79.85	351.9	138.4	3.818	1.857	<0.001	<0.001	3018	1913	889
S 8 Bot	3.683	51.05	<0.001	469.7	51.28	178.1	116.2	173	88.65	<0.001	<0.001	3639	293.4	685.8
S 9 Bot	<0.001	6.789	20.88	385.6	69.97	330.8	247.7	93.62	9.57	<0.001	<0.001	4310	3543	864
S 10 Bot	131.7	23.7	30.46	368.3	60.01	288.9	20.84	<0.001	42.88	<0.001	<0.001	4724	2545	621

S 11 Bot	6.132	38.22	37.06	441.9	57.47	336.9	74.28	204	5.174	<0.001	<0.001	5885	3001	553.5
S 12 Bot	<0.001	54.91	36.01	434.6	59.81	312.9	48.27	14.01	2.061	<0.001	<0.001	3532	1441	410
S 13 Bot	55.5	49	31.99	469	20.55	349.8	20.21	29.63	61.99	<0.001	<0.001	2578	1856	686.3
S 14 Bot	25.67	19.56	5.801	414.6	18.91	325.6	114.2	<0.001	<0.001	<0.001	<0.001	4551	2105	750.8
S 15 Bot	<0.001	23.95	5.297	209.8	<0.001	80.5	112.1	18.04	110.5	<0.001	<0.001	3528	1445	826.4
S 16 Bot	<0.001	31.8	16.26	354.6	10.57	139.9	51.79	39.49	<0.001	<0.001	<0.001	3517	2664	698.7
S 17 Bot	6.19	34.79	45.64	401.6	60.24	323.9	381.7	<0.001	7.225	<0.001	<0.001	4011	221.9	430.2
S 18 Bot	8.809	18.88	6.397	198	25.09	194.7	29.61	70.49	62.69	<0.001	<0.001	3001	1835	127.5
S 19 Bot	<0.001	34.86	24.39	310	34.76	329.3	18.31	6.131	28.73	<0.001	<0.001	3141	1648	406.2
S 20 Bot	<0.001	40.9	30.28	390	52.42	293.5	18.36	21.73	22.93	<0.001	<0.001	2518	1794	319.2
S 21 Bot	43.27	18.54	2.426	181.3	27.38	127.8	116.4	75.83	<0.001	<0.001	<0.001	2584	1215	323.5
S 22 Bot	6.364	17.53	4.976	281	23.62	151.4	301.6	26.48	41.13	<0.001	<0.001	3824	2039	643.4
S 23 Bot	<0.001	39.14	11.32	115	32.24	121.8	18.21	91.54	24.61	<0.001	<0.001	4769	2105	444.5
S 24 Bot	110.4	54.94	36.94	303.2	48.27	751.5	23.73	12.64	47.06	<0.001	<0.001	4052	2670	432
S 25 Bot	<0.001	27.5	8.233	240.8	4.781	125.3	31.41	<0.001	<0.001	<0.001	<0.001	7732	2907	1702
S 26 Bot	140.2	44.8	18.22	283	68.46	221.9	202.6	15.87	<0.001	<0.001	<0.001	5456	3155	1930
S 27 Bot	28.2	1.873	26.69	365	75.28	209.6	49.14	<0.001	4.764	<0.001	<0.001	4820	2886	1791
CTRL 1 Bot	<0.001	44.11	11.12	103.3	7.04	111.9	12.87	<0.001	37.29	<0.001	<0.001	2422	1694	952.5
CTRL 2 Bot	<0.001	34.26	13.91	279	17.4	179.8	68.71	8.619	6.319	<0.001	<0.001	6418	2554	2142
CTRL 3 Bot	<0.001	5.07	15.35	92.54	14.24	119.4	52.39	10.85	3.82	<0.001	<0.001	3775	1814	768.9
MIN	0.001	0.001	0.001	92.54	0.001	80.5	12.87	0.001	0.001	0.001	0.001	2422	221.9	127.5
MAX	140.2	76.63	45.64	469.7	82.91	751.5	381.7	204	110.5	0.001	0.001	20952	3876	5613
MEAN	24.07	32.16	20.73	335.11	41.17	260.22	106.99	35.43	23.29	0.00	0.00	5940.23	2240.38	1048.13

Organic/ Microbiology Results for Analysis of Soil Samples (Top)

S/N	Sample ID	O/G mg/kg	THC mg/kg	THB Cfu/g	THF Cfu/g	HUB Cfu/g	HUF Cfu/g	Coliform (MPN/100 ml)
1	S 1 Top	201.7	128.3	2.09x106	1.14x106	3.10X105	0.30X105	N/A
2	S 2 Top	728.3	172.5	2.93x106	1.71x106	5.60X105	0.30X105	N/A
3	S 3 Top	201.3	124.6	2.85x106	1.63x106	5.60X105	0.90X105	N/A
4	S 4 Top	1313	516.3	2.39x106	1.16x106	9.20X105	1.90X105	N/A
5	S 5 Top	288.8	148.8	2.13x106	1.22x106	4.70X105	0.40X105	N/A
6	S 6 Top	333.3	175	2.38x106	1.54x106	4.20X105	0.20X105	N/A
7	S 7 Top	953.3	183.3	2.81x106	1.66x106	8.20X105	0.40X105	N/A

