EIA

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
OF PROPOSED
SHOPPING MALL
IN PORT HARCOURT, RIVER STATE

SUBMITTED BY

QUITON INTERNATIONAL LTD

TO

FEDERAL MINISTRY OF ENVIRONMENT
MABUSHI, ABUJA

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ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OF PROPOSED

DEVELOPMENT OF SHOPPING MALL IN PORT HARCOURT, RIVER STATE

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List of Abbreviations /Acronyms

Abbreviation/ Acronyms	Meaning
%	Percentage
<	Less than
A.C. I	American Concrete Institute
A.S.T.M	American society for testing and material
AISC	American Institute of Steel Construction
ALARP	As low As Reasonably Possible
APHA	American Public Health Association
AQ	Air and Noise
ARV	Anti-retroviral drugs
BAT	Best Available Technology
BOD	Biochemical Oxygen Demand
C	Carbon
Ca	Calcium
CDC	Community Development Committee
CEC	Cation Exchange Capacity
cfu/g	Colony forming unit per gram
cfu/ml	Colony forming unit per millilitre
Cl^-	Chloride
Cm	Centimetre
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Cu	Copper
Db	Decibel
E	East, Easting
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency in USA
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FMEnv	Federal Ministry of Environment
FRSC	Federal Road Safety Corps
GC	Gas Chromatograph
GPS	Global Positioning System
H_2SO_4	Tetraoxosulpate (VI) acid
Ha	Hectare
HAZOP	Hazard and Operability
HEMP	Hazards and effects Management Process
HNO_3	Nitric acid
HP	High Pressure
HSE	Health, Safety, and Environment
HUB	Hydrocarbon Utilizing Bacteria
HUF	Hydrocarbon Utilizing Fungi
IFC	International Finance Corporation
JBN	Julius Berger Nigeria PLC
Km	Kilometres
LGA	Local Government Area
M	Metres
Max	Maximum
mg/kg	milligram per kilogram
mg/l	milligram per litre
Min.	Minimum

Abbreviation/ Acronyms	Meaning
Ml	Millilitre
Mm	Millimetre
ms^{-1}	metres per second
N	North
N	Northings
NE	North East
NGOs	Non-Governmental Organizations
NMT	Non-Motorised Transport
Nox	Nitrogen Oxides
^{O}C	Degree Celsius
PAC	Project Affected Community
PAH	Poly Aromatic Hydrocarbon
PC	Personal Computer
pH	Hydrogen ion Concentration
Ppm	Parts Per Million
Ppt	Parts Per Thousand
PDS	Particulate Size Distribution
PTDF	Petroleum Technology Development Fund
PU	Per Unit
QC/QA	Quality Control /Quality Assurance
QHSE	Quality, Health Safety and Environment
RE	Resident Engineer
RMEnv	Rivers State Ministry of Environment
RS	Rivers State
S	South
SE	South East
SPM	Suspended Particulate Matter
Spp.	Species
SSW	South-South West
STDs	Sexually Transmitted Diseases
STIs	Sexually Transmitted Infections
SW	South West
TDS	Total Dissolved Solid
TFC	Total Fungal Count
THB	Total Heterotrophic Bacterial Count
THC	Total Hydrocarbon Content
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
VIO	Vehicle Inspection Office
VOC	Volatile Organic Carbon
W	West
WHO	World Health Organization

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EXECUTIVE SUMMARY

E1.1 Introduction

The proposed project is a shopping mall with all the facilities and utilities needed at No. 4 Old Aba Road, Port Harcourt, on a plot of land of about 21000 sqm. The proposed Mall contains a main tenant (supermarket), various shops, restaurants, cinemas, and an entertainment hall. The mall has underground parking lots additional to the external parking area.

The Shopping Mall project construction involves:

- Site Clearing of all vegetation
- Earth Work
- Construction

E1.2 Quiton's Intent

Quiton International Ltd (Quiton), the proponent, recognizes the importance of comprehensive Environmental Planning and Management to the success of any project and is committed to the necessary studies to understand the environmental system of the proposed project area to address areas where significant negative environmental impacts (natural, physical and social) may occur, intending to address them, adequately.

In pursuance of this, Quiton is conducting an Environmental Impact Assessment (EIA) of the project, before the commencement of the project. This intention is in line with the Federal Ministry of Environment's (FMEnv's) Environmental Impact Assessment Procedural/Sectoral Guidelines for infrastructural projects as well as other international environmental standards.

E1.3 Proposed Project Location

The proposed Shopping Mall project is located at 4, Old Aba – Port Harcourt Road, Obi/Akpor LGA, Port Harcourt, on a 2.15 ha of land, defined by latitude 4.835117° and longitude 7.021434°

E1.4 Legal and Administrative Framework for EIA In Nigeria

The legal, regulatory and policy framework for carrying out the EIA of the proposed Shopping Mall project is contained in the applicable acts and regulations of the Federal and State Government, statutes and international conventions to which the Nigerian Government is a signatory.

Federal Ministry of the Environment

Federal Ministry of the Environment developed National EIA procedures following the enablement of the EIA Act CAP E12 LFN 2004. The procedure indicates the steps to be followed from project conception to commissioning to ensure that the project is implemented with maximum consideration for the environment.

Other applicable national laws and regulations include

- Harmful Waste (Special Criminal Provisions) Act, CAP H1, LFN 2004

- Criminal Code Act
- Land Use Act CAP 202, LFN 2004
- The Labour Act of 1990
- The Nigerian Urban and Regional Planning Act CAP N138, LFN 2004
- Federal Road Safety Act
- Engineering Standards and odes

Rivers State Ministry of Environment

The Rivers State Ministry of Environment (RMEnv) has the overall responsibility (directly or indirectly through various agencies) of environmental protection within the State.

International Regulations and Conventions

The following conventions and treaties support the use of EIA as key tool to achieving pollution control and sustainable environmental development and Nigeria is a signatory to them.

S/NO	Regulations	Year Adopted
1.	World Bank Environmental Assessment Source Books	1998
2.	UN Convention on Biological Diversity	1994
3.	UN Framework Convention on Climate Change	1992
4.	Convention on the Control of trans-boundary Movements of Hazardo Waste and their Disposal of 1989 (Basal Convention)	1989
5.	Protocol on Substances that Deplete the Ozone Layer. Note: The Protocol was amended for the first time on 29 June 1990 in London. A second set of amendments was adopted in Copenhagen in November 1992; these entered into force on 1994.	1987
6.	Convention for the Protection of the Ozone Layer	1985
7.	Convention Concerning the protection of the World Cultural and Natio Heritage (World Heritage Convention)	1972
8.	African Convention on the Conservation of nature and Natural Resources	1968

E1.5 Environmental Impact Assessment

Quiton has undertaken this environmental impact Assessment (EIA), to predict the impacts of this proposed Shopping Mall development on the environment and propose mitigation measures that will be incorporated into the project environmental management plan and detailed engineering design. The EIA covers:

- Baseline studies – including biophysical studies, social and health impact assessment
- Consultation programmes
- Environmental quality assessment and impact quantification, using predictive modelling tools.

The EIA is being carried out in parallel with the conceptual design of the project, to ensure that any identified adverse impacts are addressed in the detailed design and mitigated during the development activity stages which Involve site preparation, construction, commissioning, operation, decommissioning and abandonment.

E1.6 Terms of Reference for the EIA

In line with the EIA Procedural guidelines (FMEnv, 1995) the terms of reference (ToR) for EIA of the Shopping Mall project was submitted to the FMEnv and approval obtained, defining the scope of work, objectives, baseline data requirements and assessment tools and methods for the EIA.

❖ Objectives of the EIA

This EIA is executed to establish the environmental baseline, sensitivities, impacts and mitigation measures with respect to the development (including operation) of the proposed Shopping Mall project. The EIA will ensure the effective systematic study process. These include:

- assessment of the present environment status, establishment of environmental issues and factors which are associated with the Shopping Mall project development;
- assessment and prediction of all possible and potential impacts of the project on components of the environment in terms of magnitude and significance;
- evaluation of alternatives and identification of the best options that is both cost effective and with least potential environmental impact; and
- incorporation of EIA recommendations into the Shopping Mall project's detailed design as well as other stages of the project development.

❖ Structure of the EIA Report

The EIA Report is presented in eight chapters, containing background information and the legal and administrative framework for EIA in Nigeria among other information; project justification, the need/value and its envisaged sustainability as well as the project development and site/route options considered; detailed description of the proposed project including its location, overall layout, basis for design, type and specifications of equipment / facilities to be installed and operation/maintenance of the proposed Shopping Mall; description of the existing environment, consultation with stakeholders; identified potential and associated environmental impacts of the proposed project; the various mitigation measures proffered against the identified significant impacts; a cost-effective environmental management plan that would be adopted throughout the project's lifecycle; and conclusions the report and requests approval for project implementation.

E2.1 Project Objectives

The objectives of the proposed project are to create employments opportunities, engender competition which could reduce the prices of goods in Port Harcourt, Improvement of the local, state and national economies; Make return on investment.

E2.2 Need for the Project

Quiton's intention to undertake the development of Shopping Mall in Port Harcourt is based on the need to provide a secure, decent and accessible commercial infrastructure where trading in most vital goods and services can be obtained in one place.

E2.3 Envisaged Sustainability

The sustainability of this project stems from the fact that it will satisfy economic contributions, meet the demand for safe and secure commercial infrastructure, and also maintain environmental friendliness. The sustainable development philosophy of minimizing land-take, cost and the impact on the environment shall be adopted for this development project. The set goal is, "meeting the needs of the present without compromising the ability of future generations to meet their own needs".

E2.4 Project Options and Alternatives

The project following project options were considered based on the health, safety and environmental impacts; best available technology; and economic/social considerations:

Option 1: Do Nothing Option

This implies maintaining the status quo by not constructing the proposed Shopping Mall and investing the available funds in other projects.

This would imply that the opportunity for potential benefits of a mega commercial infrastructure, employment creation will be missed; and there will be no environmental impact due to construction but increased impacts on prospective customers in the catchment area, who have to commute longer distances to get supplies.

This option was rejected because it does not promote the potential economic development and sustainability of the City.

Option 2: Delayed Option

This implies the implementation of the proposed project at a later time for such reasons as lack of funds, communal crises, war, etc. This option was rejected since none of these situations is obtainable and the proposed Shopping Mall construction is urgently needed.

Option 3: Construction of the proposed Shopping Mall

This option was accepted for implementation because of the need to harness potential economic development of the state for the benefit of all and sundry in the City.

E3.1 Project Description

E3.2 Introduction

The proposed project is a shopping mall with all the facilities and utilities needed at No. 4 Old Aba Road, Port Harcourt, on a plot of land of about 21000 sqm. The proposed Mall contains a maintenant (supermarket), various shops, restaurants, cinemas and an entertainment hall. The mall has underground parking lots**,** additional to the external parking area. The Shopping Mall project construction will involve site clearing of all debris, earth work and construction.

E3.3 Site Plan

- The proposed project we have two (2) major access way, one for entrance and the other serves as exist.
- Parking lot for cars is sufficient. An average of about 300 cars can park at peak hours.
- Wider road network within the parking lot with asphalt concrete finishing. The parking lot is finished with interlocking stone.
- Good landscape area with much cover for green area.
- The main building is within the centre of the land, having a parking area at the front and back

E3.4 Foundation Layout

- It occupies a land area of about 3,000m^2.
- The foundation layout has 2 lifts, from the basement floor to the final floor, including a staircase support with columns of 400*400mm thick.
- The space of the beam from one column to the next column is above .5m and 8.0m in some sides of the building.

E3.5 Slab Above Ground Floor

- It has a beam span with an average of 7.6m, with 1m to 1m spacing.
- Beam sizes of 400m/850m.beam size above ground floor is 4.55m in height.

E3.6 Elevation

- The facade of the building is well finished with concrete slab cutting glasswall is finished with effect of wall tiles and their board (wall cladding).
- Steel pipe columns is used for support and finishing.

E3.7The major equipment to be deployed for the construction of the proposed Shopping Mall levels; geology

Climate and Air Quality

The measured mean wind speed within the field ranged from 0.31 - 2.04 m/s with the mean of 0.878±0.57. The prevailing wind directions were predominantly northeasterly and southeasterly.

Measured mean temperatures within the field ranged from 26.3 - 27.8 °C with the mean of 27.192±0.52 while relative humidity ranged from 79.3 - 84.6 % averaging 82.862±1.88. Based on the previous data, rain falls throughout the year in the region. On the average, the region receives annual rainfall of over 2,472mm; however it is not uncommon to record total annual rainfall of over 3,200mm, for a very wet year. The monthly variation was a minimum of 20 mm in January and a maximum of 355 mm in July. Air quality studies indicated that concentrations of NO_2, SO_2, CO_2 and CO were higher than the regulatory limits at many sampling locations. However, caution must be taken in interpreting these results because of the relatively short averaging sampling times (5 – 10 m) used in this study, compared to the averaging times of 8-24 hours used for regulatory limits (EIA Saghara AGS Project, 2015). On the other hand, it is equally probable that these concentrations may remain at these levels over longer periods.

Air Microbiology

Bacterial concentrations ranged from 5.2×10^5 - 9.8×10^5 cfu/m^3 while that of fungal isolates ranged from 1.02×10^6 - 1.25×10^6 cfu/m^3. 28 microbial genera were isolated from the study area, 12 of which were bacteria while 16 fungi. The high incidence of the microbial isolates may be associated with indiscriminate disposal of solid wastes in uncovered public drains. Improved waste management approaches may help in curtailing the discharge of microbial contaminants into the atmosphere. In other word, bio-aerosols will have significant impact on the proposed Shopping Mall project.

Heavy Metal Content

The concentrations of lead, arsenic, chromium, mercury, cadmium, nickel and vanadium ranged from 1.129 – 1.422 mg/m^3 with the mean of 1.264±0.1 mg/m^3; 0.005 – 0.018 mg/m^3 with the mean of 0.0124±0.004 mg/m^3; 0.215 – 0.247 mg/m^3 with the mean of 0.233±0.01 mg/m^3; 0.001 – 0.007 mg/m^3 with the mean of 0.004±0.002 mg/m^3; 3.114 – 3.421 mg/m^3 with the mean of 3.258±0.12 mg/m^3; 1.023 – 1.201 mg/m^3 with the mean of 1.088±0.07 mg/m^3 and 0.003 – 0.016 mg/m^3 with the mean of 0.01±0.004 mg/m^3 respectively. These values showed high concentrations of metals in air indicative of pollution largely by automobile.

Noise Concentration

The ambient noise levels ranged from 71.6 - 87.2 dB(A) with the mean of 80±4.92 dB(A). The highest recorded value of 87.2 dB(A) was above the WHO permissible limit of 85 dB(A) for 8 hourly exposures. The major noise pollution contributing factors were dense human and vehicular traffic.

- ✓ **Water Chemistry**

Potable water pH is widely used to express the intensity of acidity or alkalinity of water. The pH plays an important role in all chemical reactions associated with formation, alteration and de-solution of minerals in water. Recorded pH values ranged from 6.75 – 6.82 with the mean of 6.788±0.03. Temperature values ranged from 26.5 – 27.6 ^oC with the mean of 27.02±0.5 ^oC. Turbidity values ranged from 0.53 – 0.62 NTU with the mean of 0.568±0.03 NTU. The recorded values of turbidity were lower than the WHO limit of 5 NTU. TDS values ranged from 7.1 – 7.35 mg/l with the mean of 7.24±0.11 mg/l. These concentrations were acceptable for potable water quality as they were below the FMEnv

and WHO limits of 2000 and 1000mg/l respectively. Salinity values ranged from 0.0071 – 0.0074 ppt with the mean of 0.0073±0.0001 ppt. Neither WHO nor FMEnv has assigned permissible limit for salinity in drinking water. TSS values ranged from 0.22 – 0.26 mg/l with the mean of 0.238±0.01 mg/l. Electrical conductivity values ranged from 14.2 – 14.7 µS/cm with the mean of 14.48±0.23 µS/cm. These values are consistent with recorded values in the region (Periyasamy and Rajan, 2009). However, there is no WHO recommended limit for conductivity in drinking water.

The hardness concentrations ranged from 12.6 - 14.6 mg/l with the average of 13.84±0.78 mg/l. However, levels of hardness were within the WHO and the FMEnv limits in drinking water. The results also showed that there was no significant variation in the samples.
The concentration of dispersed THC is an important parameter for water quality and safety. THC in water can cause surface films and shoreline deposits leading to environmental degradation, and can induce human health risks when discharged in surface or ground waters. Additionally, THC may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency. The concentrations of the THC were less than the equipment detection limit of 1.00mg/l. There is no recommended WHO limit for THC in drinking water.

- ✓ The measured value of BOD level (<0.01) was less than equipment detection level. There is however, no recommended WHO limit for BOD in drinking water.
- ✓ Chemical oxygen demand (COD) describes the amount of oxygen required to breakdown chemical substance in industrial effluent. The measured COD level was less than equipment detection level. There is no recommended WHO limit for COD in drinking water.
  The nitrate concentrations ranged from 0.31 - 0.37 mg/l with the average of 0.338±0.02 mg/l. These values are below the WHO and the FMEnv recommended limit for potable water quality of 10.0 mg/l.
- ✓
  The phosphate concentrations ranged from 0.11 - 0.18 mg/l with the average of 0.148±0.03 mg/l. However, both WHO and FMEnv have no recommended limit for phosphate in drinking water. These values also compared well with recorded concentration in the region (Periyasamy and Rayan, 2009).
- ✓
  The sulphate concentrations ranged from 0.33 - 0.47 mg/l with the average of 0.402±0.05 mg/l. The concentrations were within the WHO recommended limit for drinking water quality of 250 mg/l.
  -
  The availability of heavy metals (such as iron and manganese) in potable water is controlled by physical and chemical interactions. These interactions are affected by factors like pH, temperature, type and concentration of available legands and chelating agents, as well as type and concentrations of the metal ions. Concerns over heavy metals in drinking water relate to their toxicity, bio-accumulation and hazards to human and animal health (Kikuchi *et a*l., 2009; Seshan *et al*., 2010).

The heavy metals: Pb., Cr, were not detected in the groundwater and the surface water samples, except Fe, Cu, Ba and Zn, and their concentrations were below their respective regulatory limits except Fe that was above permissible limits in surface water samples. The equipment detection limits for the various heavy metals analyzed were as follows in mg/l: Arsenic = 0.001, Mercury = 0.0002, Selenium = 0.001, Lead = 0.01, Copper = 0.05, Chromium = 0.001, Cadmium = 0.002, Manganese = 0.10, Iron =<0.05 and Zinc = 0.05, some of them were detected in the samples, and were within the WHO limit (Tables 4.1). This implies that the measured parameters (heavy metals) were all within their respective WHO limit for groundwater.

Soil Physico-chemistry

The textural class was mainly sandy loam. The soil was largely grayish brown and brown in color and well drained. The low inherent fertility of the soil showed up in the low total organic carbon, low clay and low essential plant nutrients concentration in the soil. The mean concentration of heavy metals was within the natural limits in soil environment.

- ✓ **Soil Microbiology**

are listedGenerally, soil biology is the scientific study of life in and on the soil. This entails the study of various kinds of micro-organisms; those studied are bacteria and fungi, which are most important organic matter decomposers in the soil. They form symbiotic and mutual relationships in which two different organisms live together and benefit from each other. The summary of microbial organisms of the study area is presented in Table E34.3. Total heterotrophic bacteria (cfu/g) ranged from 1.8×10^5 and 4.1×10^5; Total heterotrophic fungi (cfu/g) ranged from 1.3×10^5 and 4.5×10^5; Hydrocarbon utilizing bacteria (cfu/g) ranged from 1.0×10^5 and 2.6×10^5, and Hydrocarbon utilizing fungi (cfu/g) ranged from 1.8×10^5 and 3.8×10^5. 39 genera of microorganisms were isolated, out of which 20 were bacteria and 19 fungi.

High heterotrophic activity of the ecosystem indicates the high nutrition status of the environment. The incidence of hydrocarbon utilizing bacteria (HUB) in the soil, and their absence in the ground water samples is an indication of the fact that the environment is free of hydrocarbon contaminants.

- ✓ **Appearance**

The presence of dissolved and suspended organic materials and compounds of calcium and iron (Shelton, 1991) can cause colour in drinking water. However, the water samples collected from Rumuola axis, Tombia axis, and Ezimgbu axis were all clear in appearance. All samples conformed to WHO recommended standard for any water suitable for drinking.

Table E3: Major Project Equipment

SN	*Equipment*	*Number*
1.	Air Compressor	3

2.	Ambulance	2
3.	Back-hoe Loader	3
4.	Borehole machine	2
5.	Bulldozer	6
6.	Concrete Batching Plant	1
7.	Concrete Mixing Machine	1
8.	Concrete Pump (Mobile)	3
9.	Crawler Crane	1
10.	Dump Truck	24
11.	Excavator	4
12.	Excavator + hammer	3
13.	Forklift	7
14.	Fuel Tanker	7
15.	Generator	6
16.	Grader	6
17.	Iron Cut and Bend	10
18.	Light Equipment	1
19.	Loader	6
20.	Lubrication, Maintenance and Rescue Truck Rumuomasi y	2
21.	Maintenance Workshop	2
22.	Mini Excavator	6
23.	Mini Loader	6
24.	Mixing Plant	3
25.	Mobile Crane	3
26.	Mobile welding machine	13
27.	Paver (Ballast Laying)	3
28.	Pick - up (double deck)	12
29.	Portal Crane	4
30.	Precast Plant	1
31.	Refrigerated vehicle	2
32.	Road Car	15
33.	Rotary Driller	1
34.	Sand Washing Plant	1
35.	Scale	6
36.	Screen Plant	1
37. construction	Shotcrete Pump - Dry	8
38.	Shotcrete Pump - Wet	3
39.	Survey Equipment Set	1
40.	Survey Equipment Set for Machinery	1
41.	Tower Crane	2
42.	Tower Light	30

43.	Tractor	4
44.	Trencher	1
45.	Vibro roller	19
46.	Wagon	6
47.	Wastewater tanker	6
48.	Water tanker	6

E3.8 Waste Management

The waste management plan for the proposed project has been informed by the understanding of the possible waste characteristics.

The construction waste to be considered includes: -

- ✓ Demolition waste – concrete, soil, sand, metals
- ✓ Soil: excavated soil which will be reused as backfilling materials for the Shopping Mall foundations.
- ✓ Oil: oil & grease from malfunctioning vehicles and equipment at site
- ✓ Office waste and domestic solid waste (refuse): this is generated at the construction site.

E3.9 Proposed Maintenance Plan

Quiton is committed to making sure that the proposed Shopping Mall, on commissioning, is safe and efficient for all travellers.

A general maintenance inspection is conducted at least twice a year. The bridge inspectors are trained engineers and technicians with several years of Shopping Mall-related experience.

During inspection, inspectors will carefully assess each part of the Shopping Mall and identify any maintenance work that needs to be completed. Each Shopping Mall bridge component, as shown in the following pictures, is rigorously examined to ensure that Shopping Mall remains safe for travel.

There are four kinds of inspections the proposed Shopping Mall will undergo throughout its lifetime. They include:

- **Detailed visual inspection** which will occur every two years.
- **General maintenance inspection**, which takes place twice a year.
- **Road patrol inspection**, which takes place on a regular basis.
- **An emergency inspection** takes place after a major vehicle collision involving one or more Shopping Mall components, a flood, an earthquake, etc. This type of inspection is carried out by a trained, professional engineer.

E3.10 Test Methods

Inspectors also use technology when testing certain Shopping Mall components. Some of the testing techniques that can be used include external technology testing, steel fatigue inspections, internal technology testing, and Shopping Mall load capacity tests

E3.11 Project Execution Schedule

The proposed Shopping Mall project execution is scheduled to take 16 months.

E4. Existing Environmental Data Acquisition

E4.1 Scope of Study

Field studies and data collection for characterization of the baseline conditions of the project environment using a radius of 500m as Area of Influence, in line with the TOR approved by the FMEnv.: climate and meteorology; air quality and noise levels; geology/hydrogeology; soil & ground water qualities; socio economics/health impact, demography and community characteristics.

The entire area is built-up, therefore there were no flora, fauna, and surface water studies.

E4.2 Baseline Data Acquisition Methods

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

The data gathering exercise was undertaken on the between 25th through 30th August, 2020.

E4.3 Baseline Data

The meteorological and micro climatic conditions of the study area were characterized using relative humidity, temperature, atmospheric pressure, and wind speed and wind direction.

The study area is situated within the tropical wet climatic belt. The mean annual rainfall for the study environment is above 2300mm. Average highest rainfall peaks were attained in September (370mm), July (364mm) and August (325mm). Lowest rainfall values were attained in January (15.3mm) and December (19.2mm).

Temperature was low toward southern part of the shopping mall ranging from 26.30-27.10 ^{o}C. It recorded highest toward north of the study area ranging from 28.31-28.70 ^{o}C. Moderate concentration was observed in other part of the study area including PH-Aba expressway, Stadium Road, Old Aba Road, Market Road, among others ranging from 27.31-28.10 ^{o}C.

Due to the moist nature of the atmospheric environment in the study area, relative humidity is always high throughout the years. Relative humidity recorded throughout the entire Shopping Mall location ranging from 83.16-84.80 %. Lowest was recorded toward north of the study area, Market Road, Onwuchekwa Street, Stadium Road, Bende street ranging from 78.20-80.95 %.

South of the study area recorded lowest wind speed ranging from 0.12-0.60 m/s. Edges of the Shopping Mall, PH-Aba Expressway by Market Road and Stadium Road by Uyo Street recorded unique

wind speed of 0.29-0.44 m/s. Highest wind speed was only observed toward Old Aba Road by Market Road ranging from 1.56-2.02 m/s

Noise level did not exceed FMEnv permissible limits. Noise level recorded lowest toward south of Market Road and north of the study area ranging from 60.50-67.17 [dB(A)]. Highest concentration of noise was recorded throughout PH-Aba Expressway and Old Aba Road as well as the northern part of the Shopping Mall [80.52-87.19dB (A)]. This may be rightly attributed to the high influx of vehicle. Noise level was observed to be moderate towards the south of the Shopping Mall, Uyo Street and part of Market Road ranging from 76.08-80.51 [dB(A)].
CO concentration did not exceed FMEnv permissible limit of 10.0 – 20.0ppm. However, it was noted that toward some sections of PH-Aba Road and perhaps the northern part of the Shopping Mall, CO concentration was moderate, ranging from 4.51-5.69 ppm. The southern parts of the mall experience a significant reduction in CO concentration ranging from 2.76-3.92 ppm. The least concentration was observed towards south and south-eastern part of the study area and extreme east, which covers most part of Market Road, Onwuchekwa street, Old Aba Road and the entire Bende Street.

Peak concentration of SO_2 was recorded northwestern part of the Shopping Mall, west of PH-Aba Road, Stadium Road, Market Road, Bende Street and Onwuchekwa Street ranging from 0.19-0.20 ppm. Lowest concentration centered around east of the Shopping Mall, Market Road by PH-Aba Road axis, south of Uyo Street and the northern part of the study area within the range of 0.10-0.13 ppm. The recorded levels of SO_2 were above the FMEnv regulatory limits of 0.01ppm – 0.1ppm for daily average of 8-hourly values in Nigeria.

H_2S recorded lowest concentration toward the southern part of the Shopping Mall likewise all three control points ranging from 0.00-0.07 ppm. A slight increase in its concentration was observed in the northeastern side of the mall toward Old Aba Road ranging from 0.09-0.12ppm. Its highest concentration was recorded in the northern part of the study area along PH-Aba Road ranging from 0.16-0.20 ppm. No permissible value for H_2S has been given by Federal Ministry of Environment.

The spatial dispersion model of NO_2 concentration within the study area indicate that NO_2 reaches its highest concentration towards northeastern part of the shopping mall, Old Aba Road axis by Market Road, PH-Aba express by Stadium Road and the extreme north of the study area ranging from 0.14-0.2 ppm. Its lowest concentration was observed at the extreme east of Old Aba Road and south of Uyo Street ranging from 0-0.08 ppm. However, the recorded values were all above the Federal Ministry of Environment's limits of 0.04-0.06ppm.

HCN recorded lowest in the south, east and western part of the study area ranging from 0.17-0.67 ppm. The northern part of the map recorded highest concentration including the Shopping Mall ranging from 1.34-2.00 ppm. However, the FMEnv has no limit for HCN.
NH_3 (ppm) was observed to have recorded lowest concentration toward North-Eastern part of the Shopping Mall by Old Aba Road and towards the air quality control points. Its highest concentration (5 ppm) was observed north of PH-Aba expressway while towards Stadium Road, Market Road, Bende

Stree, Onwuchekwa Street, its concentration was in moderation (ranging from 3.51-4.25 ppm). The recorded levels of ammonia were below FMEnv permissible limits of 200ppm.
Towards west of the study area recorded highest concentration (0.23-0.30ppm) while moderate concentration centre around PH-Aba express by stadium road and extreme east of Old Aba Road ranging from 0.13-0.20ppm. The least concentration was recorded around south of Market Road and extreme north of the study area within the range of 0.03-0.08ppm. It should be noted that the concentration of Cl_2 did not exceed FMEnv limit across the entire study area. Federal Ministry of Environment has not given permissible value for Cl_2.

$PM_{2.5}$ indicates moderate concentration (though not exceeding FMEnv limits) around the Shopping Mall ranging from 37.40-41.70 µg/m^3. Only south and extreme east of the study area recorded the lowest (31.00-35.23 µg/m^3). Its highest concentration was found at the northeastern part of the Shopping Mall by Old Aba Road and PH-Aba Road by Stadium Road ranging from 39.55-44.93 µg/m^3.

PM_{10} recorded least around the study area boundary which covers part of Stadium Road, Uyo Street, Market Street, Bende Street, Onwuchekwa Street, Old Aba Road ranging from 58.00-65.95µg/m^3. Moderate concentration was found around north of the study area and east of the Shopping Mall by Old Aba Road ranging from 71.93-81.86 µg/m^3.
TVOC recorded peak concentration toward northwestern part of the shopping mall and south of Market Road ranging from 0.09-0.12 mg/m^3. Lowest reading was only found in both east and west extreme of the study area ranging from 0.03-0.06 mg/m^3.
CH_2O have been observed to have recorded a higher concentration in not less than 85% of the entire Shopping Mall ranging from 0.02-0.03 mg/m^3 while towards the boundary was observed to have recorded the least concentration (0.00-0.01 mg/m^3) especially along Stadium Road, Uyo Street, Old Aba Road as well as Market Road.
Towards the southern part of the Shopping Mall was observed to have recorded significant higher concentration of CH_4 ranging from 0.31-0.40. This was similarly observed in western part of the study area including Stadium Road, alongside Onwuchekwa Street and East of PH-Aba Expressway. On the other hand, the northern part of the Shopping Mall indicated lower concentration of CH_4 together with north and south of the study area towards Market Road ranging from 0.10-0.25ppm.

E4.5.1 Bio-aerosols (Bacteria and Fungi)

The lowest viable bacterial counts in the study area were recorded in extreme west of the study area by PH-Aba Expressway and also at the northern edge of the Shopping Mall by Old Aba road ranging from 5.20×10^5 - 7.49×10^5 cfu/m^3. This bacterial load was moderate in the central part of the study area ranging between 7.50×10^5 - 8.63×105 cfu/m^3. The peak load was recorded in northwestern part of the shopping mall by PH-Aba road within the range of 9.03×10^5 - 9.78×10^5 cfu/m^3.
Fungi isolated in ambient air in the study area shows that the highest fungi load was found south of the Shopping Mall and east of the study area including part of PH-Aba Expressway, Old Aba Road and Market Road. These counts ranged from $1.193 \times 10^6 – 1.248 \times 10^6$ cfu/m^3. Lowest concentration was recorded in east of the Shopping Mall by Old Aba Road axis ranging from 1.021×10^6 - 1.116×10^6 cfu/m^3.
E4.5.2

in Air

- **Lead (Pb)**

Lead ranged from 1.129 - 1.422 mg/^{3} with the least concentration recorded in both extreme west and east of the study area (part of PH-Aba Road and Old Aba Road). The peak concentration was recorded around the shopping mall ranging between 1.067-1.421 mg/m^3. The middle section of the study area recorded moderate concentration of lead ranging from 0.475-1.066 mg/m^3.

- **Arsenic (As)**

Arsenic was observed to have a concentration ranging from 0.005-0.018 mg/m^3. However, the peak concentration was observed around the Shopping Mall ranging from 0.011-0.0018 mg/m^3. Least concentration was recorded at the extreme of the study area which covers part of Old Aba Road, PH-Aba Expressway, Onwuchekwa Road and Market Road. The concentration was moderate in part of Uyo Street, Stadium Road and south of Market Road.

- **Chromium (Cr)**

The Shopping Mall and other central parts of the study area were observed to have recorded the highest concentration of Chromium ranging from 0.166-0.247 mg/m^3. The least concentration was found around extreme of PH-Aba Road, Market Road, Old Aba Road recording <0.123 mg/m^3.

- **Mercury (Hg)**

Mercury was captured in ambient air around the project vicinity. Its peak concentration was recorded around the Shopping Mall ranging from 0.00466-0.00697 mg/m^3 while the least was captured around extreme of PH-Aba Road, Old Aba Road, Market Road and Onwechekwa Street recording below 0.00290 mg/m^3.

- **Cadmium (Cd)**

Cadmium recorded a significant peak concentration around the Shopping Mall and the middle segment of the study area ranging from 2.281-3.420 mg/m^3. The least concentrations were recorded toward extreme west and south of the study area which covers some sections of Old Aba Road, PH-Aba Road and Market Road ranging from 0.000-1.425 mg/m^3.

- **Nickel (Ni)**

The highest load of Nickel was observed within the location of the Shopping Mall which was between 1.000-1.2 mg/m^3. The concentration reduces with increase in distance towards the extreme with the least concentration recorded at the extreme east and west of the study area which was below 0.4000mg/l.

- **Vanadium (Vn)**

Vanadium recorded a significant variability in its concentration around the study area. Toward the end of PH-Aba Road and Old Aba Road, Vanadium was observed to have recorded the least concentration below 0.005mg/m^3. The highest concentration was found around the Shopping Mall complex ranging from 0.013-0.0.016 mg/m^3. The concentration was in moderation around the central part of the study area ranging from 0.008-0.009 mg/m^3

Soil for analysis were collected at geo-referenced points in the study area. All sample collection was carried out using standard procedures recommended by the American Public Health Association (APHA, 1992). A total of 10 soil samples (8 samples and 2 control) were collected from shopping mall project sites using soil auger into sterile zip locked bags. Samples were transported to the laboratory within 24 hours of collection and air-dried for extraction/digestion for actual assay.

The moisture content of the soil ranged from 41.7 – 47.2 % with the mean of 44.385±1.4 %. No recorded WHO/FMEnv permissible limit exist for moisture content.

The permeability of the soil ranged from 33.4 – 53.2 % with the mean of 41.705±4.77 %. WHO/FMEnv permissible limit do not exist for soil permeability.

The porosity of the soil ranged from 57.7 – 78.5 % with the mean of 67.565±5.79 %. No WHO/FMEnv permissible limit available for the porosity of soil.

The bulk density of the soil ranged from 0.2 – 1.8 mg/kg with the mean of 0.96±0.56 mg/kg. WHO/FMEnv permissible limit no available.

- ✓ **pH**

The pH values of the soil of the project area ranged from 4.29 - 5.78 with the mean of 5.463±0.4, which is below WHO/FMEnv permissible limit of 6-8. This indicates a predominantly acidic soil which is consistent in all locations

- ✓ **Particulate Size Distribution**

Data obtained for PSD indicated that the soils of the sample area were predominantly sandy loam with silt on the surface and sandy-silt to clay on the sub-surface. The colour varied between dull reddish brown and reddish grey. These percentages represent a conservative ratio of 1:1:3.5 for clay, silt and sand respectively.

The concentration of magnesium recorded in the soil ranged from 5.7 mg/kg - 8.9 mg/kg with the mean of 7.195±1.02 mg/kg. No recorded WHO/FMEnv permissible limit available for magnesium.
The potassium in soils of the study area ranged from 1.1 mg/kg to 1.8 mg/kg with the average of 1.49±0.24 mg/kg. WHO/FMEnv permissible limit do not exist.

The sodium concentrations in soils of the study area ranged 2.11 mg/kg - 4.12 mg/kg with the average of 2.974±0.62 mg/kg. WHO/FMEnv permissible limit do not exist.

The concentrations for the soil of the area ranged from 28.1 mg/kg 39.2 mg/kg averaging 34.55±3.22 mg/kg. WHO/FMEnv permissible limit do not exist.
Total heterotrophic bacteria (cfu/g) ranged from 1.8×10^5 - 4.1×10^5; Total heterotrophic fungi (cfu/g) ranged from 1.3×10^5 and 4.5×10^5; Hydrocarbon utilizing bacteria (cfu/g) ranged from 1.0×10^5 - 2.6×10^5, and Hydrocarbon utilizing fungi (cfu/g) ranged from 1.8×10^5 - 3.8×10^5. 39 genera of microorganisms were isolated, out of which 20 were bacteria and 19 fungi.

E4.7 Land use

The notable land use within the study area included fuel stations, shopping mall, shopping plaza and road infrastructure network.

4.8 Geology

- ✓ **Regional Geology**

The study areas fall within the tertiary sedimentary basin of Niger Delta. The methodology adopted for this study includes field studies and high impact approved papers of previous research carried out within the geologic terrain from the Department of Geology, University of Port Harcourt. These researches addressed various aspects such as basin evolution and tectonics, biostratigraphy, sedimentology and sequence stratigraphy. The Tertiary Niger Delta Basin located in southern Nigeria at the inland margin of the Gulf of Guinea is situated at the southernmost part of the intra-continental Benue Trough. The basin which was formed at a recognized triple junction of the south Atlantic rifting (Delhaya et al, 2009), is bounded by the Calabar Flank to the east, Benin Flank to the west, Gulf of Guinea to the south and to the north by the Anambra Basin and Afikpo Syncline (Tuttle et al. 1999). The Niger delta basin is one of the largest subaerial basins in Africa. It has a total area of 300,000 km^2, and a sediment fill of 500,000 km^3 (Fatoke, 2010).

- ✓ **Local Geology**

The study area has a flat topography and its elevation varies between 15m to 20m above sea level. Thus, no outcrop was observed within the study area.
The study area consists of alluvial and fluvial sediment deposits of sandstone and clay

. According to Etu-Efeotor et al, 1990 the Niger Delta is composed of three subsurface lithostratigraphic units (Akata, Agbada and Benin formations overlain by various deposits of Quaternary Age. The Benin formation (2100m thick) is the most prolific aquifer in the region and constitutes over ninety percent (90%) massive, porous sands with localized clay/shale interbeds.
The quaternary deposits (40 – 150m thick) generally consist of rapidly alternating sequences of sand and silt/clay, with the latter becoming increasing more prominent seawards.

The Agbada formation underlies the Benin formation and was deposited under transitional environment, makeup of sands and shales. However, increasing clay may occur with depth. Underlying the Agbada formation is the Akata formation, which was deposited, in marine environment. It consists of marine clays, silts and shales with occasional turbidite sand lenses. The formation is rich in organic matter and is the source rock of oil in the Niger Delta. It has a relative thickness of 20,000ft (5882m).

E4.9 Hydrogeology and Hydrology

Geologically, the site is underlain by the coastal plain sands, overlain by firm – stiff clay/sandy clay sediments belonging to the Pleistocene formation.

The hydraulic conductivity values obtained for borehole 1 to borehole 5 were $1.5x10^{-1}$, $2.4x10^{-1}$, $3.5x10^{-1}$, $3.5x10^{-1}$, and $3.5x10^{-1}$cm/sec respectively. These high hydraulic conductivity values indicate fine to medium sandy soil, implying prolific aquifer system.

- ✓ **Ground Water Quality and Contamination**

Ground water samples were obtained from 5 boreholes. These include 3 stations as sampling point in close proximity to the study area and 2 stations as control point and these were analysed for physico-chemical and microbiological properties.

- ✓ **Odour**

All samples collected had no odour and therefore were in accordance to the recommended FMEnv/WHO standard.

- ✓ **pH**

The recorded pH values in the groundwater samples was slightly acidic with pH value ranged from 5.69 to 6.61. This can be attributed to the composition of the rocks that surround the travel pathway of the recharge water infiltrating to the ground water. The observed pH values are within the WHO/FMEnv permissible limits of 6.5-8.5 and 6.5-9.0 respectively.

- ✓ **Temperature**

Temperature values for groundwater ranged from 26.5 – 27.6 ^{o}C with the mean of 27.02±0.5 ^{o}C.

- ✓ **Turbidity**

Turbidity values for groundwater ranged from 0.53 – 0.62 NTU with the mean of 0.568±0.03 NTU. The recorded values of turbidity for groundwater were lower than the WHO and the FMEnv limits of 5 NTU, but higher than the stated limits in surface water samples.

- ✓ **Total Dissolved Solids (TDS)**

TDS values ranged from 7.1 – 7.35 mg/l with the mean of 7.24±0.11 mg/l. These concentrations were acceptable for potable water quality as they were below the FMEnv and WHO limits of 2000 and 1000mg/l respectively.

- ✓ **Total Hydrocarbon Content (THC)**

The concentrations of the THC in the water samples of the study area were less than the equipment detection limit of 1.00mg/l.