8	S 8 Top	595	560	2.61x106	1.56x106	9.70X105	1.50X105	N/A
9	S 9 Top	175	105	2.88x106	1.70x106	1.10X105	3.20X105	N/A
10	S 10 Top	166.7	108.3	2.46x106	1.27x106	0.60X105	0.30X105	N/A
11	S 11 Top	358.8	341.3	2.89x106	1.70x106	3.10X105	0.60X105	N/A
12	S 12 Top	82.5	55	2.77x106	1.21x106	0.40X105	0.40X105	N/A
13	S 13 Top	45.8	36.7	2.70x106	1.62x106	0.20X105	1.10X105	N/A
14	S 14 Top	70	52.5	2.69x106	1.54x106	3.60X105	1.30X105	N/A
15	S 15 Top	100	83.3	2.39x106	1.47x106	4.10X105	1.90X105	N/A
16	S 16 Top	105	35	2.91x106	1.80x106	0.20X105	0.30X105	N/A
17	S 17 Top	504.2	220	2.47x106	1.28x106	8.9X105	3.30X105	N/A
18	S 18 Top	1859	488.8	2.52x106	1.30x106	4.20X105	0.50X105	N/A
19	S 19 Top	927.5	813.8	2.58x106	1.44x106	9.20X105	1.20X105	N/A
20	S 20 Top	1505	1383	2.77x106	1.61x106	1.05X106	0.70X105	N/A
21	S 21 Top	3467	726.3	2.71x106	1.36x106	1.01X106	0.30X105	N/A
22	S 22 Top	34073	12591	2.87x106	1.64x106	1.53X106	3.10X105	N/A
23	S 23 Top	883.8	507.5	2.89x106	1.17x106	3.50X105	2.80X105	N/A
24	S 24 Top	495	265.8	2.98x106	1.11x106	1.60X105	1.20X105	N/A
25	S 25 Top	1024	385	2.68x106	1.59x106	5.40X105	0.20X105	N/A
26	S 26 Top	341.3	78.8	2.59x106	1.35x106	1.20X105	0.80X105	N/A
27	S 27 Top	1192	430.8	2.53x106	1.33x106	3.10X105	0.20X105	N/A
28	CTRL 1 Top	55	36.7	2.02x106	1.17x106	1.90X105	1.70X105	N/A
29	CTRL 2 Top	752.5	253.8	2.93x106	2.07x106	2.20X105	1.20X105	N/A
30	CTRL 3 Top	175	78.8	2.68x106	2.02x106	1.70X105	2.80X105	N/A
	MIN	45.8	35	2.02E+06	1.11E+06	2.00E+04	2.00E+04	N/A
	MAX	3.41E+04	1.26E+04	2.98E+06	2.07E+06	1.53E+06	3.30E+05	N/A
	MEAN	1765.76	702.87	2.64E+06	1.48E+06	4.75E+05	1.17E+05	N/A

Organic/ Microbiology Results for Analysis of Soil Samples (Bottom)

Sample ID	O/G mg/kg	THC mg/kg	THB Cfu/g	THF Cfu/g	HUB Cfu/g	HUF Cfu/g	Coliform (MPN/100 ml)
S 1 Bot	287.5	143.8	$2.06x10^6$	$1.22x10^6$	$3.80X10^5$	$0.60X10^5$	N/A
S 2 Bot	210.8	73.3	$2.48x10^6$	$1.56x10^6$	$1.80X10^5$	$0.60X10^5$	N/A
S 3 Bot	17.8	8.8	$2.65x10^6$	$1.45x10^6$	$0.40X10^5$	$3.50X10^5$	N/A
S 4 Bot	191.7	100	$2.85x10^6$	$1.37x10^6$	$4.30X10^5$	$0.20X10^5$	N/A