- ✓ **Nitrate**

These values are below the WHO and the FMENV recommended limit for potable water quality of 10.0 mg/l.

- ✓ **Phosphate**

Both WHO and FMENV have no recommended limit for phosphate in drinking water.

- ✓ **Sulphate**

250mg/l.

- ✓ **Heavy Metals**

water samples. Fe, Cu, Ba and Zn concentrations were below their respective regulatory limits. The equipment detection limits for the various heavy metals analyzed were as follows in mg/l: Arsenic = 0.001, Mercury = 0.0002, Selenium = 0.001, Lead = 0.01, Copper = 0.05, Chromium = 0.001, Cadmium = 0.002, Manganese = 0.10, Iron =<0.05 and Zinc = 0.05, some of them were detected in the samples, and were within the WHO/FMEnv permissible limits. This implies that the measured parameters (heavy metals) were all within their respective WHO/FMEnv limit for groundwater.

- ✓ **Microbial Analysis of Groundwater**

Both total coliform and fecal coliform bacteria (*Escherichia coli*) were not detected in the samples. except for total plate count which though present, but had count within NIS554:2007 Reference Standard. From the results, there exist a lower or no chance of pathogenic contamination in the sampled water.

E 4.10 **Socio-economic Baseline**

The study was conducted in Rumuomasi community in Obio/Akpor LGA of Rivers State. The study covered the socio-cultural resources of this community, demographic issues including population and growth, age and sex distribution, and adult literacy.

Demographics

Rivers State is an oil-producing state of Nigeria, located in the region known as the South-South geo-political zone with a population of 5,198,716, making it the sixth-most populous state in the country. The Capital of Rivers State is Port Harcourt and it is also called Pitakwa. Port Harcourt is the largest city of Rivers State, Nigeria. It lies along the Bonny River and is located in the Niger Delta.

There are several institutions of tertiary education in Port Harcourt, mostly government-owned. These institutions include Rivers State University, University of Port Harcourt, Kenule Besor Wiwa Polytechnic, Captain Elechi Amadi Polytechnic, Ignatius Ajuru University, and Rivers State College of Health Science and Technology. Obio/Akpor is a local government area is the project affected LGA and also in the metropolis of Port Harcourt, one of the major centres of economic activities in Nigeria, and one of the major cities of the Niger Delta, located in Rivers State.

From questionnaire responses, the mean household sizes obtained were 6.4 for the surveyed areas. In the project affected LGA, the dependency ratio obtained is about 0.8. The ratio obtained is indicative of a low economic burden.

Life Expectancy estimates for Rivers State is the same as the national estimates. The World Health Organization (WHO) in its World Health Statistics 2016 estimated that life expectancy for men in Nigeria is 42 years and 47 years for women.

The result shows that 80% of respondents were non-migrant. This trend was not entirely unexpected given that the community is an urban area

. However, there were also indications that some household members had relocated over the years for various reasons.

Almost an equal proportion (38.9% and 42.7%) of the sampled population reported possessing tertiary and post-primary (secondary) educational qualifications. Some 14.5% have primary education, while approximately 3.5% have no formal education (NFE). The proportion of the educated population that indicated possessing some technical/vocational educational training amounted to 14%, indicating the availability of some employable skills in the project affected community.

Language, Marriage, and Family

The people of the study area are dominantly of Ikwerre extraction, natively known as Iwhuruọha ethnic extraction. They are considered a part of the larger Igbo ethnic group.

The Ikwerre exists in well-delineated clans, with each clan having its paramount king. The Ikwerre does not have an overall paramount ruler or king, but designated kings, rulers, or leaders are mostly approved by their constituents. However, all paramount rulers in Ikwerre are united in what is known as Ogbakor Ikwerre, which was formed in 1963 as an umbrella socio-cultural organization of the Ikwerre people

Festival wrestling is an important part of people's culture. During the wrestling competition, different types of drums are used, such as Ikwiriku, Ekwenkalu, Ngele, Mbamba, which are of different types, shapes, and sizes. Other cultural activities include the Eregbu cultural dance, Ekpo, and Ekpe masquerades are also important features of their tradition. The Ikwerres also have a lot of cuisines such as oha soup, okpotoro and okasi soup, vegetable soup, periwinkle soup, and others. Periwinkles (isam) are important parts of their dishes.

Social Structure and Organization

Membership of socio-cultural groups (CDCs, women's groups, youth groups, CBOs, cultural groups, and social welfare groups) by household members is quite common. The roles played by these groups are distinct and significant. A group like the Community Development Committee (CDC) is set up purely to perform local administrative roles and also to liaise between the community and all external bodies, and other communities. The cultural groups mainly performed at cultural festivals, thereby ensuring the preservation of their cultural heritage.

The traditional structure comprises the traditional ruler assisted by chiefs and Community Development Committee (CDC) executives with youth and women groups. The traditional heads are elected from eligible males. Eligibility is determined by age (minimum of 30 years) and standing/integrity. Occupants hold office for life except where they are deposed by the community or the government. They could be deposed by the community or government if they are believed to be working against the community's interest if they committed a heinous crime or became incapacitated by ill health.

The women's primary role is to advise the CDC and the council of Chiefs on matters concerning women in the study area and youth, on the other hand, has become a strong force in the community. Their roles include ensuring internal and external security, enforcing law and order, and development planning.

Lifestyle and Social Indulgent Practices

Residents confirmed that the use of spirits and alcoholic beverages is quite rampant among them. Most residents, of both genders, had been drinking since their teenage and several since they were children. The local gin 'kai-kai' which is most popular is brewed in the area, and therefore, is quite readily available. Cigarette smoking is also quite common among teenage and adult males. Most residents also believe that some of the youth smoke hemp.

Teenage pregnancies, on the other hand, are experienced quite commonly in the community. Respondents expressed fears that the proposed project would further encourage some of these vices if construction workers and camp followers take up residence among them.

Belief Systems and Practices

FGDs revealed that 93% of the people are adherents to the Christian faith, while 5% and 2% are traditional worshippers and Muslims respectively. There are no communal restrictions on religious beliefs and worship. Residents are at liberty to pursue their religious beliefs and interests. The study area has a shrine call Uhuile. Uhuile means the face of the land and it is the only surviving shrine in the area.

Conflict Management and Security

The study area is part of the Niger Delta region which has experienced several conflicts with violent outcomes. In particular, there was the issue of militancy in the region. The conflicts that gave rise to militancy involved the youth more than any other group. Many of them have become violence-prone and even social misfits. The youth will be a group to watch and also dialogue within the course of the proposed Shopping Mall construction project in the area.

Quality of Life

In general, the study area is relatively large to medium-sized. Going by NPC's definition of a town as a settlement with a population of 20,000 or more, the study area is qualified as a town. The community has the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the area. The nuclear characteristics derive from the clustering of houses. The houses are quite diverse in their design and construction materials. Some houses have modern designs and they are built with utilities like kitchen, toilet, and bath, in-house.

The identified activities are mainly commerce and provision of services like petty trading, artisanship practices, and employment in the civil/public services. The largest proportion of household members in the community are engaged in trading, Artisanship practices inclusive of electrical repairs, tailoring, etc are significant in the study area. Civil/public service employees in the community are limited

mostly to Local Government workers, teachers, and health workers. Others are inclusive of a few residents who are employed in oil companies and those involved in contracting.

Unemployment was experienced in several households in the community. Results obtained from the discussion and interview sessions indicated that 72% of households across the community had one or two unemployed members.

The major items of expenditure in the households are food, health care, purchase of household items including utilities (kerosene, petrol, etc), transportation, and clothing.

Health Study

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

Apart from the orthodox facility, there are drug stores (chemists) located in the study area. There are also hawkers (individuals who carry drugs, especially malaria drugs, analgesics, antibiotics, and various creams and balms) hawking drugs from one settlement to another. The number and the quality of drugs being distributed could not determine during the study. The sources of water used in households in the study area include water from rainwater, well and water from public and private boreholes.

Refuse is, unfortunately, mostly deposited by the roadside and medians by households, for eventual collection and disposal by Rivers State Waste Management Agency. Similarly, two methods of sewage disposal practices are the use of pier system toilets and water closet toilets. About 91% of households in the study community dump their refuse in open space awaiting the government to evacuate, while 32% use the pit toilets.

The average household in the study area can provide two meals daily for its members. The meals consist predominantly of carbohydrate and protein. Commonly available sources of protein are fish and seafood, especially periwinkles, oysters, prawns, and crayfish. These proteins are always available in the soups with which garri (the staple and most common food) is eaten.

Interviews in households and with health workers in the proposed project community revealed that the most frequently reported diseases are malaria, diarrhoeal diseases, and respiratory tract infections (RTI). There is a low prevalence of HIV/AIDS among the population.

Physically and Mentally Challenged Persons

Some surveyed households (1%) in the area have cases of physically/mentally challenged individuals, the majority of whom do not attend schools. No government or non-governmental organization (NGO) assistance has ever been offered to them, and their families/kindred who do not have enough to cater for them. This group of persons is however not discriminated against since they are familiar faces who reside with their kith and kin who largely understand them.

Land Ownership and Tenure

Land in the project community is primarily owned by families. Ownership rights over lands are handed down from one generation to another within the extended family. Such inherited land is put to any use as desired by the owner(s). These are the lands on which family members build their houses and are allocated for businesses.

Infrastructural Base

Public access to the project affected community is by roads. The project area has paved internal link streets and lanes. Additionally, telecommunication services from GSM service providers are received in all parts of the community.

Education facilities in the LGA consist mainly of public primary, junior and senior secondary schools and an array of private schools. The infrastructures in many of the schools are inadequate. There is generally a dearth of functional orthodox health facilities in the entire study area. The basic problems of government hospitals and PHC are inadequate staffing, broken down and unmaintained equipment, and lack of drugs.

Public water and electrification are very much dysfunctional in the community. Several water boreholes have been constructed in the community but most of them are not working largely because the water produced is deemed unfit for consumption by community residents, usually because of colouration. Similarly, electricity in the area is generally characterized by a frequent blackout and poor voltage.

Vulnerable Groups

A key vulnerable group is adolescent youths. Another vulnerable group is the elderly. In any economy, the elderly usually requires special attention which includes health care and welfare, but the required facilities for the provision of these social services are not available across the study community.

Additionally, widows and single mothers will have an uphill task providing for their households in an environment where there are construction workers who earn salaries higher than what generally obtains in the community.

Stakeholders Engagement

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the shopping mall project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also to notify the stakeholders of the nature, scale, and timing of the proposed project, thereby eliminating any fears or apprehension. The process was also used to facilitate information gathering between the EIA consulting team/proponent and the other stakeholders. The consultation exercise commenced at the very early stage of the environmental impact process and it is planned to continue throughout the project duration.

The Stakeholders Engagement process has been designed to comply with regulatory requirements set out in Nigerian environmental legislation and, where possible, implement international good practice guidelines, for example, those of the IFC.

Two levels of consultations, as are generally recognized in the ESIA process, were held. These are institutional and Project Affected Community (PACs) involvement. The subject of this section relied heavily on both, though with emphasis on PACs involvement, ie. getting the public, host community, all other stakeholders that may be directly or indirectly affected by the project to participate in assessing the project.

The public forum with Project Affected Community, NGOs, and CBOs, youth groups, Women organizations, religious organizations, and traditional bodies held between 24-29 August 2020 in the project-affected community and traditional rulers in attendance and also with major institutional stakeholders on 27 August 2020 in Port Harcourt.

At the end of the presentation, participants were given ample opportunity to ask questions and/or make comments on the project. They were unanimous in praising the proponent for considering them suitable to host the project and promised to accord the proponent all the needed support.

The key stakeholders identified and consulted for the proposed construction of shopping mall at Port Harcourt are:

- Federal Ministry of Environment
- Federal Ministry of Works and Housing (Controller)
- State Coordinator, National Environmental Standard Regulation Enforcement Agency (NESREA), Rivers State Office
- Nigerian Civil Aviation Authority (NCAA)
- Nigerian Airspace Management Agency (NAMA)
- Port Harcourt Electricity Distribution Company (PHEDC)
- GOC, 6 Division, Nigerian Army, Port Harcourt
- Sector Commander, Federal Road Safety Corps (FRSC), Rivers State Command
- Commandant, Nigeria Security and Civil Defense Corps (NSCDC), Rivers State Command
- Commissioner of Police, Nigeria Police Force (NP), Rivers State Command
- The Director, Directorate of State Service (DSS), Rivers State Command
- Rivers State Ministry of Works
- Rivers State Ministry of Environment
- Rivers State Ministry of Lands & Physical Planning
- Rivers State Ministry of Women Affairs
- Rivers State Ministry of Urban Development
- Rivers State Ministry of Employment and Empowerment
- Rivers State Ministry of Health
- Rivers State Ministry of Transport
- Rivers State Waste Management Agency (RIWAMA)
- The Director, Vehicle Inspection Office, VIO, Port Harcourt
- The Chairman, Obio Akpor Local Government Council
- Rumuomasi Community
- The Chairman of Nigeria Society of Engineers (Rivers State Chapter)

- The Chairman, Nigeria Union of Road Transport Workers (Port Harcourt branch)
- The Chairman, Road Transport Employers Association (Rivers State Chapter)
- The Association of Environmental Impact Assessment of Nigeria (AEIAN)
- Institute of Natural Resources and Environmental Studies (INRES), University of Port Harcourt
- Institute of Natural Resources and Environmental Studies (INRES), University of Port Harcourt
- National Inland Waterways Authority (NIWA), HQ, Lokoja
- The Commanding Officer, NAF Base, Port Harcourt.

Community's Concerns:

- Environmental damage
- Social problems
- Health problems
- Payment of compensation

Community Expectations:

- Creation of employment opportunities for residents of the community.
- Empowerment of community members through skills acquisition, an award of contracts, and provision of scholarships.
- Infrastructural development in community in terms of provision of potable water, electricity, functional orthodox health care facilities, renovation, and equipping schools, and erosion control projects.

Grievance Mechanisms

During the implementation of the project activities, disputes/disagreements between the project developer and the PAPs may occur especially in terms of compensation, boundaries, etc. Two stages have been identified in the grievance procedure: customary mediation and judiciary hearings.

A grievance procedure based on community grievance committees, one per community, will be established for resolution of the disputes and complaints.

Traffic Survey

This traffic study was carried out to analyze the traffic characteristics in the selected routes. This study helps in deciding the geometric design features for traffic control for safe and efficient traffic movement. The study was to determine the number of vehicles crossing sections of roads proposed for the Shopping Mall per unit time at any selected period and also to quantify the measure of flow. The units used are vehicles/day or vehicles/hour.

This study reveals the predominant use of cars as a means of transportation for short shuttles within the state capital and neighbouring LGAs.

Traffic situations in these areas both during weekends and weekdays are similar. One domination in the area is that there are more cars and buses on the routes than trucks, and tricycles popularly known as Keke and motorcycles are not allowed access to these routes.

Data obtained from the field shows that Port Harcourt-Aba express route have more traffic flow than others with 21,112 vehicles plying the route from 7 am to 6 pm on a weekend and it is followed by old Port Harcourt-Aba express route with 11,919 vehicles plying the route between 7 am to 6 pm on a weekend. The multipurpose nature of these routes makes determining peak days and time difficult as it changes regularly depending on other variables like school sessions, events, and functions in and around Port Harcourt.

ES 5.1 Summary of Impacts

Table E5: Associated and Potential Impacts of the proposed shopping mall project

Project phase	Project Activities	Environmental Aspect	Potential/Associated Impacts
Site preparation and Survey	Mobilization	Socio-economic, health and safety	Influx of heavy traffic leading to higher accident possibility, influx of people leading to pressure on existing infrastructure, public institutions and amenities, and inflation Decline in social values leading to increased crime rate
	Soil Testing	Soil and groundwater	Exposure of soil to weather conditions and loss of soil micro fauna and flora, and groundwater contamination
	Material transportation	Air Quality, Health. Public Safety	Increase in vehicular exhaust gases emission into the air, Exposure of road users to increased traffic, and higher accident possibility.
	Offices and Base Camp	Soil and groundwater Public health and safety	Loss of soil quality due to exposure to weather conditions and groundwater contamination due to office/base campsite location and construction.

Project phase	Project Activities	Environmental Aspect	Potential/Associated Impacts
			Predisposition to injury from site construction activities. Domestic waste generation
	Site clearing	Soil and health	Loss of soil quality due to exposure of soil to weather conditions CO_2 emitted by machines, etc
Shopping mall Construction	Access road construction	Soil, air and groundwater	Predisposition of the site to soil erosion and loss of soil fauna; air pollution, noise and vibrations. Construction waste generation
	Impact on site drainage	Soil and Health	The excavation of the site will alter the natural drainage of the site thus creating pools during rainy season Stagnant water will lead to breeding grounds for mosquitoes
	Topsoil removal Excavation &	Soil and Health,	Soil compaction due to heavy vehicle movement, alteration of drainage pattern. Excavated material will affect diversity of soil fauna within the area. Occupational health and safety issue
		Air Quality/Noise	Increase in exhaust gases from equipment exhausts. Increase in ambient noise level and vibration.
	Installation of building components and furniture	Health and safety, (Heat and Radiation)	Welders exposed to heat and light radiation, heat rashes, welding flashes leading to eye diseases etc
		Socio-economic	Decline in social values.
	levelling, compaction	Soil, Water	Exposure of soil organisms to weather conditions and contamination of surface water.
Shopping mall Operations and Maintenance	Operations and Maintenance	Socio-economic, health, public safety and air	Exposure of road users to increased traffic, and higher accident possibility, Increase in vehicular exhaust gases emission into the air and noise, waste generation

Project phase	Project Activities	Environmental Aspect	Potential/Associated Impacts
			Operational and maintenance health and safety issues **Improvement of infrastructure**
Shopping Mall Decommissioning and Abandonment	Dismantling Waste disposal	Soil, Air, Water, Health	Soil and water contamination, noise and vibration during dismantling; construction debris generation.

ES 6.1 Summary of Impacts Mitigation Measures

Table E6: Proposed Mitigation Measures for the Identified and Associated Impacts of the proposed shopping mall project

Project phase	Project Activities	Potential/Associated Impacts	Impact significance before mitigation	Impact Mitigation	Impact significance after mitigation
Site preparation and Construction	Mobilization	Influx of heavy traffic leading to higher accident possibility, influx of people leading to pressure on existing infrastructure, public institutions and amenities and inflation Decline in social values leading to increased crime rate.	Medium Significance	Quiton/JBN shall: Strict adherence to road transport regulations. Institute public enlightenment campaigns and implement its corporate social responsibility.	Low Significance
Building Construction	Material transportation	Increase in vehicular exhaust gases emission and fugitive dust into the air, Exposure of road users to increased traffic, and higher accident risks.	High Significance	Quiton/JBN shall: Ensure the proper maintenance of vehicles, wetting of the construction site regularly with water to suppress dust, and the use of exhaust mufflers; Training and retraining of project environments, deployment of road signs and rewarding environments for zero accident cases	Low Significance

				Ensure that all fuel-propelled construction machines are well maintained and serviced	
	Offices and Base Camp	Injury due to site clearing and construction activities.	Medium Significance	Quiton/JBN shall: Strict adherence to EPC's safety policy	Low Significance
		Domestic waste generation	High Significance	Quiton/JBN shall: Adopt waste minimization strategy of, reduction, re-use, recycle and recovery Disposable waste will be contracted to the State waste management agency	Low Significance
	Overburden removal & excavation	Increase in exhaust gases from equipment exhausts. Increase in ambient noise level	High Significance	Quiton/JBN shall: Construct the access roads in the dry season; ensure proper compaction of the road, provision of drainage channels, wetting of the roads at least twice daily during earth work. Regular maintenance of equipment. Ensure the use of appropriate PPE and institute an adequate Workmen Compensation Insurance Scheme Ensure the use of light vibrators Ensure Construction activities must be	Low Significance

				carried between 0800hrs and 1700hrs.	
	Impact on site drainage	The excavation of the site will alter the natural drainage of the site thus creating pools during rainy season Stagnant water will lead to breeding grounds for mosquitoes	Medium Significant	Quiton/JBN shall: Ensure that storm drainage system remains clear during construction clear Any excess soil from the construction site should be dumped at an approved site if it has to be disposed away from the site. Design clear drainage system to ensure that the site is properly drained even during the construction period	Low Significant
	Installation of building components and furniture	Exposure of workers to construction site accidents	High Significant	Quiton/JBN shall: EPC Contractor shall ensure strict adherence to its Safety Policies by all personnel	Low Significant
Operations and Maintenance					
		Increased road traffic volume and risk of acci injury	Medium	Quiton/JBN shall: Ensure strict implementation of the Traffic Management Plan Ensure the delivery of materials is done during off-peak hours Ensure the provision of PPE to worker during construction time.	