S 5 Bot	175	96.3	$2.14x10^6$	$1.40x10^6$	$2.10X10^5$	$0.30X10^5$	N/A
S 6 Bot	481.3	210	$2.33x10^6$	$1.46x10^6$	$5.30X10^5$	$0.30X10^5$	N/A
S 7 Bot	311.7	183.3	$2.58x10^6$	$1.38x10^6$	$2.40X10^5$	$0.30X10^5$	N/A
S 8 Bot	577.5	288.8	$2.73x10^6$	$1.38x10^6$	$4.90X10^5$	$0.60X10^5$	N/A
S 9 Bot	140	78.8	$2.68x10^6$	$1.57x10^6$	$0.80X10^5$	$0.90X10^5$	N/A
S 10 Bot	216.7	116.7	$2.78x10^6$	$1.62x10^6$	$2.10X10^5$	$0.40X10^5$	N/A
S 11 Bot	358.8	148.8	$2.63x10^6$	$1.55x10^6$	$1.80X10^5$	$1.80X10^5$	N/A
S 12 Bot	27.5	18.3	$2.63x10^6$	$1.50x10^6$	$0.30X10^5$	$0.60X10^5$	N/A
S 13 Bot	45.8	36.7	$2.92x10^6$	$1.78x10^6$	$0.60X10^5$	$1.60X10^5$	N/A
S 14 Bot	70	43.8	$2.45x10^6$	$1.20x10^6$	1.50X105	$4.60X10^5$	N/A
S 15 Bot	52.5	43.8	$2.79x10^6$	$1.63x10^6$	$1.70X10^5$	$0.40X10^5$	N/A
S 16 Bot	43.8	35	$2.98x10^6$	$1.76x10^6$	$0.70X10^5$	$0.80X10^5$	N/A
S 17 Bot	345	143.8	$2.44x10^6$	$1.36x10^6$	$5.80X10^5$	$0.90X10^5$	N/A
S 18 Bot	2177	385	$2.78x10^6$	$1.52x10^6$	$2.80X10^5$	$1.10X10^5$	N/A
S 19 Bot	175	158.3	$2.73x10^6$	$1.50x10^6$	$2.70X10^5$	$0.90X10^5$	N/A
S 20 Bot	1199	726.3	$2.47x10^6$	$1.44x10^6$	$9.70X10^5$	$1.60X10^5$	N/A
S 21 Bot	1675	741.7	$2.35x10^6$	$1.35x10^6$	$6.80X10^5$	$0.50X10^5$	N/A
S 22 Bot	7737	2539	$2.35x10^6$	$1.20x10^6$	$8.10X10^5$	$4.70X10^5$	N/A
S 23 Bot	516.3	297.5	$2.33x10^6$	$1.34x10^6$	$2.10X10^5$	$0.10X10^5$	N/A
S 24 Bot	408.3	275	$2.46x10^6$	$1.28x10^6$	$3.20X10^5$	$2.30X10^5$	N/A
S 25 Bot	3633	1250	$2.42x10^6$	$1.24x10^6$	$8.80X10^5$	$0.10X10^5$	N/A
S 26 Bot	586.3	245	$2.37x10^6$	$1.37x10^6$	$2.80X10^5$	$0.40X10^5$	N/A
S 27 Bot	813.8	227.5	$2.37x10^6$	$1.42x10^6$	$2.50X10^5$	$0.20X10^5$	N/A
CTRL 1 Bot	55	36.7	$2.33x10^6$	$1.48x10^6$	$1.20X10^5$	$0.70X10^5$	N/A
CTRL 2 Bot	583.3	250	$2.05x10^6$	$1.70x10^6$	$0.40X10^5$	$0.30X10^5$	N/A
CTRL 3 Bot	463.8	192.5	$2.73x10^6$	$1.45x10^6$	$0.10X10^5$	$0.50X10^5$	N/A
MIN	17.8	8.8	2.05E+06	1.20E+06	1.00E+04	1.00E+04	N/A
MAX	7737	2539	2.98E+06	1.78E+06	9.70E+05	4.70E+05	N/A
MEAN	785.87	303.15	2.54E+06	1.45E+06	3.17E+05	1.00E+05	N/A

C: Air Quality Results

S/No	SO_2 (µg/m³)	O_3 (µg/m³)	NO_2 (µg/m³)	CO (µg/m³)	H_2S (µg/m³)	VOC (µg/m³)	Ambient Temp (°C)	Relative Humidity(%)	SPM (µg/m³) PM 2.5	SPM (µg/m³) PM 10	Wind direction (degrees)	Wind Speed (m/s)	Noise Level (dBA)	Time
1	0	0	0.1	0	0	0	33.12	20.7	40	54	10°E	0.4	67.1	9:52am
2	0	0	0.2	0.02	0	0	35.24	23.5	34	46	31°W	1	53.5	10:03am
3	0	0	0	0	0.001	0.003	35.72	20.4	40	54	W	0.2	65.9	10:07am
4	0	0	0	0.01	0	0	37.11	22.2	28	71	W	1	68.9	10:13am
5	0	0	0.1	0.01	0.001	0.004	37.88	19.1	30	83	30°W	3.77	81.5	10:15am
6	0	0	0.1	0.01	0	0.001	38.74	20.1	30	81	6°N	0.83	85.2	10:20am
7	0	0	0	0.01	0	0.001	38.84	22.1	40	54	W	2.74	56.4	10:27am
8	0	0	0	0	0	0	36.6	19	26	70	7°N	1.87	62.2	11:21am
9	0	0	0.1	0.01	0	0	38.23	18.4	25	70	E	1.76	82.1	11:54am
10	0	0	0	0.01	0	0	36.2	17.6	27	72	W	1.15	75.2	12:07am
Min	0	0	0	0	0	0	33.12	17.6	25	46		0.2	53.5	
Max	0	0	0.2	0.02	0.001	0.004	38.84	23.5	40	83		3.77	85.2	
Mean	0	0	0.06	0.008	0.0002	0.0009	36.77	20.31	32	66		1.47	69.8	

APPENDIX E: **Wet Season Results**

A: Water Quality Results

Physico-Chemistry Results for Analysis of Water Samples

S/N	Sample ID	PH	TEMP.OC	COND.µS/cm	TDS mg/l	Turb. NTU	COD mg/l
1	AFR/EIA/W/P1	7.2	25.5	82	39	2.1	2.1
2	AFR/EIA/W/P2	7	24.8	89	42	2	2
3	AFR/EIA/W/P3	8.8	24.8	78	37	2.6	2.2
4	AFR/EIA/W/C1	8.1	25	96	41	2.2	1.6
5	AFR/EIA/W/C2	6.5	25.7	122	57	2	2.1
MIN		6.5	24.8	78	37	2	1.6
MAX		8.8	25.7	122	57	2.6	2.2
MEAN		7.52	25.16	93.4	43.2	2.18	2
Highest Desirable Level by NESREA		7.0 - 8.5	NA	NA	NA	NA	NA
Maximum permissible Level by NESREA		6.5 - 9.2	NA	NA	NA	NA	NA