			Ensure the Provision of first Aid facilities emergency plan at the site. Fencing off construction sites to minimize avoid risks to the general public Ensure the supervision of the project is done throughout the project implementation period.	
	Improvement of infrastı	Low	Quiton/JBN shall: Ensure strict implementation of the facility Maintenance Policy Ensure strict implementation of employment and labour policy ensure good corporate social responsibility to the host communities Ensure construction do not interfere with way leaves Explore use of modern technologies e.g use of solar and wind energy to reduce pressure on existing infrastructure	High Significance

		Waste generation/dispc	Medium	Quiton/JBN shall: Ensure strict implementation of the Waste Management Plan Contract a licenced waste collector Ensure wastes are disposed at the designated site	Low
Decommissioning	Dismantling	Soil and water contamination, due to improper domestic and dismantling/demolition waste disposal.	Medium Significant	Quiton/JBN shall: Ensure strict adherence to a decommissioning plan that would be based on the BAT of the time, and approved by FMEnv.	Low Significance

Environmental Monitoring Plan

Monitoring Scope	Parameter	Location	Frequency		Responsibility	Oversight
			Construction	Operation		
Air	TSP, NO_2, SO_2, CO, CH_4	Settlement areas, close to Shopping Mall sites	Weekly	-	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Noise	Sound level (dBA)	Sensitive spots, e.g., school, residential buildings close to Shopping Mall	Weekly	-	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Solid waste	Ignitability, Corrosivity, Reactivity etc	Designated dump site	Monthly	-	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Public safety	Signs, culvert, incidence/ accident records	Shopping Mall Locations	Monthly	Quarterly for the first year, then annually thereafter	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Land acquisition and population and structures resettlement	Compensation, income, employment, social adaptation	Relocated families and receiving communities	Middle and end of land acquisition and resettlement		Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC

Conclusion and Recommendation

It is hoped that all data/evidence contained in this report is sufficient in the development of an environmental impact statement (EIS), and afterward in the acquiring of necessary permits for commencement of project; and also, that there is no major environmental issue to impede the development of the proposed project. We strongly recommend the proposed Shopping Mall project for EIA Approval.

1 INTRODUCTION

1.1 Introduction

The proposed project is a shopping mall with all the facilities and utilities needed at No. 4 Old Aba Road, Port Harcourt, on a plot of land of about 21,000 sqm. The proposed Mall contains a main tenant (supermarket), various shops, restaurants, cinemas and an entertainment hall. The mall has underground parking lots, additional to the external parking area.

The Shopping Mall project construction will involve:

- Site Clearing of all debris
- Earth Work
- Construction

1.2 Project Location

The proposed Shopping Mall project is located at 4, Old Aba – Port Harcourt Road, Rumuomasi, Obio/Akpor LGA., Port Harcourt and defined by latitude 4.835117° and longitude 7.021434° (Figures 1.1,1.2, and 1.3).

1.2.1 Environmental Setting of the Shopping Mall Locations

The Shopping Mall location is in the city centre, at the beginning of the Old Port Harcourt – Aba Road, about 100m from the (new) Port Harcourt – Aba Expressway. It is completely surrounded by buildings, in a mixed development setting. Important landmarks around the site include the NAF base on the opposite side of the Port Harcourt – Aba Expressway, Oando filling station, First Bank Branch, Mater Misericordiae Catholic Church (Figure 1.22). The entire area is built-up, with no bushes for flora and fauna studies.

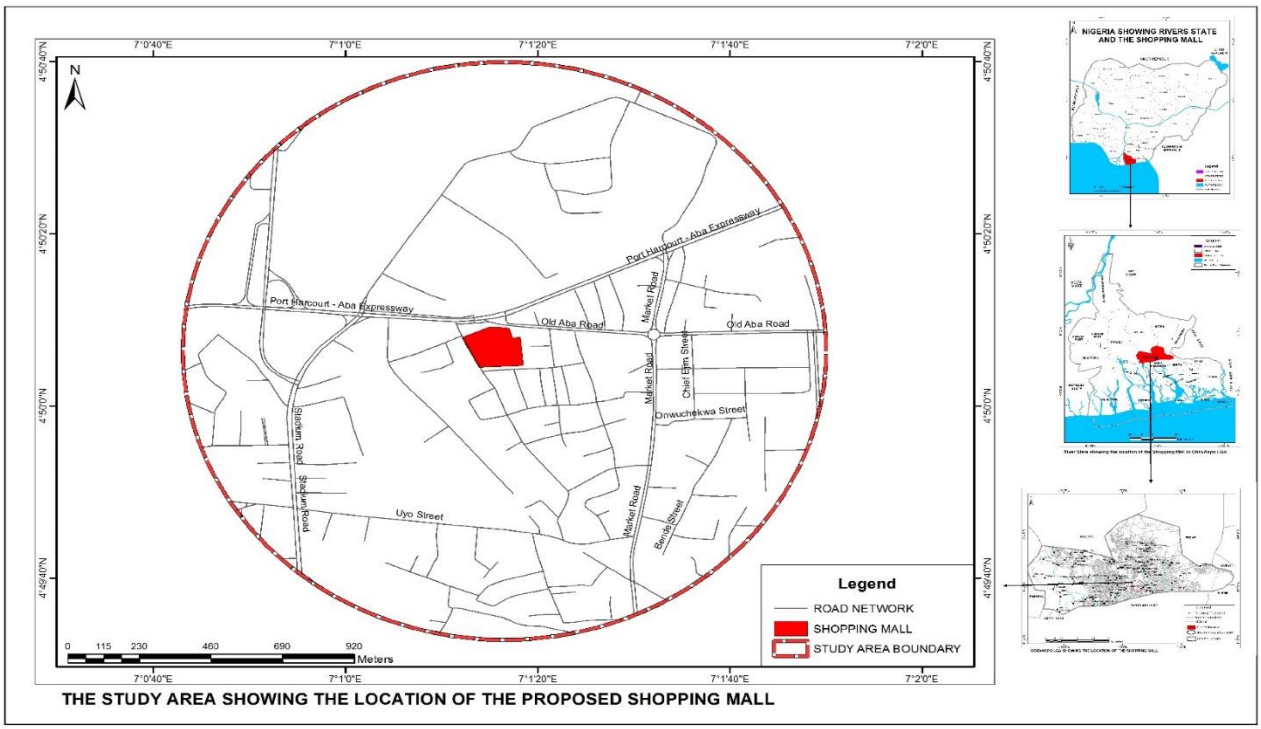


Figure 1.1: Map of Rivers State showing the location of the proposed Shopping Mall

Figure 1.2: Generalized View of the proposed Shopping Mall Site in Port Harcourt

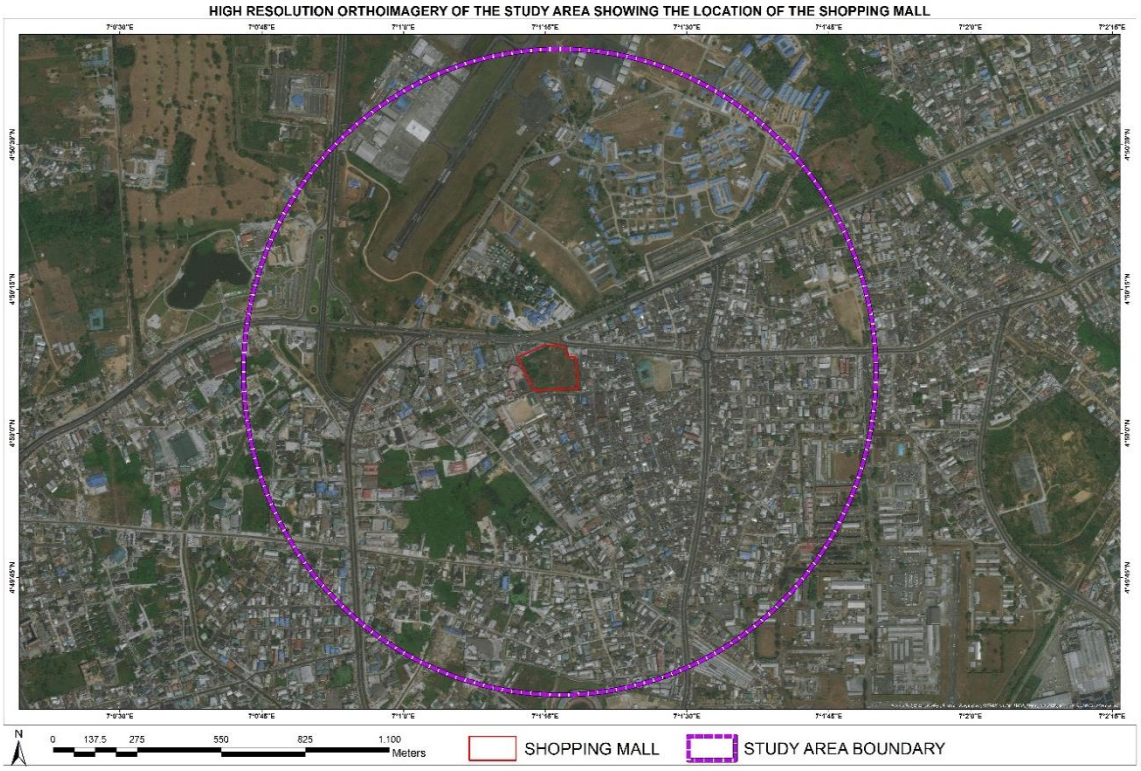


Figure 1.3: High Resolution Orthoimagery of the study area showing the location and Area of Influence of the proposed Shopping Mall

1.3 Applicant's Intent

Quiton International Ltd (Quiton), the proponent, recognizes the importance of comprehensive environmental planning and management to the success of the proposed project and is committed to the necessary studies to understand the environmental system of the proposed project area in order to address areas where significant negative environmental impacts (natural, physical and social) may occur, with a view to addressing them, adequately.

In pursuance of this, Quiton is conducting an Environmental Impact Assessment (EIA) of the project prior to the commencement of the project. This intention is in line with the Federal Ministry of Environment's (FMEnv's) Environmental Impact Assessment Procedural/Sectoral Guidelines for infrastructural projects as well as other international environmental standards.

1.4 Legal and Administrative Framework for EIA in Nigeria

The legal, regulatory and policy framework for carrying out the EIA of the proposed Shopping Mall project is contained in the applicable acts and regulations of the Federal and State Government, statutes and international conventions to which the Nigerian Government is a signatory.

Various environmental studies and related strategic initiatives would meet or surpass the relevant Nigerian and international environmental legislative requirements and guidelines. These include but not limited to:

1.4.1 Federal Ministry Environment

Act No 58 of 1988 established the Federal Environmental Protection Agency (FEPA), now Federal Ministry Environment, as the chief regulatory body for environmental protection in Nigeria. The Act establishing FEPA placed on it the responsibility of ensuring that all industries respect the limits prescribed in the national guidelines and standards and the associated various regulations of environmental pollution management in Nigeria (e.g. effluent limitation, management of solid hazardous waste, etc.). FMEnv may update the National Guidelines and Standards from time to time.

Relevant specific standards, discharge limits, and other environmental requirements of the FEPA guidelines (1991) and subsequent relevant directives were reviewed. The Federal Government released the Environmental Impact assessment (EIA) Act CAP E12 LFN 2004. The Act makes the EIA process mandatory for any major development project and prescribes the procedures for conducting and reporting EIAs.

1.4.2 FMEnv's Guidelines on EIA

Federal Ministry of the Environment developed National EIA procedures following the enablement of the EIA Act CAP E12 LFN 2004. The procedure indicates the steps to be followed from project conception to commissioning to ensure that the project is implemented with maximum consideration for the environment.

- ***EIA Sectoral Guidelines of the Federal Ministry of Environment***

Federal Environmental Protection Agency (FEPA) was established by Act 58 of 1988 to monitor and prevent the pollution of the environment following the Koko toxic waste dump incident. This status empowered the FEPA to prepare Environmental Guidelines and Standards as instruments for prevention of environmental pollution. This Act also gives specific powers to FMEnv to facilitate environmental assessment of projects.

In addition, FMEnv regulations S.I.8, S.I.9 and S.I.15 of 1991 provide guidelines and standards for the following:

- Solid and Hazardous waste management
- Effluent limitations
- Pollution abatement in industries generating waste.

In September 1995, EIA Sectoral Guidelines for proposed projects in Nigeria were published. The guidelines are intended to assist the proponent to conduct proper and detailed EIA Studies in compliance with the EIA Act of 1992.

The procedure for EIA involves the project proposal stage where the project proponent officially notifies FMEnv of the proposed project. This proposal is to contain concise information of the project including a land use map.

The legal and regulatory framework for carrying out EIA of the proposed Shopping Mall project are contained in relevant national statutes and international environmental conventions to which Nigeria is a signatory.

This stage is followed by the screening phase, whereby an Initial Environmental Examination (IEE) is executed by the FMEnv then the projects are assigned into categories based on the following criteria:

Magnitude

- Extent or Scope
- Duration and Frequency
- Risks
- Potential Environmental Impacts

Another stage of FMEnv's EIA procedure is the scoping stage, the main feature of which the proponent is required to submit the Terms of Reference (ToR) for the proposed EIA. In some cases, the FMEnv may demand a Preliminary Assessment Report from the proponent to assist in vetting the scope and the ToR of the proposed EIA.

This stage is followed by:

- Actual Implementation of the EIA
- Preparation of Draft Report
- Final EIA Reports
- Review Process and Approval/Certification.

Apart from the general EIA Guidelines, the Ministry has issued sectoral guidelines for EIA in different infrastructural sectors.

Harmful Wastes (Special Criminal Provisions etc) Act No 42

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

Criminal Code

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

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

Land Use Act CAP 202 LFN 2004

The Land Use Act of 2004, the Constitution of 1999 and the Public Lands Acquisition Laws of the relevant States constitute the governing policy for land acquisition in Nigeria. As is the case with most national and state laws on compulsory acquisition of land in the public interest or for a public purpose, the legislation enables the State to acquire land (more precisely, to abrogate leases and other authorizations to occupy land). The Act also specifies the procedures the State must follow to clear the land, and defines the compensatory measures the State must implement in order to compensate the people affected.

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

This law established a Development Control Department (DCD) charged with the responsibility for matters relating to development control and implementation of physical development plans at Federal, State and Local Government levels within their respective jurisdiction.

1.4.3 FRSC Act CAP 141 LFN 2007

In February 1988, the Federal Government created the Federal Road Safety Commission through Act No. 45 of the 1988 as amended by Act 35 of 1992 referred to in the statute books as the FRSC Act CAP 141 LFN 2007.

The Revised Nigeria Highway Code 2016

The code aims to protect quality of road designs and code of conducts for road usage British Design Manual for Roads and Bridges as adopted by Nigeria. British standards for roads and bridges construction as adopted by Nigeria covers

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

1.4.4 The Labour Act, (1990)

The Labour Act (1990) is the primary law protecting the employment rights of individual workers. The act covers protection of: wages; contracts; employment terms and conditions; and recruitment. It also classifies workers and special worker types. Union membership is governed by the Trade Union

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

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

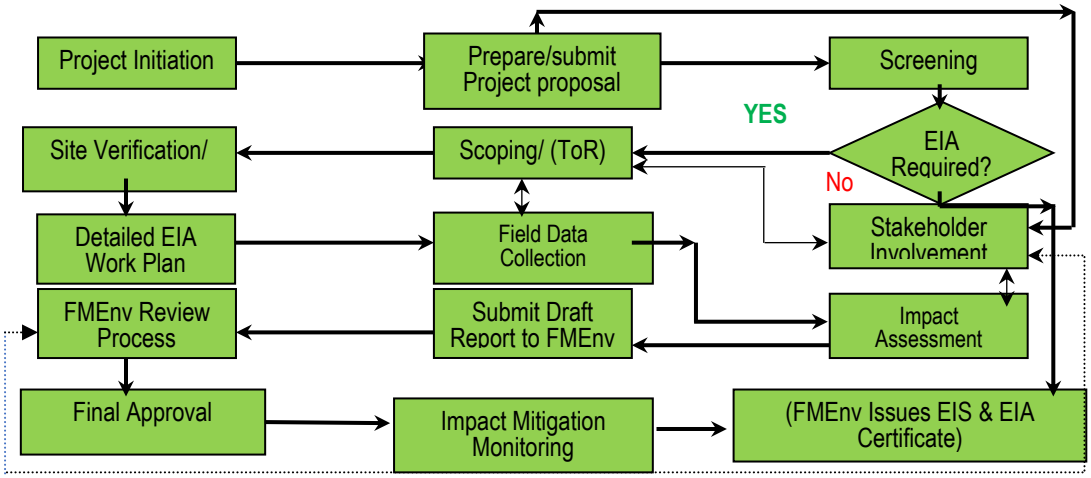


Figure 1.6: FMEnv.'s EIA Process

1.5 International Guidelines and Conventions

In addition to the national laws and regulations, Nigeria is signatory to several international conventions and treaties supporting the use of EIA as the key tool for achieving pollution control and sustainable environmental development.

Basel Convention on the Control of trans-boundary Movement of Hazardous Waste and their Disposal

The Basel Convention addresses the worldwide concern over the risks posed by the generation and disposal of hazardous and other harmful substances. This Convention classifies the waste and controls the Trans-boundary movement of hazardous waste and other harmful substances against the adverse effects it can impose on human health and the environment. In the proposed road project, no waste generated shall be transported outside the country.

The objectives of this convention, in addition to the Montréal protocol and the London amendment (1994) are:

- To protect human health and the environment against adverse effects resulting or likely to result from human activities, which modify or are likely to modify the ozone layer; and
- To adopt agreed measures to control human activities found to have adverse effects on the ozone layer.

A list of international regulations and conventions has been provided in Table 1.1. These treaties support the use of EIA as key tool to achieving pollution control and sustainable environmental development.

Table 1.1 International Legislation Summaries

S/NO	Regulations	Year Adopt
1.	World Bank Environmental Assessment Source Books	1998
2.	UN Convention on Biological Diversity	1994
3.	UN Framework Convention on Climate Change	1992
4.	Convention on the Control of trans-boundary Movements of Hazardous Waste a their Disposal of 1989 (Basal Convention)	1989
5.	Protocol on Substances that Deplete the Ozone Layer. Note: The Protocol was amended for the first time on 29 June 1990 in London. A second set of amendments was adopted in Copenhagen in November 1992; these entered into force on 1994.	1987
6.	Convention for the Protection of the Ozone Layer	1985
7.	Convention Concerning the protection of the World Cultural and National Herita (World Heritage Convention)	1972
8.	African Convention on the Conservation of nature and Natural Resources	1968

1.6 Terms of Reference for the EIA

Quiton has undertaken this environmental impact Assessment (EIA), to predict the impacts of this proposed Shopping Mall development on the environment and propose mitigation measures that will be incorporated into the project environmental management plan and detailed engineering design. The EIA covers:

- Baseline studies – including biophysical studies, social and health impact assessment
- Consultation programmes
- Environmental quality assessment and impact quantification, using predictive modelling tools.

The EIA is being carried out in parallel with the conceptual design of the project, to ensure that any identified adverse impacts are addressed in the detailed design and mitigated during the development activity stages which Involves site preparation, construction, commissioning, operation, decommissioning and abandonment.

In line with the EIA Procedural guidelines (FMEnv, 1995) the terms of reference (ToR) for EIA of the Shopping Mall project was submitted to the FMEnv and approval obtained defining the scope of work, objectives, baseline data requirements and assessment tools and methods for the EIA. The document also outlined the regulatory and administrative framework within which the EIA is conducted, highlighting key issues and activities of environmental concerns in the proposed project planning and implementation.

EIA Methodology

The procedure adopted for completing this EIA involved site identification and characterization, consultation with stakeholders and experts, literature review, field sampling, laboratory analysis and interpretation, collection of data, impact identification and evaluation, environmental impact analysis, impact mitigation and environmental management planning. The preparation of the report was performed by a multi-disciplinary team. The team selection was based on characteristics of the project environment, experience and subject discipline of each specialist. A team leader coordinated the tasks of team members towards achieving set targets as well as liaison with client.

This EIA study was conducted in compliance with Federal Ministry of Environment requirements. The methods adopted in performing specific tasks of the EIA for the proposed project are as follows.

Desktop Research

The geography and the relevant environmental and socio-economic information on the proposed project location were gathered from maps, charts, articles, previous study reports on the area and similar environment, photographs, etc. The information generated enabled definition of limits of the area to be studied. Data gap analysis was carried out to identify areas where additional information was required and the result used in planning the execution of field sampling and measurement aspects of the EIA project.

Field data Collection

The information gathered from desktop research and site identification were used in categorizing the major habitats in the area, and their respective sampling requirements defined to effectively collect qualitative and quantitative data on the flora and fauna of the project area. The fieldwork covered all relevant elements of the ecological and socio-economic environments.