Metal Results for Analysis of Water Samples

S/N	Sample ID.	Ni (mg/l)	Cd (mg/l)	Cu (mg/l)	Fe (mg/l)	Zn (mg/l)	Mn (mg/l)	Cr (mg/l)	Pb (mg/l)	Co (mg/l)	Ag (mg/l)	V (mg/l)
1	AFR/EIA/W/P1	0.127	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2	AFR/EIA/W/P2	0.35	0.047	<0.001	<0.001	0.039	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3	AFR/EIA/W/P3	0.169	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	AFR/EIA/W/C1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
5	AFR/EIA/W/C2	0.185	<0.001	0.105	0.044	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MIN		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MAX		0.35	0.047	0.105	0.044	0.039	0	0	0	0	0	0
MEAN		0.21	0.05	0.11	0.04	0.03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Highest Desirable Level by NESREA		0.075	0.006	1.5	1	15	NA	0.03	0.08	0.10	NA	NA

Metal Results for Analysis of Plant Samples

S/N	Sample ID.	Ni (mg/l)	Cd (mg/l)	Cu (mg/l)	Fe (mg/l)	Zn (mg/l)
1	P1	44.66	6.558	<0.001	178.3	9.065
2	P2	39.69	13.35	<0.001	493.7	9.616
3	P3	19.63	<0.001	4.815	<0.001	17.14
4	CTRL 1	35.24	<0.001	8.778	144.4	19.08
5	CTRL 2	<0.001	<0.001	18.09	382.9	57.26
6	CTRL 3	<0.001	<0.001	5.152	621.9	11.11
MIN		19.63	6.558	4.815	144.4	9.065
MAX		44.66	13.35	18.09	621.9	57.26
MEAN		34.81	9.95	9.21	364.24	20.55

Organic/ Microbiology Results for Analysis of Water Samples

S/N	Sample ID	O/G mg/l	THC mg/l	THB Cfu/ml	HUB Cfu/ml	THF Cfu/ml	HUF Cfu/ml	Coliform (MPN/100 ml)
1	AFR/EIA/W/P1	<0.01	<0.01	$1.56x10^2$	$0.02X10^2$	$8.60x10^2$	$0.03X10^2$	18+
2	AFR/EIA/W/P2	<0.01	<0.01	$2.31x10^2$	0	$7.20x10^2$	$0.03X10^2$	18+
3	AFR/EIA/W/P3	<0.01	<0.01	$1.67x10^2$	$0.04x10^2$	$4.90x10^2$	$0.03X10^2$	18+
4	AFR/EIA/W/C1	<0.01	<0.01	$1.32x10^2$	$0.03X10^2$	$4.50x10^2$	$0.08X10^2$	18+
5	AFR/EIA/W/C2	<0.01	<0.01	$2.15x10^2$	$0.05X10^2$	$6.90x10^2$	$0.04X10^2$	18+
MIN		**<0.01**	**<0.01**	1.32E+02	2.00E+00	4.50E+02	3.00E+00	18+
MAX		**<0.01**	**<0.01**	2.31E+02	5.00E+00	8.60E+02	8.00E+00	18+
MEAN		**<0.01**	**<0.01**	1.80E+02	3.50E+00	6.42E+02	4.20E+00	18+
Highest Desirable Level by NESREA		0.3	0.3	NA	NA	NA	NA	NA

B: Soil Quality Results

Physico-Chemistry Results for Analysis of Soil Samples (Top)

S/N	Sample ID	pH	TEMP.OC	COND µS/cm	SO_4 mg/kg	NO_3 mg/kg	CO_3^{2-} mg/kg	Moisture content (%)
1	S 1 Top	6.66	26.6	28	2	1.2	0.22	11.62
2	S 2 Top							
3	S 3 Top	8	26.3	110	8	0.6	0.64	12.28
4	S 4 Top		26.6	92	2	0.6	0.88	10.46
5	S 5 Top	7.1	26.5	44	6	0.7	0.56	9.89
6	S 6 Top	7.9	26.4	92	8	1.2	0.54	11.06
7	S 7 Top	8.3	26.3	114	2	0.6	0.2	12.81
8	S 8 Top	8.5	26.9	94	2	0.9	0.55	8.4
9	S 9 Top	7.1	26.6	44	5	1.6	0.11	13.24
10	S 10 Top	7.8	26.7	24	<1	<0.1	0.65	11.46
11	S 11 Top	6.5	26.5	26	<1	0.2	0.81	12.1
12	S 12 Top	7.3	25.9	54	2	<0.1	0.51	11.9
13	S 13 Top	7.5	26.5	74	1	0.3	0.19	7.81
14	S 14 Top	7.4	24.9	110	5	0.14	0.72	10.06
15	S 15 Top	8.1	26.5	92	8	1.2	0.73	10.4
16	S 16 Top	7.7	25.9	56	10	1.4	0.11	11.28
17	S 17 Top	7.5	25.7	70	2	0.8	0.1	10.42
18	S 18 Top	7.4	26.7	44	4	1.4	0.13	9.84
19	S 19 Top	7.1	25.8	56	8	<0.8	0.3	10.11
20	S 20 Top	7.8	26.4	74	6	0.6	0.14	12.04
21	S 21 Top	8.2	26.3	110	10	1.6	0.11	10.11