Consultation with Stakeholders and Experts

In order to efficiently deliver improved project sustainability and protect the interest of the affected communities, especially the poor and vulnerable, an elaborate public consultation process was undertaken as part of this EIA. It involved engaging each identified community in a dialogue characterized by two-way information flow. Consultation allowed obtaining from the affected population, information that might influence the decision-making process in scoping, project design, mitigation, monitoring and management plans, as well as the analysis of alternatives to be implemented.

Impact Identification and Evaluation

The environmental aspects of the proposed project that may interact positively or negatively with the environment at the construction, operation and decommissioning phases were identified at this stage of the assessment. In the identification and evaluation process, the information collated, were processed using procedures in the FMEnv EIA Sectoral guidelines for Infrastructure projects and the World Bank Environmental Source Book.

Impact Mitigation

Mitigation measures designed to prevent, reduce or control the adverse impacts of the proposed project activities were proffered using professional judgment based on scientific deductions and

project experience. Other resource documentation referred to include the FMEnv Sectoral Guidelines for infrastructures projects, and the World Bank Environmental Assessment Source Book. Similarly, enhancement measures were proffered to ensure that beneficial impacts of the project were optimized. Furthermore, post-auditing or monitoring has been designed into the project and its environmental management plan.

1.7 Objectives of the EIA

This EIA is executed to establish the environmental baseline, sensitivities, impacts and mitigation measures with respect to the development (including operation) of the proposed Shopping Mall project. EIA will ensure the effective systematic study process; these include:

- assessment of the present environment status, establishment of environmental issues and factors which are associated with the Shopping Mall project development;
- assessment and prediction of all possible and potential impacts of the project on components of the environment in terms of magnitude and importance;
- evaluation of alternatives and identification of the best options that is both cost effective and with least potential environmental impact; and
- incorporation of EIA recommendations into the Shopping Mall project's detailed design as well as other stages of the project development.

Benefits of the EIA

The benefits of the EIA will include, but not limited to:

- obtaining permits usually required by regulatory authorities before the commencement of any major development
- providing a forward-planning tool for environmental implications to be taken into account with other design considerations at the conceptual design stage which allow important decisions to be built into the project while avoiding undue damage to the environment;
- providing a design tool that will allow a systematic evaluation of potential environmental problems from the proposed Shopping Mall and identification of key issues which require special consideration for effective environmental management and controls;
- involving all stake holders through consultation so as to address common problems, impacts and mitigating measures that might be proposed; and
- informing and assisting management with a view to establishing and achieving long term management objectives and plans associated with specific activities, in order to minimize associated financial and environmental risks.

1.8 Structure of the EIA Report

The EIA Report is presented in eight chapters.

- Chapter one is an introduction containing relevant background information and the legal and administrative framework for EIA in Nigeria among other information;

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

Other sections of the report include the table of content, list of EIA preparers, list of abbreviations and acronyms, acknowledgement page, the executive summary, the list of references, and various appendices.

2 PROJECT JUSTIFICATION

2.1 Project Justification

This chapter presents the needs, benefits; economic, technical and environmental sustainability of the proposed Shopping Mall project in Port Harcourt. Also presented are project options of the proposed Shopping Mall project.

2.2 Project Objectives

The objectives of the proposed project are derived from the following:

- Create employments opportunities
- Engender competition which could reduce the prices of goods in Port Harcourt
- Improvement of the local, state and national economies
- Make return on investment

2.3 Need for the Project

Quiton's intention to undertake the development of Shopping Mall in Port Harcourt is based on the need to provide a secure, decent and accessible commercial infrastructure where trading in most vital goods and services can be obtained in one place.

2.4 Benefits of the Project

The major benefits are as stated in section 2.3. Moreover, it will offer accommodation for traders of goods and services, reduce or eliminate the stress associated with commuting long distances in search of various goods and services are to be accommodated in the proposed mall, create employment for indigenes of host and the neighbouring communities during all project phases.

2.5 Value of the Proposed Project

The proposed project is estimated to cost about 1.5 billion Naira.

2.6 Envisaged Sustainability

The sustainability of this project stems from the fact that it will satisfy economic contributions, meet the demand for safe and secure commercial infrastructure, and also maintain environmental friendliness. The sustainable development philosophy of minimizing land-take, cost and the impact on the environment shall be adopted for this development project. The set goal is, "meeting the needs of the present without compromising the ability of future generations to meet their own needs".

Social Desirability

In view of the proponent's continuous consultations with host community and other stakeholders, a cordial relationship shall be maintained with the people. This no doubt will create a sustainable social relationship between the proponent and the host community.

Technical Feasibility

The technical feasibility of the proposed project stems from the application of best available technology (BAT) to the development of the proposed project. In addition, strict adherence to international and national engineering designs e.g., construction standards and codes of practices which shall be adopted at all stages of the proposed project development shall ensure the technical feasibility of the project. Quiton shall depend on the EPC Contractor for the procurement of all materials and construction of the proposed Shopping Mall.

Environmental Friendliness

The proposed project shall be environmentally friendly because of the adoption of the best available technology (BAT), EPC Contractor's HSE policy and the improved EIA process for the project. Incorporating the findings and recommendations of this EIA and subsequent implementation of the Environmental Management Plan for every phase of the proposed Shopping Mall project will ensure the required environmental friendliness.

Economic Viability

The locals shall gain employment and requisite skills through direct and indirect involvement of unskilled labour, contractors, consultants, suppliers and other professionals during the construction and operation of the proposed Shopping Mall. Apart from the direct employment of persons at the facility, indirect employment and associated economic effects will be derived from potentially induced development and ease of doing business. These will increase the IGR of the State and host LGA.

2.7 Project Options and Alternatives

The project following project options were considered based on the health, safety and environmental impacts; best available technology; and economic/social considerations:

Option 1: Do Nothing Option

This implies maintaining the status quo by not constructing the proposed Shopping Mall and investing the available funds in other projects.

This would imply that the opportunity for potential benefits of a mega commercial infrastructure, employment creation will be missed; and there will be no environmental impact due to construction but increased impacts on prospective customers in the catchment area, who have to commute longer distances to get supplies.

This option was rejected because it does not promote the potential economic development and sustainability of the City.

Option 2: Delayed Option

This implies the implementation of the proposed project at a later time for such reasons as lack of funds, communal crises, war, etc. This option was rejected since none of these situations is obtainable and the proposed Shopping Mall construction is urgently needed.

Option 3: Construction of the proposed Shopping Mall

This option was accepted for implementation because of the need to harness potential economic development of the state for the benefit of all and sundry in the City.

3 PROJECT DESCRIPTION

3.1 Project Description

The proposed project is a shopping mall with all the facilities and utilities needed at No. 4 Old Aba Road, Port Harcourt, on a plot of land of about 21000 sqm. The proposed Mall contains a maintenant (supermarket), various shops, restaurants, cinemas and an entertainment hall. The mall has underground parking lots additional to the external parking area (Figure 3.1).

3.1 Site Plan

- We have 2 major access way, 1 for entrance and the other serves as exist.
- Parking lot for cars is sufficient. An average of about 300 cars can park at peak hours.
- Wider road network within the parking lot with asphalt concrete finishing. The parking lot is finished with interlocking stone.
- Good landscape area with much cover for green area.
- The main building is within the centre of the land, having a parking area at the front and back

3.2 Foundation Layout (Figures 3.2 a-ef)

- It occupies a land area of about 3,000m^2.
- The foundation layout has 2 lifts, from the basement floor to the final floor, including a staircase support with columns of 400*400mm thick.
- The space of the beam from one column to the next column is above 5.5m and 8.0m in some sides of the building.

3.3 Slab Above Ground Floor (Figure 3.3)

- It has a beam span with an average of 7.6m, with 1m to 1m spacing.
- Beam sizes of 400m/850m.
- The beam size above ground floor is 4.55m in height.

3.4 Elevation (Figures 3.4 a-c)

- The facade of the building is well finished with concrete slab cutting glass
- The wall is finished with effect of wall tiles and their board (wall cladding).
- Steel pipe columns is used for support and finishing.

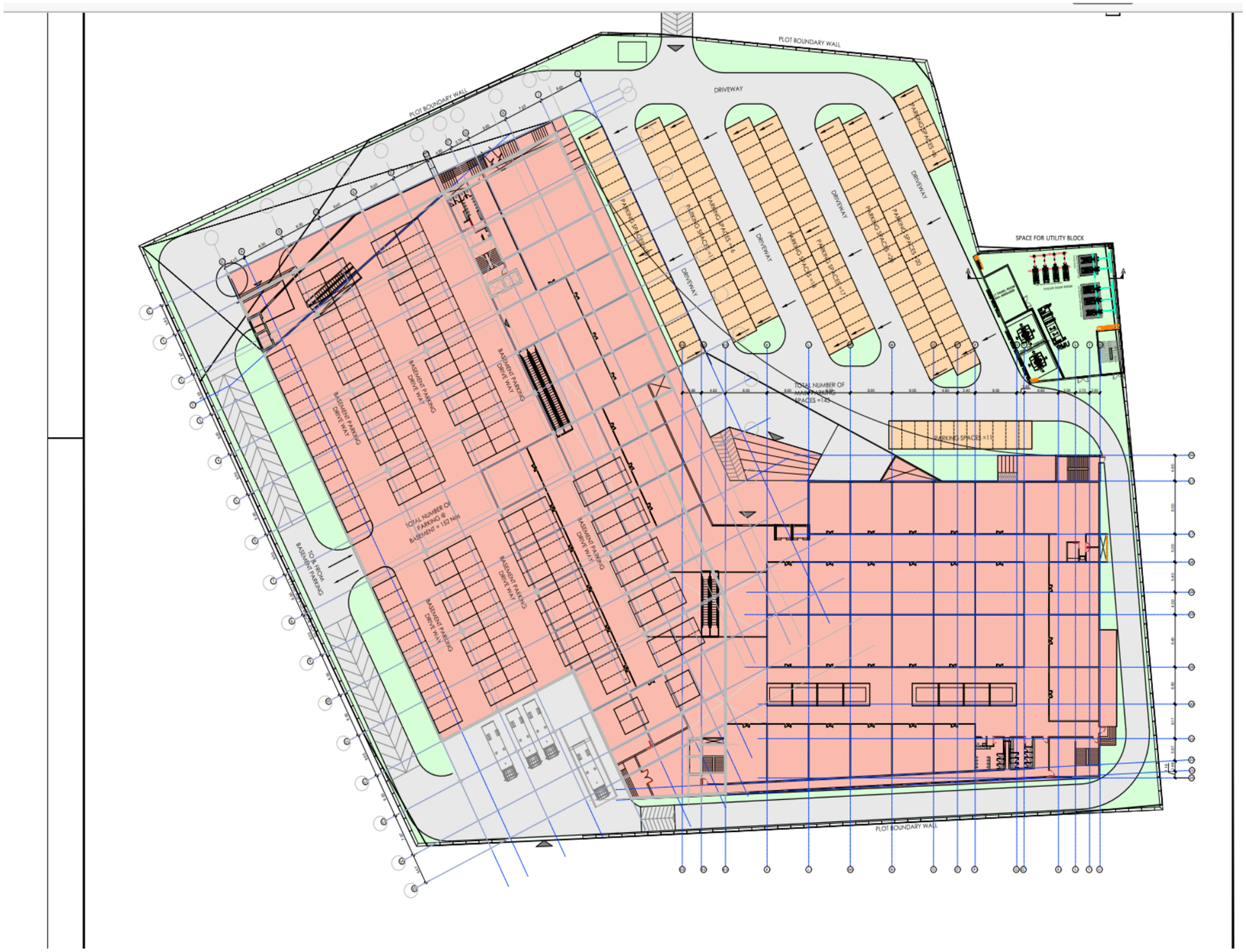


Figure 3.1: General Layout of the proposed Shopping Mall

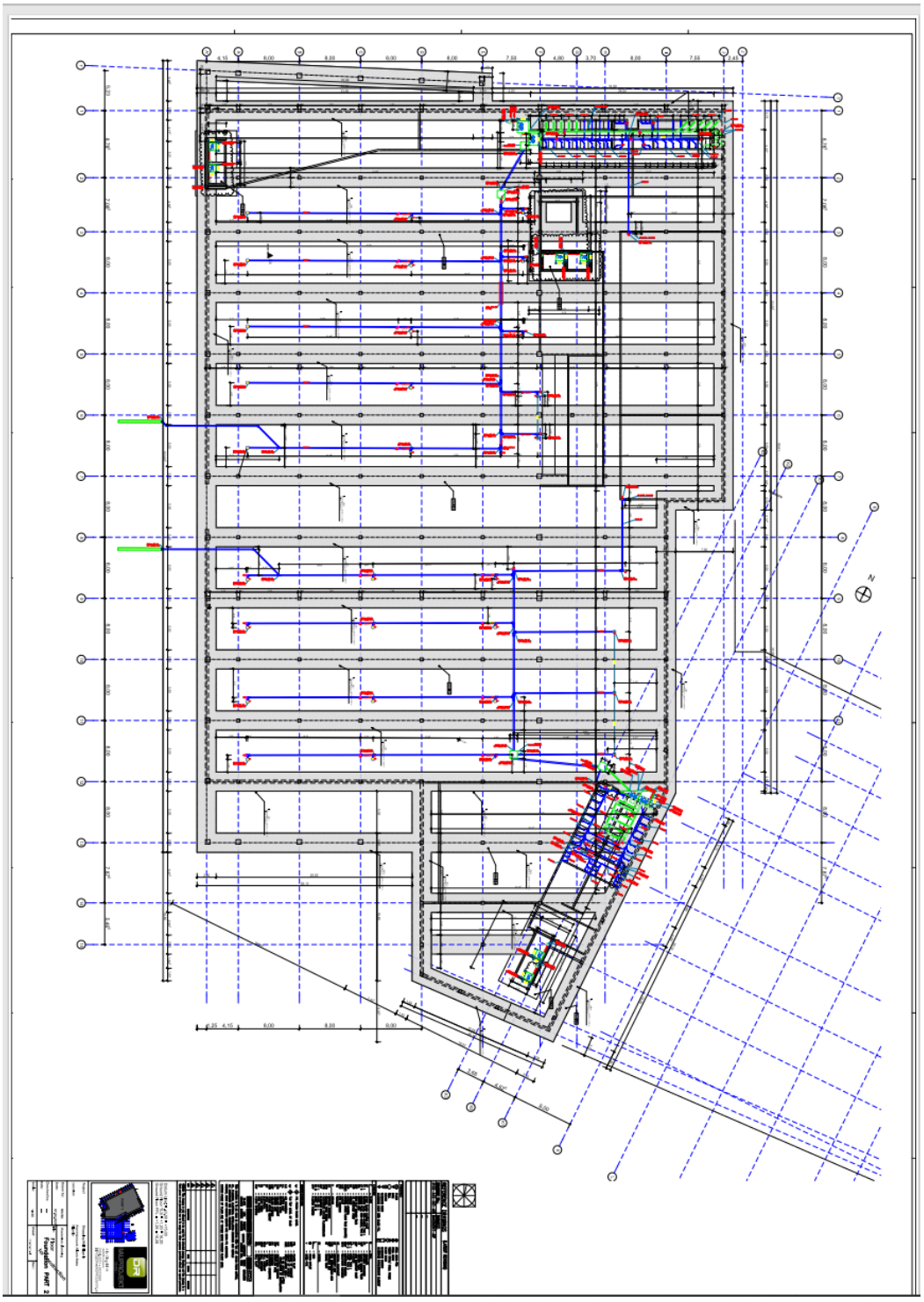


Figure 3.2a: AIP Foundation (Part 1, Sheet 1)

Figure 3.2b: AIP Foundation (Part 1, Sheet 2)

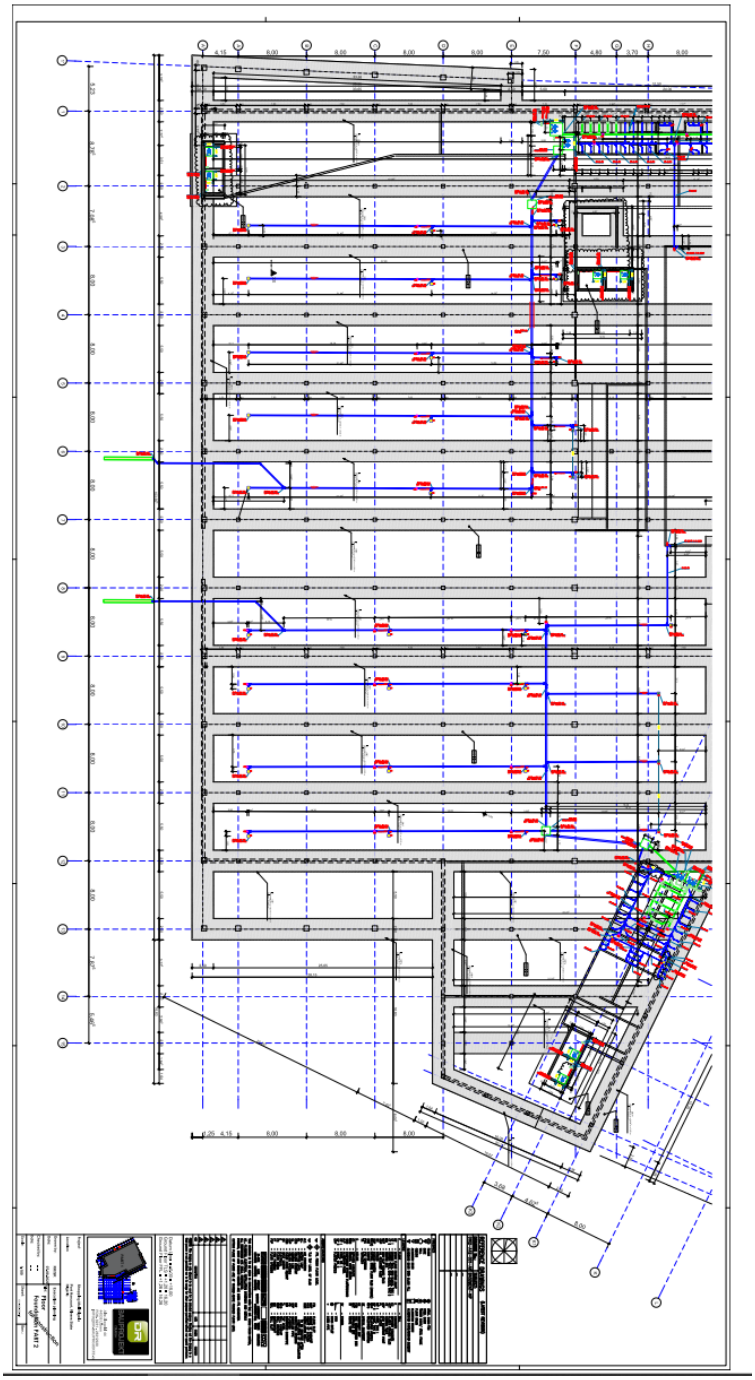


Figure 3.2**c**: AIP Foundation (Part 1 Sheet 2**3**)

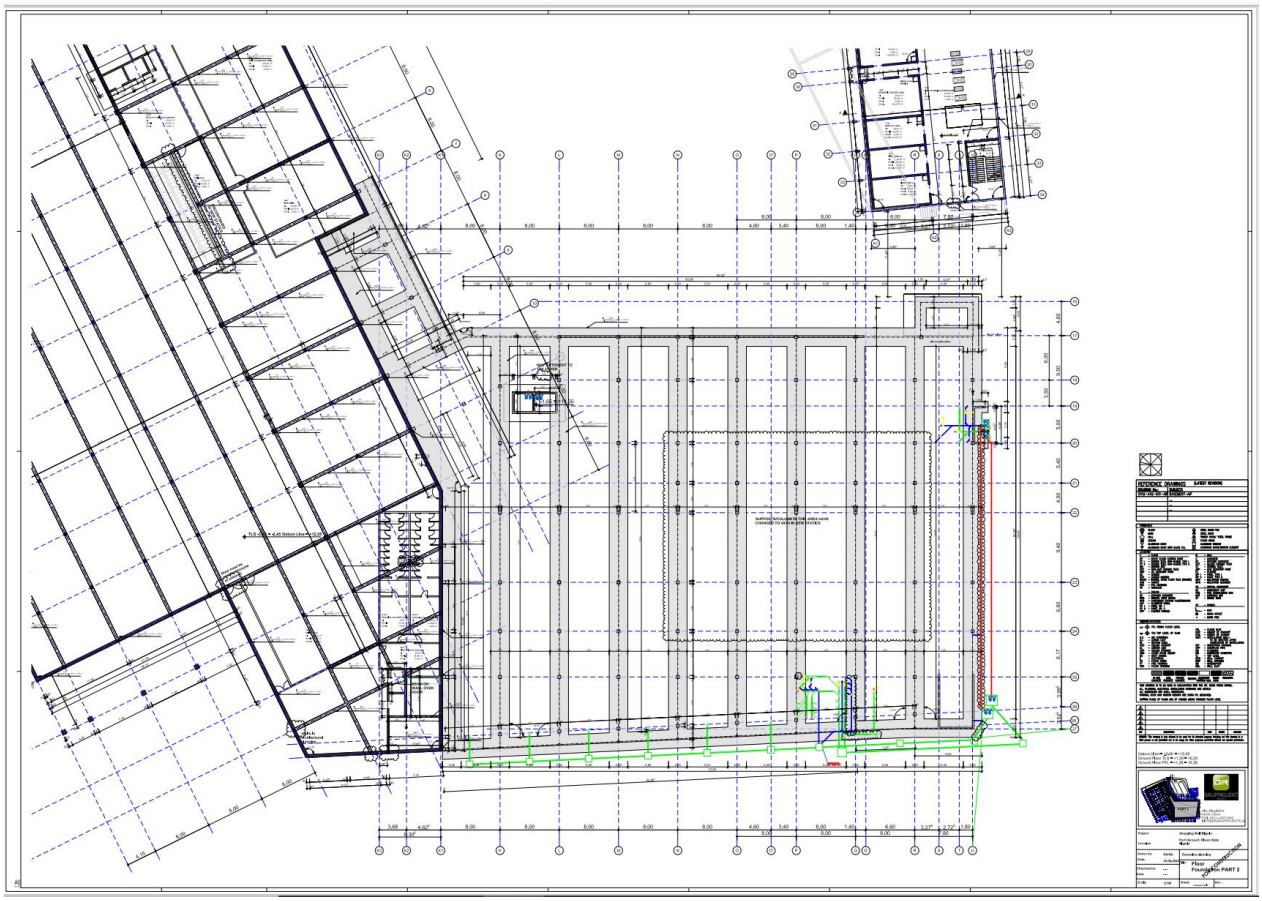


Figure 3.2d: AIP Foundation (Part 2 Sheet 1)

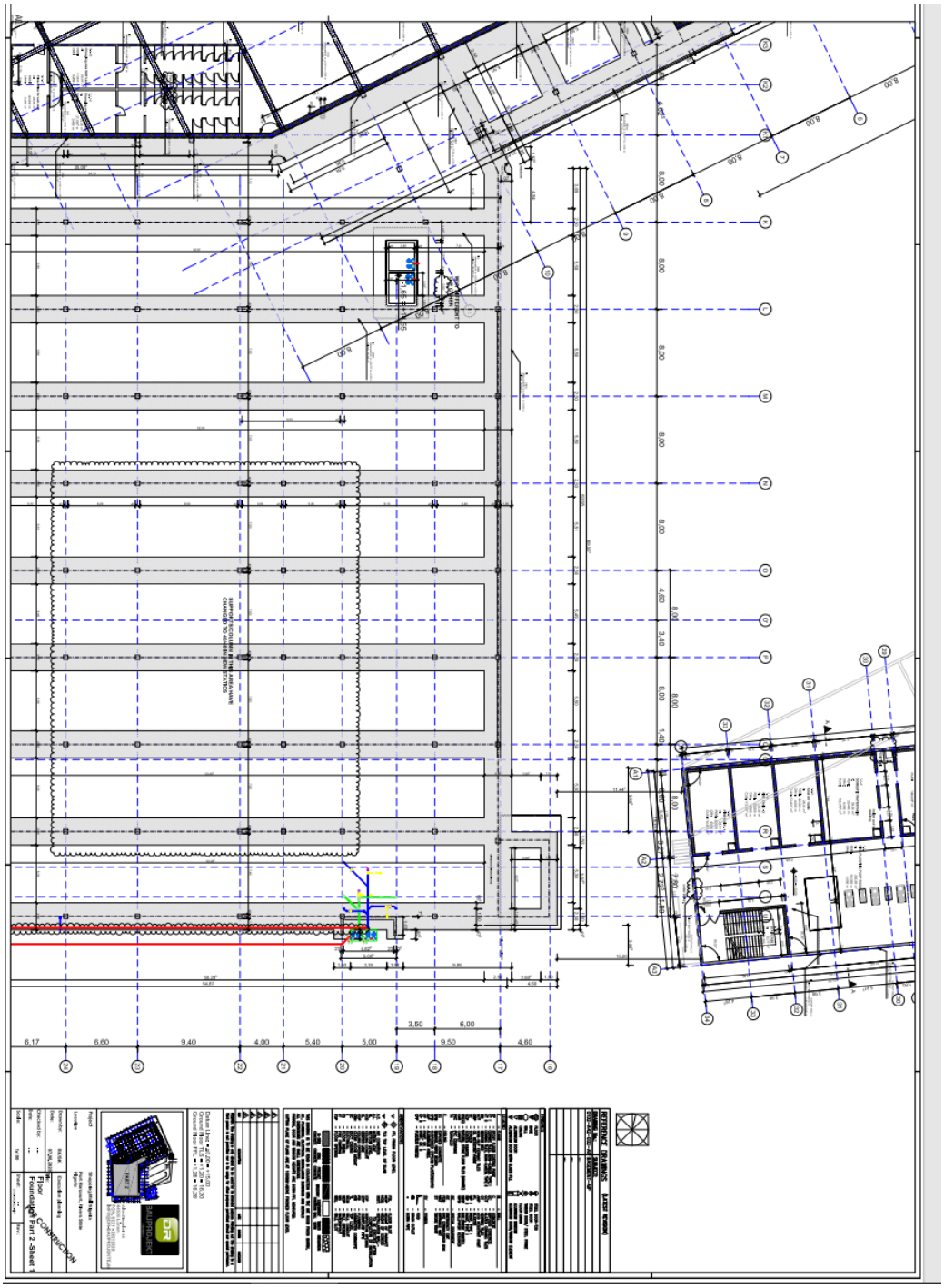


Figure 3.2e: AIP Foundation (Part 2 Sheet 2)

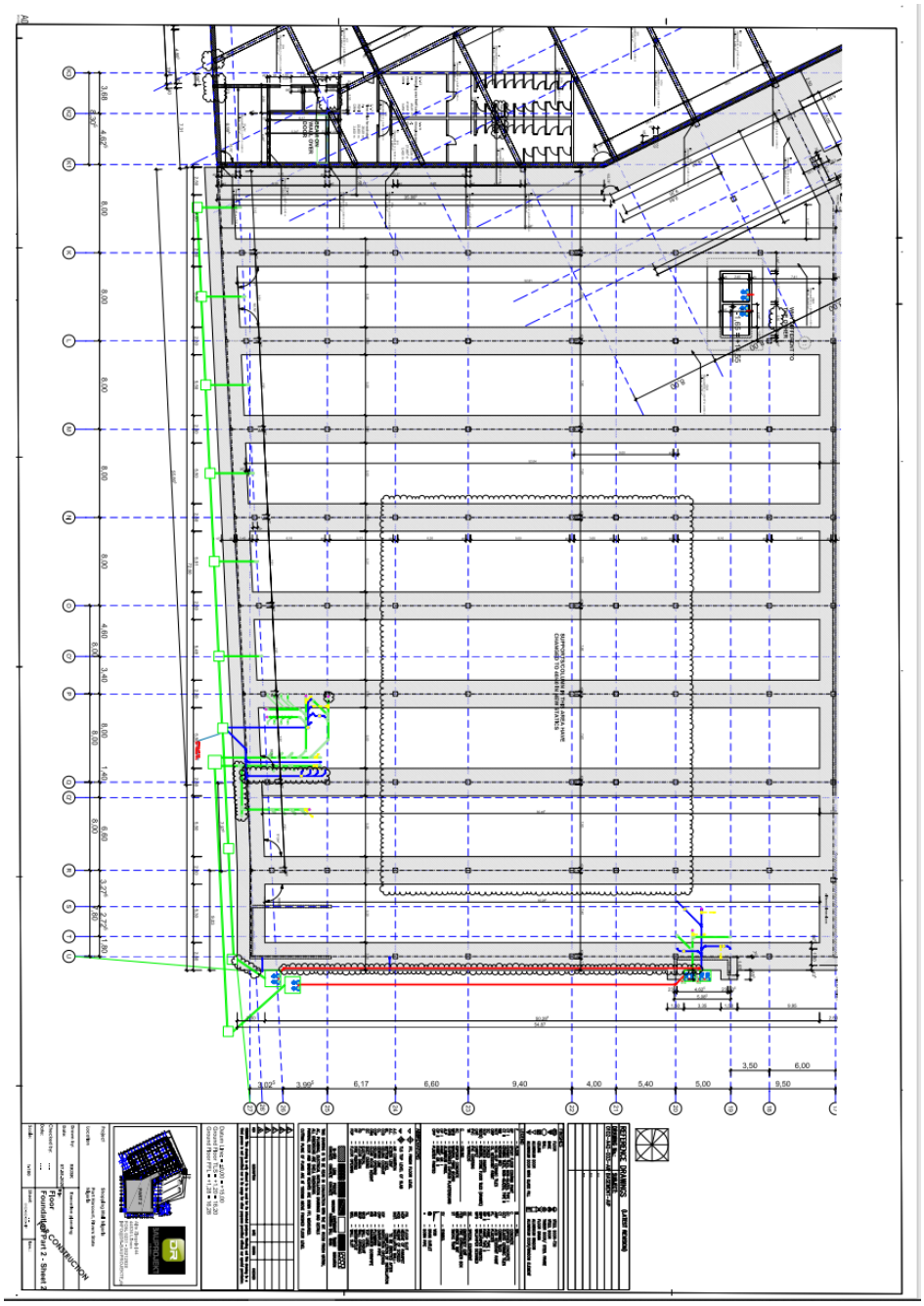


Figure 3.**2f**: AIP Foundation (Part 2 Sheet 3)

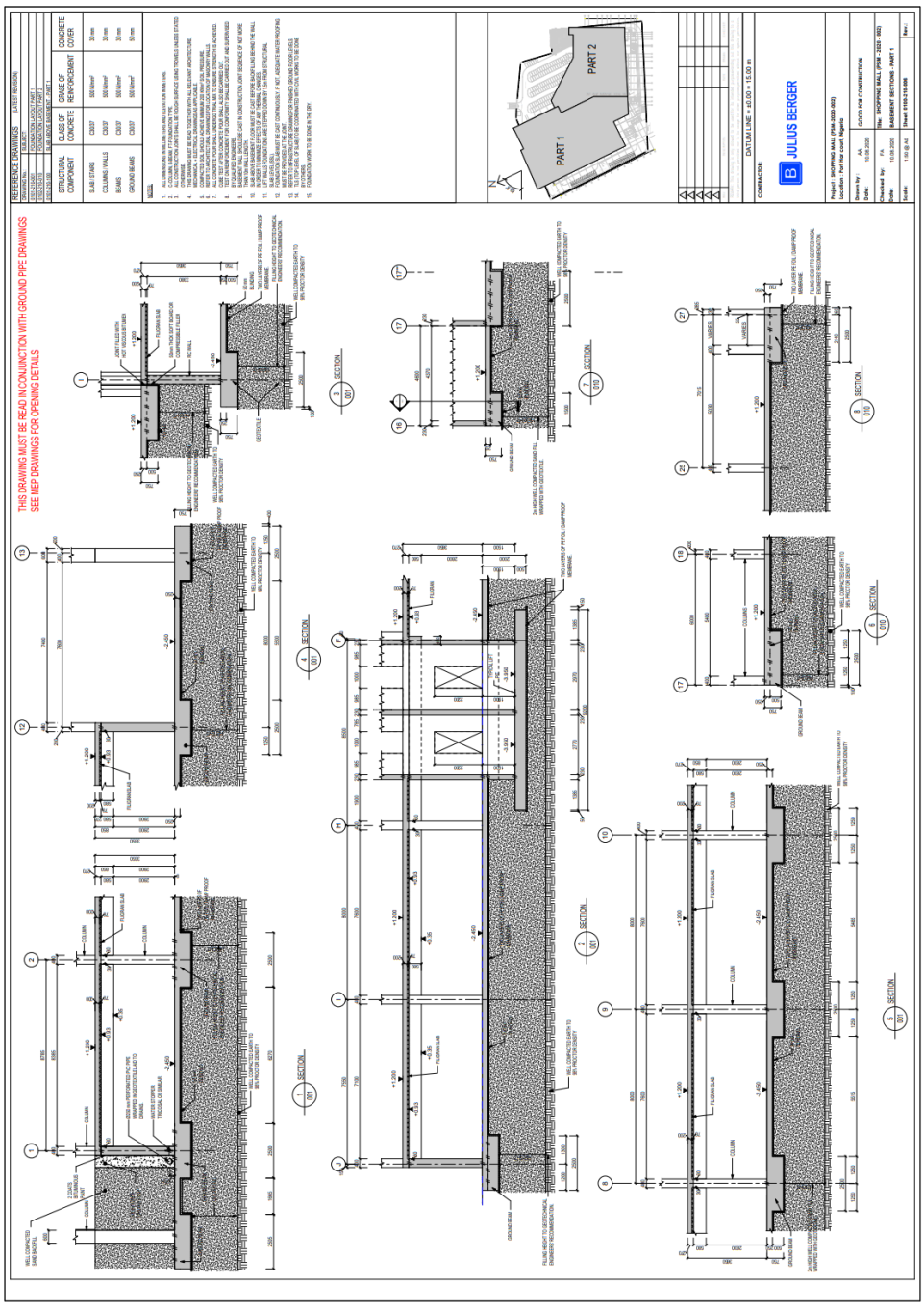


Figure 3.3: Basement Sections

Aerial View

Side view

Front view

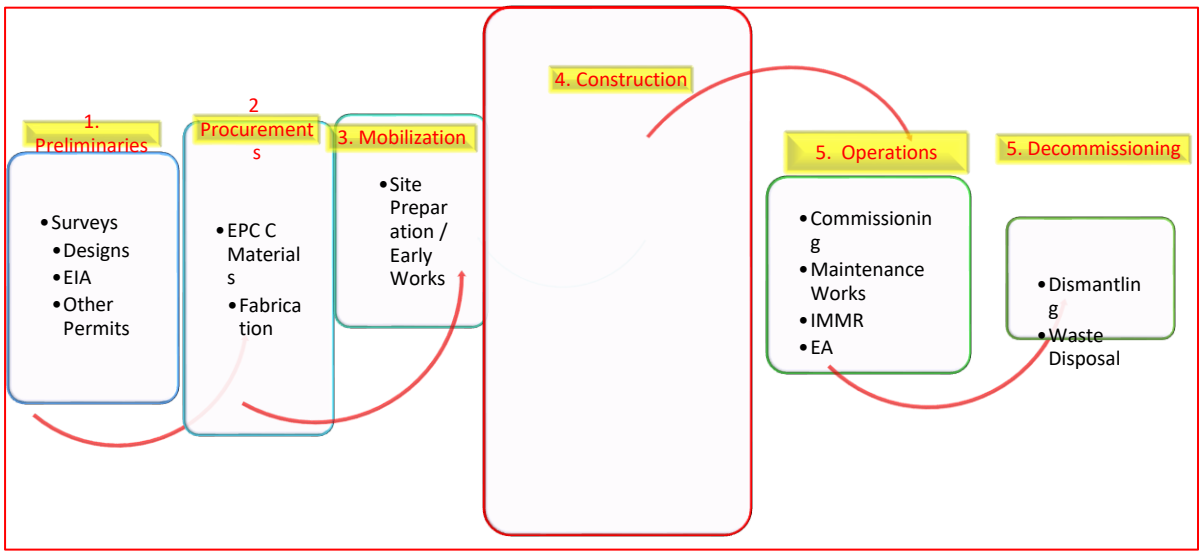
Figure 3.4: 3D Elevations

3.5 Construction Stages

The whole project could be divided into three (3) parts: main mall, external works and utilities area. These parts of the project are typically constructed in the sequence shown in Figure 3.55:

3.6 Shopping Mall Work Scope

Figure 3.5 presents flow chart of the work scope and the principal sequence of construction works process for the proposed Shopping Mall:



Figures 3.5: Flow Chart of the Work scope

Table 3.1: Material Balance

S/N	Material Input		Product Output	
	Material	Quantity/Month (Tons)	Product	Quantity/Month
1	Cement	513	Concrete	1426m^2
2	River sand	1975	Asphalt	7140 tons
3	Stone dust	2691		
4	Grave 5/15	3340		
5	Gravel 15/22	1890		
6	Bitumen	350		

3.7 Energy Consumption

The Project yard has 4 Nos, 1275kVa generators which supply electrical energy for its operations. Three of the generators are operational for 24hrs while one is on standby. The generators consume about 800 litres of diesel (Automotive Gas oil – (AGO) per day (i.e. 400 litres per generator per day).

3.8 Major Construction Equipment

The major equipment to be deployed for the construction of the proposed Shopping Mall are listed in Table 3.2.

Table 3.2: Major Project Equipment

SN	Equipment	Number
49.	Air Compressor	3
50.	Ambulance	2
51.	Back-hoe Loader	3
52.	Borehole machine	2
53.	Bulldozer	6
54.	Concrete Batching Plant	1
55.	Concrete Mixing Machine	1
56.	Concrete Pump (Mobile)	3
57.	Crawler Crane	1
58.	Dump Truck	24
59.	Excavator	4
60.	Excavator + hammer	3
61.	Forklift	7
62.	Fuel Tanker	7
63.	Generator	6
64.	Grader	6
65.	Iron Cut and Bend	10
66.	Light Equipment	1
67.	Loader	6
68.	Lubrication, Maintenance and Rescue Truck	2
69.	Maintenance Workshop	2
70.	Mini Excavator	6
71.	Mini Loader	6
72.	Mixing Plant	3
73.	Mobile Crane	3
74.	Mobile welding machine	13
75.	Paver (Ballast Laying)	3
76.	Pick - up (double deck)	12
77.	Portal Crane	4
78.	Precast Plant	1
79.	Refrigerated vehicle	2
80.	Road Car	15
81.	Rotary Driller	1
82.	Sand Washing Plant	1
83.	Scale	6

SN	Equipment	Number
84.	Screen Plant	1
85.	Shotcrete Pump - Dry	8
86.	Shotcrete Pump - Wet	3
87.	Survey Equipment Set	1
88.	Survey Equipment Set for Machinery	1
89.	Tower Crane	2
90.	Tower Light	30
91.	Tractor	4
92.	Trencher	1
93.	Vibro roller	19
94.	Wagon	6
95.	Wastewater tanker	6
96.	Water tanker	6

3.9 Load Transport

Load transported to site include rebar, batched concrete, wood, parapets, cross beams, formworks, filigram, sand, U-channels, stone base etc. The transport routes are the existing urban road network, utilising more, the roads that are closed to public use by the traffic diversion. These are transported in trucks and articulated vehicles at least peak periods to the site, from the yard.

3.9.1 Personnel Requirement and Transport

Approximately 120 personnel in the Shopping Mall and the fabrication yard. There are specialised sub-contractors that will be engaged by the main contractors when the needs arise. These will be sourced from JBN staff and host communities. Personnel carriers pick up workers at designated points within the town and in the outskirts, to work before 7am and return them at close of work.

3.10 Waste Management

The waste management plan for the proposed project has been informed by the understanding of the possible waste characteristics.

The construction waste to be considered includes: -

a. Demolition waste – concrete, soil, sand, metals
b. Soil: excavated soil which will be reused as backfilling materials for the Shopping Mall foundations.
c. Oil: oil & grease from malfunctioning vehicles and equipment at site
d. Office waste and domestic solid waste (refuse): this is generated at the construction site.

From the above, the Engineering, Procurement and Construction (EPC) Contractor will design its waste management plan under two categories:

- Solid Waste
- Emissions

The over-burden will be separated into top soil and sub-soil which shall be dumped in separate locations for reuse during phased construction-pit reclamation.

Generated scrap metals, paper, glasses and plastics will be sorted and sold out for recycling or reuse.

There will be at-source segregation of solid wastes (Figure 3.66). The Rivers Waste Management Agency will be contracted to collect and dispose of the waste that will be generated after the EPC Contractor has recovered those it can reuse. The waste shall be tracked and dumped in any of the existing approved dumpsites in the City.

On completion of construction works, the EPC Contractor shall demobilize from site and shall clear the site of all debris, including the remains of abandoned temporary structures erected in the vicinity of the Shopping Mall site by food and other vendors, to serve the workers at the site. These will be collected and disposed of also by the EPC Contractor's waste disposal subcontractor.