22	S 22 Top	7.8	27.5	110	14	1.4	0.21	11.46
23	S 23 Top	8.1	25.9	112	4	0.3	0.22	10.03
24	S 24 Top	8.2	25.6	112	6	0.6	0.29	8.44
25	S 25 Top	8.4	25.9	118	4	0.4	0.24	9.26
26	S 26 Top	8.2	26.9	116	3	1.1	0.21	12.67
27	S 27 Top	8	26.4	110	4	0.9	0.14	10.42
28	CTRL 1 Top	6	25.9	42	<1	0.6	0.29	10.24
29	CTRL 2 Top	7	27.5	92	2	0.8	0.3	9.84
30	CTRL 3 Top	6.6	26.3	40	6	0.2	0.15	9.2
	MIN	6	24.9	24	1	0.14	0.1	7.81
	MAX	8.5	27.5	118	65	1.6	0.88	13.24
	MEAN	7.58	26.34	77.93	6.23	0.82	0.35	10.65

Physico-Chemistry Results for Analysis of Soil Samples (Bottom)

Sample ID	pH	TEMP.OC	COND µS/cm	SO_4 mg/kg	NO_3 mg/kg	CO_3^{2-} mg/kg	Moisture content (%)
S 1 Bot	6.9	25.1	28	6	1.8	0.27	10.11
S 2 Bot							
S 3 Bot	8.2	25.2	114	12	1.8	0.78	12.75
S 4 Bot	8.3	24.8	92	6	1.4	0.16	11.02
S 5 Bot	6.3	25.1	44	16	2.6	0.12	10.24
S 6 Bot	8.2	24.7	92	10	2.8	0.76	11.54
S 7 Bot	8.1	25.6	108	4	1.4	0.16	11.34
S 8 Bot	8.6	24.8	94	6	2.8	0.88	9.1
S 9 Bot	7.1	25.7	42	8	2.4	0.1	13.86
S 10 Bot	7.9	24.9	90	4	0.4	0.7	11.81
S 11 Bot	6.8	25.4	38	6	0.6	0.54	11.84
S 12 Bot	8.1	24.6	112	8	0.8	0.46	11.42
S 13 Bot	8	25.7	110	6	0.1	0.82	11.36
S 14 Bot	7.4	24.2	152	12	0.2	0.6	11.08
S 15 Bot	7.6	25.3	116	14	2.6	0.2	10.56
S 16 Bot	7	24.4	56	16	1.8	0.26	12.11
S 17 Bot	7.3	25.3	54	6	2.4	0.49	11.1
S 18 Bot	7.3	26.1	56	9	2.1	0.18	8.4
S 19 Bot	7.2	24.4	54	15	0.8	0.28	11.02
S 20 Bot	7.7	25.9	90	4	1.2	0.55	11.86
S 21 Bot	8.1	24.7	108	8	2.1	0.2	10.28
S 22 Bot	7.8	26.1	92	21	2.4	0.14	11.64
S 23 Bot	8.3	24.2	110	18	0.7	0.15	10.42
S 24 Bot	8.4	24.2	108	12	1.2	0.22	8.9
S 25 Bot	8.3	25.3	95	11	1.6	0.26	9.44
S 26 Bot	8.3	25.4	112	8	1.4	0.28	11.56
S 27 Bot	8.1	26.2	116	5	1.4	0.2	11.01
CTRL 1 Bot	7.8	24.5	114	12	1.2	0.33	10.4
CTRL 2 Bot	6.8	24.9	56	10	1.4	0.31	9.46
CTRL 3 Bot	6.1	25.2	22	3	1.8	0.19	9.04
MIN	6.1	24.2	22	1	0.1	0.1	8.4
MAX	8.6	26.2	152	65	2.8	0.88	13.86

MEAN	7.66	25.10	85.34	6.23	1.56	0.37	10.85

Metal Results for soil samples (Top)

S/N	Sample ID	Ni mg/kg	Cd mg/kg	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Pb (mg/kg)	Ag (mg/kg)	V (mg/kg)
1	S 1 Top	116.8	2.279	24.25	591.7	91.63	631.8	<0.001	<0.001	<0.001
2	S 2 Top									
3	S 3 Top	92.1	<0.001	73.29	481.6	29.14	374.2	<0.001	<0.001	<0.001
4	S 4 Top	<0.001	13.74	21.53	458.2	65.68	215.3	843.3	<0.001	<0.001
5	S 5 Top	81.65	1.536	<0.001	408.6	70.87	324.4	55.51	<0.001	<0.001
6	S 6 Top	83.87	2.622	33.73	373.3	50.44	283.4	149.2	<0.001	<0.001
7	S 7 Top	112.8	<0.001	4.919	277.4	35.63	431.5	<0.001	<0.001	<0.001
8	S 8 Top	53.77	18.84	<0.001	488.5	41.22	337	424.2	<0.001	<0.001
9	S 9 Top	69.74	<0.001	<0.001	505	206.6	496.2	<0.001	<0.001	<0.001
10	S 10 Top	70.75	<0.001	<0.001	590.6	102.3	447.1	114.7	<0.001	<0.001
11	S 11 Top	54.52	4.763	<0.001	516.3	72.81	518.9	<0.001	<0.001	<0.001
12	S 12 Top	102.4	<0.001	95.42	558.5	76.28	216.7	<0.001	<0.001	<0.001
13	S 13 Top	28.91	<0.001	42.12	599.4	105.1	729.5	22.75	<0.001	<0.001
14	S 14 Top	58.3	<0.001	30.39	585.7	37.97	245.1	130.9	<0.001	<0.001
15	S 15 Top	119.3	<0.001	82.65	315.3	35.16	207.8	<0.001	<0.001	<0.001
16	S 16 Top	119.3	<0.001	<0.001	387.5	86.69	216.2	<0.001	<0.001	<0.001
17	S 17 Top	103.1	3.553	37.75	442.7	50.36	278.9	<0.001	<0.001	<0.001
18	S 18 Top	<0.001	<0.001	17.37	524.5	87.63	564.3	237.2	<0.001	<0.001
19	S 19 Top	155.6	2.004	40.75	563.9	70.31	339.6	<0.001	<0.001	<0.001
20	S 20 Top	35.03	<0.001	12.45	419.3	54.14	234.9	<0.001	<0.001	<0.001
21	S 21 Top	133.4	<0.001	8.39	462.6	81.66	301.1	359.6	<0.001	<0.001
22	S 22 Top	54.13	4.393	<0.001	361.2	52.44	176.2	111.2	<0.001	<0.001
23	S 23 Top	<0.001	9.284	19.32	229.4	22.73	207.9	<0.001	<0.001	<0.001
24	S 24 Top	<0.001	33.8	11.34	479.5	151.7	176.3	251.6	<0.001	<0.001
25	S 25 Top	29.65	<0.001	47.55	321.9	50.67	396.9	61.67	<0.001	<0.001
26	S 26 Top	16.91	2.664	12.02	350.7	58.77	<0.001	352.5	<0.001	<0.001
27	S 27 Top	47.09	<0.001	<0.001	355.6	69.04	216.2	28101	<0.001	<0.001
28	CTRL 1 Top	<0.001	<0.001	6.929	412.7	21.57	866	<0.001	<0.001	<0.001
29	CTRL 2 Top	22.73	<0.001	54.31	802.5	18.33	265.4	150.8	<0.001	<0.001