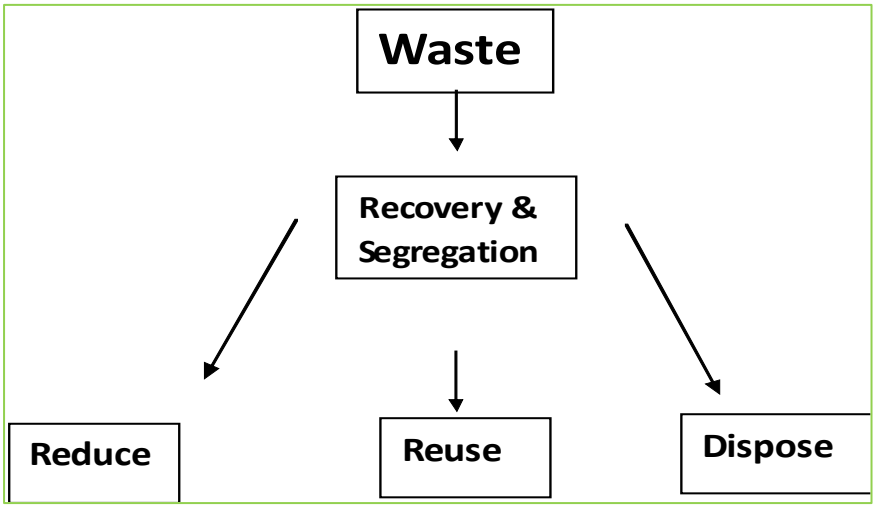


Figure 3.6: Waste Management flowchart for the proposed Shopping Mall project.

Figure 3.6 presents a simplified flowchart for proposed waste management strategy for the proposed Shopping Mall project. Appendix 1 also presents the JBN's Waste Management plan.

Plate 3.1: Demolition waste

3.11 Project Execution Schedule

Figure 3.7 presents the proposed Shopping Mall Project execution schedule.

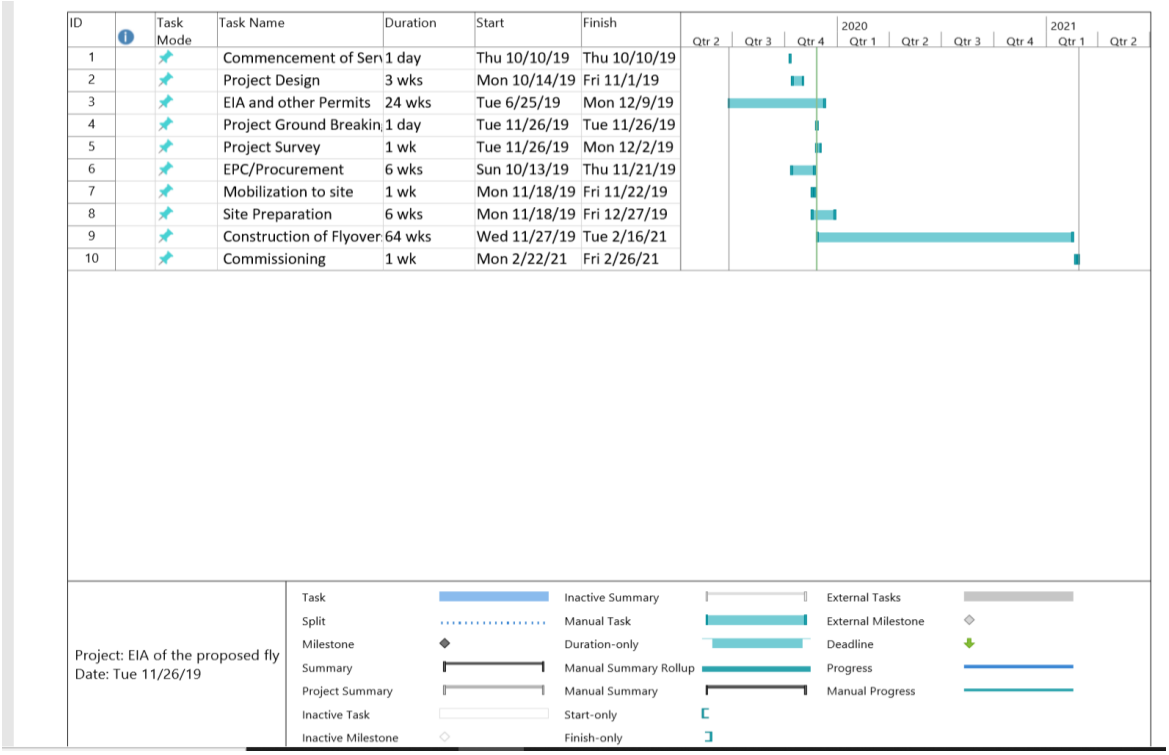


Figure 3.7 Proposed Shopping Mall Project execution schedule

4 DESCRIPTION OF THE ENVIRONMENT

4.1 Existing Environmental Data Acquisition

The establishment of a comprehensive existing environmental condition of the project area is an integral part of this Environmental Impact Assessment (EIA) process. Such environmental data provide information on the current status, characteristics and features of the environment of the project area.

The knowledge of the environmental data is essential in the assessment of the associated/potential impacts of the project activities and future assessment and monitoring of the environment. The existing environmental data of the project area for Shopping Mall at Rumuomasi, Port Harcourt were established through extensive desktop studies, field sampling, laboratory analysis of samples and interpretation of results, social and health environment data collection and analysis.

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

4.1 Scope of Study

Field studies and data collection for characterization of the baseline conditions of the project environment using a radius of 500m as Area of Influence, in line with the TOR approved by the FMEnv.:

- Climate and meteorology;
- Air quality and noise levels;
- Geology/hydrogeology;
- Geotechnical survey;
- Soil;
- Ground water quality;
- Socio economics/health impact, demography and community characteristics.

Due to the built-up nature of the project location (Figures 1.212), there were no flora, fauna, and surface water studies.

4.2 Baseline Data Acquisition Methods

The acquisition of data basically involved field data gathering, measurements and the collection of representative samples used to establish the environmental conditions of the study area. This exercise involved a multi-disciplinary approach and was executed within the framework of a QHSE Management System approach. This approach assured that the required data and samples were collected in accordance with agreed requirements (scientific and regulatory) using the best available equipment, materials and personnel. Elements of this approach include:

- review of existing reports that contain environmental information on the study area;
- designing and development of field sampling strategies to meet work scope and regulatory requirements;
- pre-mobilization activities (assembling of field team, sampling equipment/materials calibrations/checks, review of work plan and schedule with team, and job hazard analysis);
- mobilization to field;
- fieldwork implementation - sample collection (including positioning and field observations), handling, documentation and storage protocols and procedures;
- Demobilization from field; and
- Transfer of sample custody to the laboratory for analyses.

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

4.2.1 Desktop Studies

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

4.2.2 Field Sampling/Measurement

In order to effectively establish the environmental characteristics of study area, a one season field data gathering exercise (as approved by FMEnv, refer to scoping report) was performed between 25th through 30th August, 2020. The specific objectives of the ecological field sampling were to:

- determine the ambient air quality and noise level of the study area;
- determine the physico-chemical and biological characterization of groundwater within the study area;
- establish the socio-economic and health status of the host and impacted communities.
- Geological study

Groundwater samples were collected as appropriate. The exercise involved in situ measurement of salinity, temperature and pH. Samples were taken at defined sample points using bottle sampler for water quality determinants. These were stored and preserved as appropriate for each analysis. Water samples were collected for laboratory analyses using

- 2-litre plastic bottle for groundwater samples for physicochemical analysis;
- 1-litre plastic bottle for water samples for microbiological analysis;
- 1-litre glass bottle with Teflon seal cap for water samples to be analysed for hydrocarbon content (oil and grease, etc.).

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

4.3 Field Study and Sampling Design

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

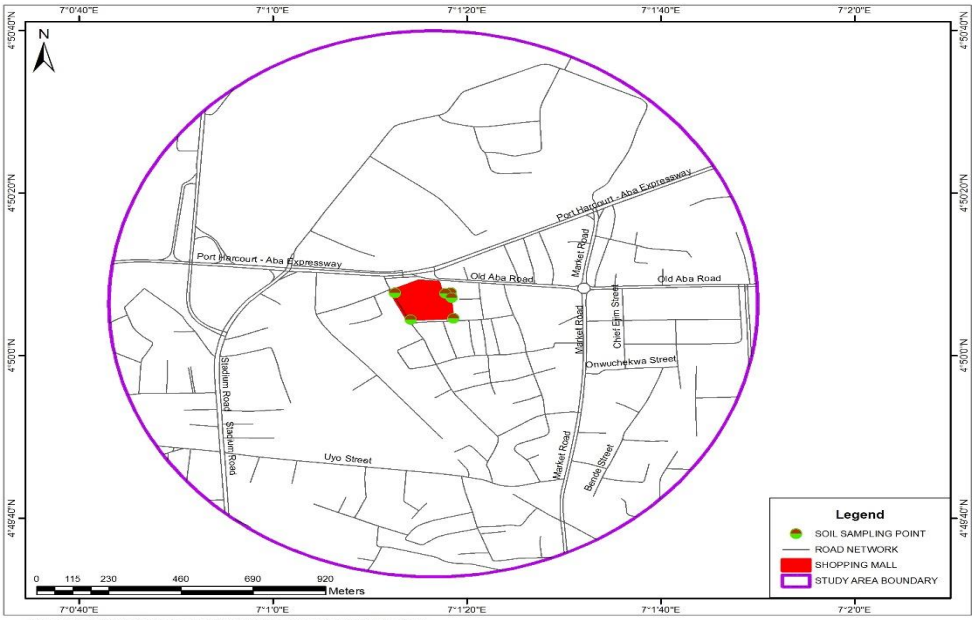
Sampling locations were decided as waypoints in Geographic Position System (GPS) and later plotted in a sampling map used during the field studies. Locations for biophysical sampling considered ecological types around the project areas, vulnerable environmental attributes with regards to the potential and associated impacts of the environment and control or buffer zones. Socio economic and health impact studies on the other hand, considered human habitations, infrastructure, cultural heritage sites and prevailing health conditions of people within the sphere of influence to the project area. Table 4.1 presents an inventory of the biophysical and socioeconomics/health details collected during field studies while the map (Figure 4.2) shows the spatial locations of the sampled points.

Table 4.1 Inventory of Biophysical and Social Samples

SN.	Environmental Component	Parameter/Details	No. of Samples approved by FMEnv in the scoping report	Actual No. of Samples Collected
1	Ambient Air	Carbon oxides; Sulphur oxides; Nitrogen oxides; Volatile organic compounds (VOC); Oxygen (O_2); Hydrogen sulphide (H_2S); Particulate matter (PM); Methane and Combustible gas.	Upto 9 samples and control	13 air samples + 3 controls
2	Soil samples	Soil type, grain size, Total organic matter, soil microbiology, soil colour, texture, porosity, bulk	Upto 6 samples and control	8 soil sample + 2 controls

SN.	Environmental Component	Parameter/Details	No. of Samples approved by FMEnv in the scoping report	Actual No. of Samples Collected
		density and permeability and Nutrients microbiology		
3	Noise	Acoustical measurements using a Type I or Type II integrating sound level meter will be taken. All measurements will be taken in decibels (dB). The continuous attended noise measurements will record continuous equivalent sound measurements (LAmax, LAmin, LA1, LA5, LA10, LA50, LA90, LA95, LA99) at each of the sampling points.	Upto 9 samples and control	13 noise samples + 3 controls
4	Groundwater	depth to and thickness, hydraulics, recharge, colour, pH and temperature, Salinity and conductivity, Hardness, Heavy metals (Cu, Pb, Fe, K, Ba), Phosphate, SO_4, NO_3, Biological and chemical oxygen demands (BOD and COD), Turbidity, Dissolved and suspended solids, Total hydrocarbons (THC), Oil and grease (mineral and FOG), VOC and SVOC including BTEX, Nutrients microbiology	Upto 3 samples and control	3 groundwater samples + 2 controls

Sources: Resourcefield survey, 2020



THE STUDY AREA SHOWING SOIL SAMPLING POINTS

Figure 4.2a: Soil Sampling Location Map

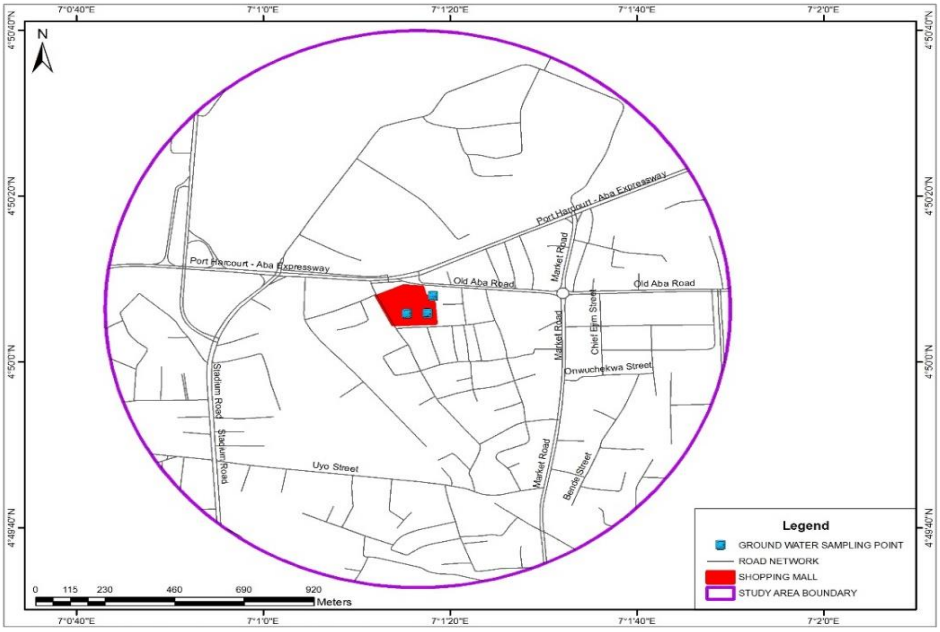
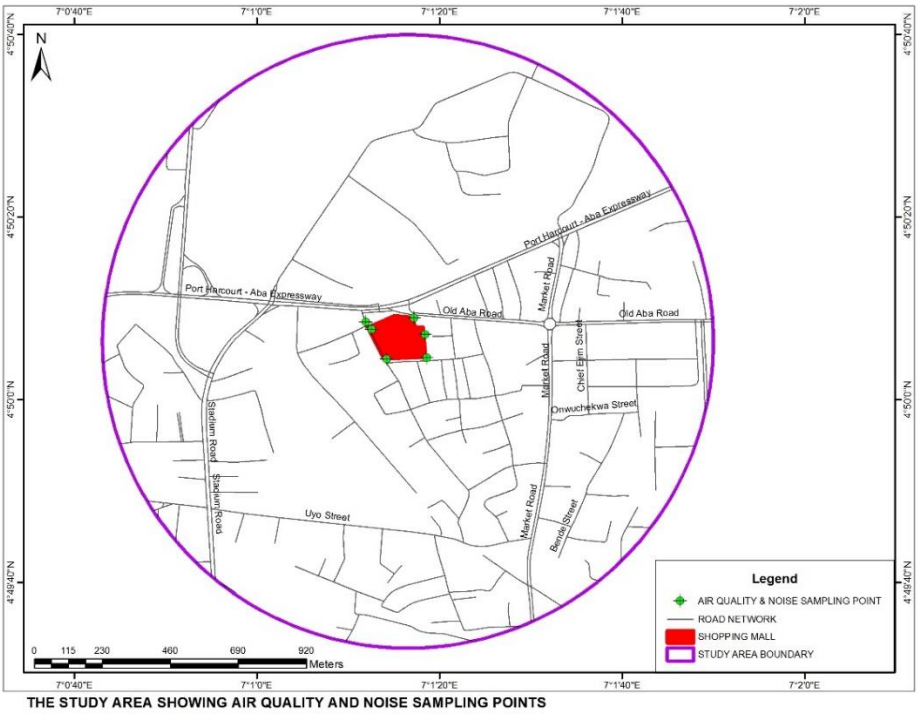


Figure 4.2b: Water Sampling Location Map



THE STUDY AREA SHOWING AIR QUALITY AND NOISE SAMPLING POINTS

Figure 4.2c: Air Quality and Noise Sampling Location Map

4.4 Analytical Methods

Samples collected from the field were analysed in Akwa Ibom State Ministry of Science and Technology laboratory using the various methods shown in Table 4.2. Also shown on the table are the equipment detection limits for the different parameters analysed.

Table 4.2 Laboratory Analytical Methods

Parameters	Methods	Detection Limits
Ground Water Samples		
Temperature (°C)	APHA 2110B	-
pH	APHA 4500H^+B	-
TSS (mg/l)	APHA 2540D	1
TDS (mg/l)	APHA 2510A	-
Conductivity (µS/cm)	APHA 2510A	-
THC (mg/l)	ASTM D3921	1.0
DO (mg/l)	APHA 4500-O G	-
BOD (mg/l)	APHA 5210A	0.5
COD (mg/l)	APHA 5220D	0.8
Reactive Silica (mg/l)	APHA 4500-SiO_2	0.1
Nitrate (mg/l)	EPA 352.1	0.02
Phosphate (mg/l)	APHA4500-P D	0.002

Parameters	Methods	Detection Limits
Ammonium (mg/l)	APHA 4500-NH_3	0.02
Calcium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Magnesium (mg/l)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/l)	APHA 3111B/ASTM D3561	0. 1
Sodium (mg/l)	APHA 3111B/ASTM D3561	0.1
Lead (mg/l)	APHA 3111B	0.20
Total Iron (mg/l)	APHA 3111B	0.05
Copper (mg/l)	APHA 3111B	0.05
Polychlorinated biphenyls (PCBs)	EPA8082A	0.1
Zinc (mg/l)	APHA 3111B	0.05
Manganese (mg/l)	APHA 3111B	0.10
Cadmium (mg/l)	APHA 3111B	0.02
Total Chromium (mg/l)	APHA 3111B	0.10
Mercury (mg/l)	APHA 3112B	0.0002
Arsenic (mg/l)	APHA 3030B/3114B	0.001
Soil samples		
pH (H_2O)	ASTM D4972	-
TOC/TOM (mg/kg)	BS 1377	-
Conductivity (mg/kg)	APHA 2510B	-
THC (mg/kg)	ASTM D3921	10.0
Nitrate (mg/kg)	EPA 352.1	0.02
Phosphate (mg/kg)	APHA 4500-P D/CAEM	0.002
Sulphate (mg/kg)	EPA 9038	1.0
PSD (mg/kg)	ASTM D422	-
Calcium (mg/kg)	APHA 3111D	0.1
Magnesium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Potassium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Sodium (mg/kg)	APHA 3111B/ASTM D3561	0.1
Zinc (mg/kg)	ASTM D5198/APHA 3111B 0.05	
Lead (mg/kg)	ASTM D3111B /D5198	0.20
Mercury (mg/kg)	APHA 3112B/ASTM D 3223	0.0002
Arsenic (mg/kg)	APHA 3030F/3114B	0.001
Total Iron (mg/kg)	APHA 3111B/ASTM D5198	0.05
Copper (mg/kg)	APHA 3111B/ASTM D5198	0.05
Cadmium (mg/kg)	APHA 3111D/ASTM D5198	0.02
Polychlorinated biphenyls (PCBs)	EPA 9078	0.5
Total Chromium (mg/kg)	APHA 3111B/ASTM D5198	0.10

Source: Akwa Ibom State Ministry of Science and Technology Laboratory

4.5 Biophysical Sample Collection and Analyses Methods

4.5.1 Air Quality Field Study

Ambient air quality measurements were carried out on site using *in situ* digital meters (table 4.3) at 16 locations with three of them as control points (control points were outside the spatial boundary).

Table 4.3: List of Air and Noise Quality Equipment Used in the Study

Parameter	Equipment
Total Suspended Matter	Casella Cel Micro Dust Pro 880nm
Hydrogen sulphide	Gas Alert Extreme (BW Technologies) Model GAXT-H-DL
Carbon monoxide	Gas Alert Extreme (BW Technologies) Model GAXT-M-DL
Sulphur oxides	Gas Alert Extreme (BW Technologies) Model GAXT-S-DL
Ammonia	Gas Alert Extreme (BW Technologies) Model GAXT-A-DL
Nitric Oxide	Toxi RAE II PGM -1140
Nitrogen iv oxide	Gas Alert Extreme (BW Technologies) Model GAXT-N-DL
Carbon iv oxide	Alnor CF910
Total Hydrocarbon (THC)	Crowcon MultiGas indicator
Noise Level	Pulasa Sound Metre Model 14
Meteorology	Aeroqual aerocet series 531
Chlorine (Cl_2)	Cl_2 Crowcon Gasman S/N: 19812H
Hydrogen Cyanide (HCN)	HCN Crowcon Gasman S/N: 19773H

Source: Resourcefield survey, 2020

Measurements were conducted between 08:00 and 19:00hrs Nigerian time, for air measurements. Specific locations for measurements were selected with consideration for concentrations of human receptors such as residential areas, commercial areas, hospitals, churches and schools. The co-ordinates of the sampled locations for air quality are presented in Table 4.3 while the spatial distribution for the points are shown as figure 4.2c.