30	CTRL 3 Top	2.385	<0.001	14.08	633.3	13.78	313.2	<0.001	<0.001	<0.001
	MIN	2.385	1.536	4.919	229.4	13.78	176.2	22.75	0	0
	MAX	155.6	33.8	95.42	802.5	206.6	866	28101	0	0
	MEAN	73.51	8.29	32.88	465.43	65.88	357.57	2091.08	#DIV/0!	#DIV/0!

Metal Results for soil samples (Bottom)

Sample ID	Ni mg/kg	Cd mg/kg	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Pb (mg/kg)	Ag (mg/kg)	V (mg/kg)
S 1 Bot	<0.001	<0.001	<0.001	339.9	26	498.8	<0.001	<0.001	<0.001
S 2 Bot									
S 3 Bot	79.43	<0.001	<0.001	386.7	31.18	274.9	<0.001	<0.001	<0.001
S 4 Bot	41.98	<0.001	38.75	570	8.774	315.2	179.5	<0.001	<0.001
S 5 Bot	19.24	10.79	68.52	676.2	10.23	314.5	<0.001	<0.001	<0.001
S 6 Bot	94.05	3.066	91.27	373.4	77.95	286.2	524.9	<0.001	<0.001
S 7 Bot	26.02	<0.001	33.63	445.6	51.69	401.2	326.7	<0.001	<0.001
S 8 Bot	<0.001	<0.001	58.03	278.2	102.4	269.2	51.55	<0.001	<0.001
S 9 Bot	<0.001	<0.001	14.69	242.8	11.6	69.61	381.5	<0.001	<0.001
S 10 Bot	105.2	<0.001	14.65	457.5	63.77	424.5	<0.001	<0.001	<0.001
S 11 Bot	5.337	4.606	<0.001	515.6	41.69	245.8	159.1	<0.001	<0.001
S 12 Bot	<0.001	<0.001	<0.001	387.2	10.97	330.1	<0.001	<0.001	<0.001
S 13 Bot	63.87	<0.001	<0.001	583.4	24.56	349.2	137.3	<0.001	<0.001
S 14 Bot	25.72	<0.001	<0.001	528.6	17.12	146.9	308.7	<0.001	<0.001
S 15 Bot	181.4	20.47	29.69	554.8	99.52	316.3	132.2	<0.001	<0.001
S 16 Bot	<0.001	2.615	8.597	359	32.44	261.9	205.2	<0.001	<0.001
S 17 Bot	<0.001	<0.001	43.56	301.6	43.34	74.81	287.6	<0.001	<0.001
S 18 Bot	177.2	<0.001	52.73	411.2	13.89	206.6	15.15	<0.001	<0.001
S 19 Bot	78.24	0.211	<0.001	647.2	30.1	164.2	147.2	<0.001	<0.001
S 20 Bot	51.66	<0.001	18.34	338.1	46.23	137.9	<0.001	<0.001	<0.001
S 21 Bot	<0.001	3.849	<0.001	460.8	80.69	456.6	150.1	<0.001	<0.001
S 22 Bot	12.24	<0.001	28.16	250.9	74.9	170.5	<0.001	<0.001	<0.001
S 23 Bot	55.99	9.907	<0.001	422.5	30.67	564.7	<0.001	<0.001	<0.001
S 24 Bot	<0.001	<0.001	7.73	438.2	88.15	197.5	<0.001	<0.001	<0.001
S 25 Bot	77.92	7.398	<0.001	183.9	41.56	41.45	<0.001	<0.001	<0.001
S 26 Bot	16.7	<0.001	10.54	211.6	19.92	376.8	<0.001	<0.001	<0.001

S 27 Bot	129.9	<0.001	6.387	401.9	71.75	335.6	<0.001	<0.001	<0.001
CTRL 1 Bot	<0.001	<0.001	16.75	582.4	20.47	671.5	187.4	<0.001	<0.001
CTRL 2 Bot	<0.001	<0.001	11.66	510.2	2.314	46.85	<0.001	<0.001	<0.001
CTRL 3 Bot	0.732	<0.001	11.17	591.7	26.09	130.7	68.11	<0.001	<0.001
MIN	0.732	0.211	6.387	183.9	2.314	41.45	15.15	0	0
MAX	181.4	20.47	91.27	676.2	102.4	671.5	524.9	0	0
MEAN	65.41	6.99	29.73	429.35	41.38	278.62	203.89	#DIV/0!	#DIV/0!

Organic/ Microbiology Results for Analysis of Soil Samples (Top)

S/N	Sample ID	O/G mg/kg	THC mg/kg	THB Cfu/g	THF Cfu/g	HUB Cfu/g	HUF Cfu/g	Coliform (MPN/100 ml)
1	S 1 Top	201.7	128.3	2.72x106	1.52x106	2.40X105	1.80X105	N/A
2	S 2 Top	728.3	172.5	219x106	1.23x106	1.40X105	1.30X105	N/A
3	S 3 Top	201.3	124.6	2.51x106	1.83x106	1.20X105	0.04X105	N/A
4	S 4 Top	1313	516.3	2.47x106	1.53x106	3.50X105	2.30X105	N/A
5	S 5 Top	288.8	148.8	2.63x106	1.93x106	3.70X105	3.20X105	N/A
6	S 6 Top	333.3	175	2.41x106	1.82x106	2.10X105	2.20X105	N/A
7	S 7 Top	953.3	183.3	2.38x106	1.01x106	6.60X105	0.05X105	N/A
8	S 8 Top	595	560	2.71x106	2.12x106	4.40X105	2.30X105	N/A
9	S 9 Top	175	105	2.41x106	1.41x106	4.20X105	1.30X105	N/A
10	S 10 Top	166.7	108.3	2.32x106	1.38x106	5.10X105	1.40X105	N/A
11	S 11 Top	358.8	341.3	2.51x106	1.83x106	4.30X105	0.04X105	N/A
12	S 12 Top	82.5	55	2.18x106	1.20x106	6.60X105	2.30X105	N/A
13	S 13 Top	45.8	36.7	2.72x106	1.81x106	4.20X105	1.70X105	N/A
14	S 14 Top	70	52.5	2.41x106	1.63x106	3.50X105	0.07X105	N/A
15	S 15 Top	100	83.3	2.73x106	2.10x106	2.80X105	2.20X105	N/A
16	S 16 Top	105	35	2.37x106	1.52x106	1.80X105	1.90X105	N/A
17	S 17 Top	504.2	220	2.86x106	1.02x106	5.30X105	4.70X105	N/A
18	S 18 Top	1859	488.8	2.61x106	1.19x106	2.90X105	0.02X105	N/A
19	S 19 Top	927.5	813.8	2.52x106	1.32x106	3.50X105	0.04X105	N/A
20	S 20 Top	1505	1383	2.92x106	1.21x106	1.80X105	0.05X105	N/A
21	S 21 Top	3467	726.3	2.81x106	1.72x106	2.10X106	0.07X105	N/A
22	S 22 Top	34073	12591	2.17x106	1.52x106	2.10X105	0.02X105	N/A
23	S 23 Top	883.8	507.5	2.73x106	2.10x106	1.80X105	0.04X105	N/A
24	S 24 Top	495	265.8	2.71x106	2.11x106	2.40X105	1.30X105	N/A
25	S 25 Top	1024	385	2.82x106	1.17x106	2.50X105	1.10X105	N/A
26	S 26 Top	341.3	78.8	2.21x106	1.51x106	2.10X105	0.01X105	N/A

27	S 27 Top	1192	430.8	2.16x106	1.51x106	3.20X105	0.02X105	N/A
28	CTRL 1 Top	55	36.7	2.26x106	1.43x106	5.20X105	0.02X105	N/A
29	CTRL 2 Top	752.5	253.8	2.46x106	2.02x106	1.50X105	0.09X105	N/A
30	CTRL 3 Top	175	78.8	2.97x106	1.17x106	3.20X105	0.06X105	N/A
	MIN	45.8	35	2.16E+06	1.01E+06	1.20E+05	1.00E+03	N/A
	MAX	3.41E+04	1.26E+04	2.19E+08	2.12E+06	2.10E+06	4.70E+05	N/A
	MEAN	1765.76	702.87	9.76E+06	1.56E+06	3.88E+05	1.05E+05	N/A

Organic/ Microbiology Results for Analysis of Soil Samples (Bottom)

Sample ID	O/G mg/kg	THC mg/kg	THB Cfu/g	THF Cfu/g	HUB Cfu/g	HUF Cfu/g	Coliform (MPN/100 ml)
S 1 Bot	287.5	143.8	2.81x106	1.62x106	4.30X105	2.10X105	N/A
S 2 Bot	210.8	73.3	2.38x106	1.49x106	2.30X105	0.04X105	N/A
S 3 Bot	17.8	8.8	2.31x106	2.11x106	2.90X105	1.70X105	N/A
S 4 Bot	191.7	100	2.82x106	2.21x106	2.70X105	0.08X105	N/A
S 5 Bot	175	96.3	2.77x106	1.31x106	3.40X105	1.40X105	N/A
S 6 Bot	481.3	210	2.15x106	1.43x106	2.10X105	2.10X105	N/A
S 7 Bot	311.7	183.3	2.52x106	1.92x106	4.30X105	1.10X105	N/A
S 8 Bot	577.5	288.8	2.23x106	1.52x106	3.40X105	2.70X105	N/A
S 9 Bot	140	78.8	2.18x106	1.52x106	3.10X105	1.40X105	N/A
S 10 Bot	216.7	116.7	2.66x106	2.01x106	2.20X105	1.40X105	N/A
S 11 Bot	358.8	148.8	2.43x106	1.51x106	3.70X105	1.10X105	N/A
S 12 Bot	27.5	18.3	2.81x106	1.51x106	3.10X105	0.09X105	N/A
S 13 Bot	45.8	36.7	2.55x106	1.92x106	2.20X105	0.04X105	N/A
S 14 Bot	70	43.8	2.52x106	1.62x106	4.30X105	2.10X105	N/A
S 15 Bot	52.5	43.8	2.41x106	1.21x106	2.80X105	2.30X105	N/A
S 16 Bot	43.8	35	2.51x106	1.32x106	1.30X105	0.04X105	N/A
S 17 Bot	345	143.8	2.52x106	1.58x106	3.10X105	2.70X105	N/A
S 18 Bot	2177	385	2.44x106	1.41x106	2.10X105	2.10X105	N/A
S 19 Bot	175	158.3	2.43x106	1.22x106	2.60X105	1.60X105	N/A
S 20 Bot	1199	726.3	2.79x106	1.16x106	3.70X105	0.04X105	N/A
S 21 Bot	1675	741.7	2.55x106	1.23x106	1.90X105	1.20X105	N/A
S 22 Bot	7737	2539	2.66x106	1.61x106	2.20X105	0.01X105	N/A
S 23 Bot	516.3	297.5	2.21x106	1.62x106	2.20X105	1.60X105	N/A
S 24 Bot	408.3	275	2.44x106	1.52x106	1.80X105	0.09X105	N/A
S 25 Bot	3633	1250	2.64x106	1.82x106	1.20X105	2.00X105	N/A
S 26 Bot	586.3	245	2.52x106	1.22x106	1.80X105	0.04X105	N/A
S 27 Bot	813.8	227.5	2.41x106	1.23x106	2.20X105	0.02X105	N/A
CTRL 1 Bot	55	36.7	2.96x106	1.32x106	2.60X105	0.03X105	N/A
CTRL 2 Bot	583.3	250	2.91x106	2.04x106	2.10X105	0.04X105	N/A
CTRL 3 Bot	463.8	192.5	2.52x106	1.92x106	2.20X105	1.60X105	N/A
MIN	1.78E+01	8.80E+00	2.15E+06	1.16E+06	1.20E+05	1.00E+03	N/A

MAX	7.74E+03	2.54E+03	2.96E+06	2.21E+06	4.30E+05	2.70E+05	N/A
MEAN	7.86E+02	3.03E+02	2.54E+06	1.57E+06	2.66E+05	1.09E+05	N/A

C: Air Quality Results

S/No	Sample ID	SO_2 (µg/m3)	O_3 (µg/m3)	NO_2 (µg/m3)	CO (µg/m3)	H_2S (µg/m3)	VOC (µg/m3)	Ambient Temp (°C)	Relative Humidity(%)	SPM (µg/m^3) PM 2.5	SPM (µg/m^3) PM 10	Wind direction (degrees)	Wind Speed (m/s)	Noise Level (dBA)	Time
1	AF/EIA/AQ1	0	0	0	0	0	0.001	29.89	55.8	20	122	1°NW	2.1	68.1	9:36am
2	AF/EIA/AQ2	0	0	0.1	0	0	0	30.2	49.6	19	115	23°NW	0.4	67	9:22am
3	AF/EIA/AQ3	0	0	0	0	0	0.003	30.9	53.6	20	122	W	1.4	67.7	9:43am
4	AF/EIA/AQ4	0	0	0	0.1	0	0	31.1	60.9	20	121	1°NE	0.7	65.6	9:30am
5	AF/EIA/AQ5	0	0	0	0	0	0	30.5	53.4	16	87	6°NW	0.6	68.1	9:49am
6	AF/EIA/AQ6	0	0	0.1	0	0	0	31.5	57.3	22	138	12°SE	1.4	62.5	9:58am
7	AF/EIA/AQ7	0	0	0	0	0	0.001	28.5	42.9	24	150	6°NW	0.2	56	9:15am
8	AF/EIA/AQ/Ctrl1	0	0	0	0	0	0.001	31.8	61.3	26	182	26°SE	2.3	72.8	10:27am
9	AF/EIA/AQ/Ctrl2	0	0	0.1	0	0	0.003	28.24	59.5	27	165	87°SW	2.3	75.3	10:14am
10	AF/EIA/AQ/Ctrl3	0	0	0.1	0.1	0	0.001	29.6	62.8	25	151	59°NE	2.5	88.7	10:36am
Min		0.00	0.00	0.00	0.00	0.00	0.00	28.50	42.90	16.00	87.00		0.20	56.00	
Max		0.00	0.00	0.10	0.10	0.00	0.00	31.50	60.90	24.00	150.00		2.10	68.10	
Mean		0.00	0.00	0.03	0.01	0.00	0.00	30.37	53.36	20.14	122.14		0.97	65.00	
Mean for control Locations		0.00	0.00	0.07	0.03	0.00	0.00	29.88	61.20	26.00	166.00		2.37	78.93	

APPENDIX F: Traffic Impact Assessment Report