Table 4.3: Air Quality Sampling Location

s/n	Sampling station/Code	Latitude	Longitude
1	AQ1	4°50'8.50"N	7° 1'11.96"E
2	AQ2	4°50'8.97"N	7° 1'17.21"E
3	AQ3	4°50'7.14"N	7° 1'18.43"E
4	AQ4	4°50'4.60"N	7° 1'18.64"E
5	AQ5	4°50'4.43"N	7° 1'14.23"E
6	AQ6	4°50'7.72"N	7° 1'12.60"E
7	AQ7	4° 50’ 10.267”N	7° 1’ 0.312”E
8	AQ8	4° 50’ 8.318”N	7° 1’ 32.146”E
9	AQ9	4° 50’ 17.945” N	7° 1’ 33.141” E
10	AQ10	4° 49’ 48.118”N	7° 0’ 55.093”E

s/n	Sampling station/Code	Latitude	Longitude
11	AQ11	4° 49' 58.462"N	7° 1' 40.26"E
12	AQ12	4° 49' 44.85"N	7° 1' 29.968"E
13	AQ13	4° 50' 29.642"N	7° 1' 17.016"E
14	CTRL-1	4° 50' 13.195"N	7° 0' 45.407"E
15	CTRL-2	4° 50' 8.938"N	7° 1' 48.966"E
16	CTRL-3	4° 49' 34.28"N	7° 1' 10.893"E

Sources: Resourcefield survey, 2020

4.6 Precaution/Quality Assurance/Quality Control (QA/QC)

In marking sampling location, special preference was given to the following:

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

4.7 Meteorological Data Acquisition

The existing meteorological and climatic data from Port Harcourt meteorological station are used for the write-up. However, additional field data were collected for atmospheric pressure, relative humidity, temperature, wind speed and wind direction. The measurements were taken at 13 stations with 3 control stations. The measurements of the meteorological parameters were carried out using *in situ* portable pieces of equipment as given in Table 4.4.

Table 4.4: Meteorological Instruments

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

4.7.1 Gaseous Emission Data Acquisition

Concentrations of air pollutants were measured at 13 locations with 3 control stations. Highly sensitive digital portable meters were used for the measurement of NO_2, SO_2, H_2S, HCN, CH_4, NH_3 Cl_2 CO and SPM. The portable meters used in the measurement of gaseous pollutants are presented in Table 4.5

Table 4.5: Gaseous Emissions and Noise Measuring Instruments

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

Unit for gaseous pollutants is ppm.

4.7.2 Enumeration of Microbial Loads of the Study Area

Sedimentation (or settle plate) method described by Downes and Ito (2001) was employed. It is an apparatus-free method that is based on deposition of viable particles (bio-aerosols) on the surface of a solid medium per a given exposure time (APHA, 1992). The numbers of aerobic bacteria count and fungi (yeast and molds) were determined using Nutrient Agar (NA), MacConkey agar (MCA), Eosin Methylene Blue agar (EMB) and Saboraud dextrose agar (SDA) respectively, according to methods proposed by APHA (1992) and Downes and Ito (2001). The media was fortified with Chloramphenicol (-µg/ml) and a combination of 100 µg/ml Cycloheximide & 50 µg/ml Benomyl respectively for the selective enumeration and isolation of fungi and bacteria. Also enumerated were the densities of coliforms using MacConkey Agar as the analytical medium.

Plate 4.1: Sampling of bio-aerosols at the study area

4.7.3 Sampling Procedure for Heavy Metal Content in Air

Description of IOM Sampler is a head that houses a reusable two-part filter cassette with specified 25 mm filter for the collection of inhalable dust particles (Fig. 3.7). The filter and cassette assembly are pre- and post-weighed as a single unit for gravimetric analysis. A newly loaded cassette was removed from its transport clip to remove the cassette cover. It was ensuring that the O-rings were fitted correctly inside the sampler housing body. The front plate was screwed into the housing body. The sampler was clipped onto my lab coat's lapel. The outlet of the sampler was connected using flexible tube with the inlet of a sample pump calibrated to 2 l/min. The cover was removed and the pump was switched on and then sampled for 2 min. After sampling, the pump was put off. The front plate was unscrewed from the housing body to remove the cassette from the sampler. Sterile forceps and hand gloves were used to avoid contaminant of interest. The cover was placed on the cassette and the external surface of the cassette was wiped with clean lint-free paper. The cassette cover was placed on the cassette and loaded it into the transport clip.

4.8 Results and Discussion

4.8.1 Results

The results of the air quality, noise levels, sensitive receptors, field meteorology, bio-aerosols and heavy metal content in the study area are presented in Tables below, while the detailed air quality measurement is attached in appendix 2.1.1.

Table 4.6: Summarized Air Quality Measurement

Parameters	NO_2 (ppm)	SO_2 (ppm)	H_2S (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (ppm)	Cl_2 (ppm)	HCN (ppm)	TVOC (mg/m³)	CH_2O (mg/m3)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	CH_4 (PPM)
Mean	0.138	0.162	0.069	3.846	718.231	3.308	0.154	0.923	0.064	0.5004	38	67.534	0.285
Range	0.1-0.2	0.1-0.2	<0.1-0.2	2.0-8.0	502-943	2.0-5.0	0.1-0.3	<1.0-2.0	0.026-0.123	0.441-0.554	33-45	60-82	0.1-0.4
SD	0.05	0.05	0.1	1.63	134.66	0.95	0.07	1.19	0.03	0.05	3.11	5.5	0.11
FMEnv limits	0.04 - 0.06	0.01-0.1	-	10.0 - 20.0		200	-	-	-	-	-	-	-

Sources: Resourcefield survey, 2020

Table 4.7: Measurements of Noise Levels

Sample code	Noise level [dB(A)]	Minimum noise level [dB(A)]	Maximum noise level [dB(A)]
AQ_1	75.4	53.6	77.4
AQ_2	77.7	58.1	84.7
AQ_3	72.2	49.3	75.5
AQ_4	80.4	62.5	82.8
AQ_5	81.3	65.6	85.6
AQ_6	84.3	61.3	86.5
AQ_7	86.6	63.6	88.7
AQ_8	87.2	67.4	91.4
AQ_9	78.2	68.3	81.3
AQ_{10}	81.5	61.3	85.4
AQ_{11}	83.3	64.6	86.1
AQ_{12}	71.6	57.7	77.8
AQ_{13}	80.3	62.7	84.4
CTRL-1	60.5	56.2	67.7
CTRL-2	63.3	47.4	68.8
CTRL-3	65.2	55.5	69.1
Mean	**80**	**61.23**	**83.662**
Range	**71.6-87.2**	**49.3-68.3**	**75.5-91.4**
SD	**4.92**	**3.17**	**4.6**
FME limit	**90 [dB(A)]**		

Sources: Resourcefield survey, 2020

Table 4.8: Field Meteorological Measurements

Sample code	Temperature (^oC)	Rel. Humidity (%)	Pressure (kpa)	Wind Direction	Wind Speed (m/s)
AQ_1	26.3	84.8	1005.3	277° NW	0.31

Sample code	Temperature (^{oC})	Rel. Humidity (%)	Pressure (kpa)	Wind Direction	Wind Speed (m/s)
AQ_2	26.3	84.7	1005.3	45° NE	1.09
AQ_3	26.6	84.8	1005.5	177° SSE	0.43
AQ_4	26.8	83.5	1005.5	332° NNW	0.37
AQ_5	27.3	83.4	1005.5	24° NNE	0.75
AQ_6	27.3	83.5	1005.7	90° E	1.22
AQ_7	27.4	83.6	1005.6	147° SE	0.68
AQ_8	27.4	83.6	1006.3	280° SW	0.43
AQ_9	27.4	83.7	1006.4	27° NE	2.04
AQ_{10}	27.6	81.4	1006.4	5° N	0.75
AQ_{11}	27.6	81.5	1006.6	77° ENE	1.93
AQ_{12}	27.7	79.3	1006.8	270° SSW	0.37
AQ_{13}	27.8	79.4	1006.8	32° NE	1.04
CTRL-1	27.8	79.3	1006.7	22° SW	0.12
CTRL-2	28.5	78.2	1006.6	137° SE	0.25
CTRL-3	28.7	78.5	1007.3	87° ENE	1.18
Mean	**27.192**	**82.862**	**1005.98**	**-**	**0.878**
Range	**26.3-27.8**	**79.3-84.8**	**1005.3-1006.8**	**-**	**0.31-2.04**
SD	**0.52**	**1.88**	**0.58**	**-**	**0.57**

Sources: Resourcefield survey, 2020

Table 4.9: Viable Counts of Microorganisms isolated in Ambient Air of the Study Area

Location	Bacteria (cfu/m^3)	Fungi (cfu/m^3)
AQ_1	8.8×10^5	1.22×10^6
AQ_2	6.5×10^5	1.17×10^6
AQ_3	8.5×10^5	1.02×10^6
AQ_4	9.1×10^5	1.12×10^6
AQ_5	7.6×10^5	1.25×10^6
AQ_6	9.8×10^5	1.07×10^6
AQ_7	7.8×10^5	1.21×10^6
CTRL-1	5.2×10^5	1.12×10^6
CTRL-2	7.7×10^5	1.16×10^6

Sources: Resourcefield survey, 2020

Table 4.10: Distribution and Occurrence of Microorganisms isolated from Ambient Air

Isolate	Sampling Location									% Occurrence
	AQ-1	AQ-2	AQ-3	AQ-4	AQ-5	AQ-6	AQ-7	CTRL-1	CTRL-2	
Bacteria										
Pseudomonas aeruginosa	-	+	+	+	-	-	+	-	+	57
Staphylococcus sp	-	-	-	+	-	-	+	+	-	29
Bacillus cereus	-	-	-	-	+	+	-	-	-	29
Bacillus subtilis	+	+	-	+	-	+	+	+	-	71
Staphylococcus aureus	+	-	-	+	-	+	+	-	+	57
Escherichia coli	-	-	-	-	+	+	-	-	-	29
Micrococcus sp	-	+	+	-	+	+	-	+	+	57
Salmonella sp	+	-	+	+	+	-	-	-	+	57
Pseudomonas sp	-	-	+	+	+	-	-	-	-	43
Streptococcus faecalis	-	-	+	+	+	-	-	+	+	43
Fungi										
Aspergillus glaucus	-	-	-	+	-	-	+	+	+	29
Aspergillus utilis	-	-	-	+	+	+	-	+	+	43
Trichoderma sp	-	-	-	+	-	-	-	-	+	14
Microsporum sp	-	+	-	-	+	-	-	-	-	29
Fusarium sp	-	-	-	-	+	+	-	-	-	29
Candida albicans	-	+	+	+	+	-	+	-	-	71
Aspergillus niger	-	-	+	+	+	-	+	+	-	57
Aspergillus flavus	-	+	+	+	+	-	+	+	-	71
Eurotium sp	-	-	+	-	-	-	-	-	-	14
Pichia sp	-	-	-	+	-	+	-	-	-	29
Trichosporon sp	-	-	-	-	+	-	+	-	-	29
Monascus sp	+	-	-	+	-	-	+	-	+	43
Cladosporium sp	+	+	-	-	-	+	-	-	-	43

+ = Present - = Absent

Sources: Resourcefield survey, 2020

Table 4.11: Heavy Metal Content in Ambient Air

Parameter	Sampling Location							Mean	Range	SD	CTRL-1	CTRL-2
	AQ-1	AQ-2	AQ-3	AQ-4	AQ-5	AQ-6	AQ-7					
Lead (mg/l)	1.243	1.315	1.422	1.322	1.129	1.204	1.211	1.264	1.129-1.422	0.1	0.025	0.022
Arsenic (mg/l)	0.011	0.013	0.018	0.005	0.013	0.015	0.012	0.0124	0.005-0.018	0.004	0.003	0.006
Chromium (mg/l)	0.224	0.241	0.236	0.247	0.242	0.215	0.228	0.233	0.215-0.247	0.01	0.095	0.088
Mercury (mg/l)	0.002	0.001	0.007	0.006	0.003	0.005	0.001	0.004	0.001-0.007	0.002	<0.001	<0.001
Cadmium (mg/l)	3.203	3.114	3.121	3.421	3.332	3.267	3.346	3.258	3.114-3.421	0.12	0.053	0.035
Nickel (mg/l)	1.025	1.101	1.008	1.201	1.023	1.116	1.141	1.088	1.023-1.201	0.07	0.102	0.1
Vanadium (mg/l)	0.003	0.006	0.011	0.014	0.005	0.016	0.012	0.01	0.003-0.016	0.004	<0.001	<0.001

Sources: Resourcefield survey, 2020

4.8.2 Rainfall Pattern

The study area is situated within the tropical wet climatic belt. In this belt, rainfall variation is the most important parameter for the determination of season. In general, two seasons are characteristic of the climate in the region, namely the dry and wet seasons. In wet season, the annual distribution starts with the initial rains in March, which ceases in late November. Typically, there are two major seasons, sometimes, heavier rainfall than usual may occur and the rain is extended into the dry season and often the August break may not even occur. Rainfall is the most important element of climate change and water resources potential. It impacts almost all areas of human life such as agriculture, health, transportation etc. The amount and distribution of rainfall in the study area is such that it plays an important role in moving pollutants from the atmosphere to other spheres of the environment. The mean annual rainfall for the study environment is above 2300mm. The data retrieved from close meteorological station and shown in Table 4.2.2, present the mean monthly rainfall distribution for 30 years (1985-2015) in the study area. Average highest rainfall peaks were attained in September (370mm), July (364mm) and August (325mm). Lowest rainfall values were attained in January (15.3mm) and December (19.2mm). It should be noted that rainfall is very important in managing construction projects since it may cause erosion and erode soil particles from ground level surfaces.

4.8.3 Air Temperature

Analysis from the macro data shows that the months of July-September recorded lower temperatures (28-29 ^{o}C) due to rainy periods while the months December to March recorded higher temperatures (32-34^{o}C) due to intense solar radiation prevalent in the dry season (Uko and Tamunobereton-Ari, (2013) noted that the average maximum and minimum temperatures during the dry and wet seasons are within 31-33 ^{o}C and 21-23 ^{o}C as well as 25-33 ^{o}C and 18 23^{o}C respectively. The degree of air temperature is dependent on the amount of solar radiation received, atmospheric conditions, such as

cloud cover and humidity, which trap heat and this impacts on the stability pattern of the atmosphere in the area. Port Harcourt exhibit a very stable stability class F at nights that inhibits emission dispersion and slightly unstable/moderate stability classes C-B during the day periods that enhances emission dispersions (Edokpa and Nwagbara 2017). Air temperature also affects nearly all other weather parameters. For instance, air temperature affects: the rate of evaporation, wind speed and direction, precipitation patterns as well as the unstable, stable and neutral conditions of the atmospheric environment. Measuring air temperature is critical to the proper identification of the micro and macro environment of living organisms. It is especially critical for researchers in the animal and biological sciences since ambient temperature can influence their physiological, nutritional and behavioral status. The study environment is bounded heavily by open vegetation areas and this modifies ambient temperature. Ansari (2003) noted that the major parts of a healthy environment are vegetation associated with area. He emphasized that vegetation improves the environment by lowering the maximum temperature and increasing the minimum temperature most especially in locations of increased elevation. When air passes through vegetation it cools and obtains moisture which when mixed with the open environment reduces temperature thereby generating was is referred to as local precipitation (Ansari, 2003). Ayoade (2004) highlighted that the features which impact the distribution of temperature at any location include: the amount of insulation received, nature of the surface, distance from water bodies, relief, nature of prevailing winds and ocean currents. Figures 4.3 to 4.5 shows the processed satellite data for average surface temperature for 0000, 0600, 1200 and 1800 hours in the study environment for July 2017.

Temperature was low toward southern part of the shopping mall ranging from 26.30-27.10 ^{o}C. It recorded highest toward north of the study area ranging from 28.31-28.70 ^{o}C. Moderate concentration was observed in other part of the study area including PH-Aba expressway, Stadium Road, Old Aba Road, Market Road, among others ranging from 27.31-28.10 ^{o}C.

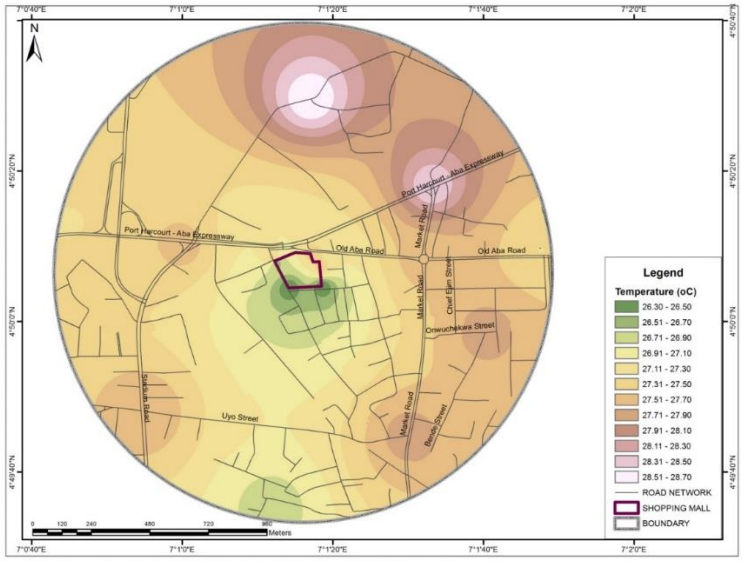


Figure 4.3: Map showing spatial dispersion of the recorded air temperature

4.8.4 Relative Humidity

As ambient temperature increases, percentage humidity decreases and vice-versa. Relative humidity which measures water vapour in the atmosphere is noted to be low during dry season and high during the peak of rainy season due to the influence of moisture laden South- Westerly winds as seen from the macro average monthly results. A 30-year mean monthly relative humidity analysis shows that the study environment has high relative humidity throughout the year with peaks during the wet season. Oluyole *et al*., (2013) disclosed that average annual relative humidity for the area is above 80%. Due to the moist nature of the atmospheric environment in the study area, relative humidity is always high throughout the years.

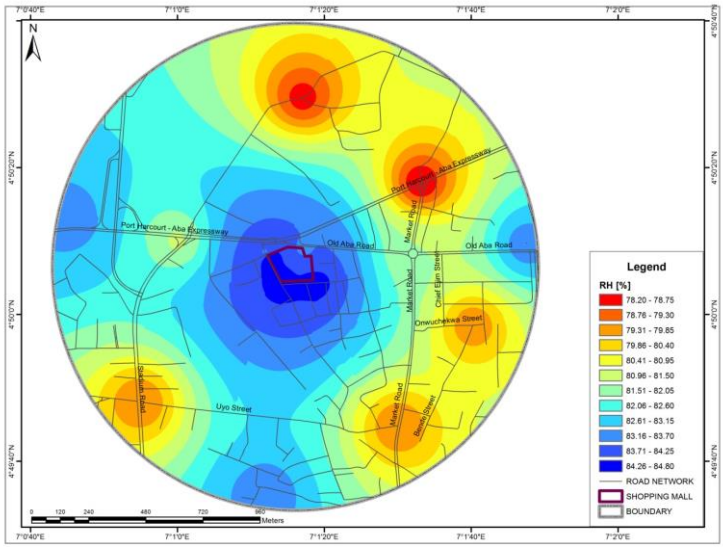


Figure 4.4: Map showing spatial dispersion of the recorded relative humidity

Relative humidity recorded throughout the entire Shopping Mall location ranging from 83.16-84.80 %. Lowest was recorded toward north of the study area, Market Road, Onwuchekwa Street, Stadium Road, Bende street ranging from 78.20-80.95 %.

Table 4.12: Average Weather Trend for Port Harcourt (1985-2015)

S/N	Month	Average Temp (°C)	Rainfall (mm)	Pressure (kpa)	Relative Humidity (%)	Wind Speed (m/s)
1	January	33.5	15.3	1006.5	72	2.8
2	February	34.1	7.4	1005.8	77	2.5
3	March	33.7	92.7	1005.6	81	3.6
4	April	32.6	143	1005.7	83	3.6
5	May	32.1	247.4	1007.4	87	3.7
6	June	30.4	310	1008.4	89	3.8

S/N	Month	Average Temp (°C)	Rainfall (mm)	Pressure (kpa)	Relative Humidity (%)	Wind Speed (m/s)
7	July	28.3	364	1009.7	91	4.2
8	August	29.0	325	1009.6	91	4.1
9	September	28.6	370	1008.9	91	4.3
10	October	30.8	242	1007.7	88	3.5
11	November	32.1	72.8	1006.8	84	2.6
12	December	33.4	19.2	1006.7	73	2.4

Source: NIMET, Port Harcourt (EIA Report, 2017).

4.8.5 Wind Speed/Direction

South of the study area recorded lowest wind speed ranging from 0.12-0.60 m/s. Edges of the Shopping Mall, PH-Aba Expressway by Market Road and Stadium Road by Uyo Street recorded unique

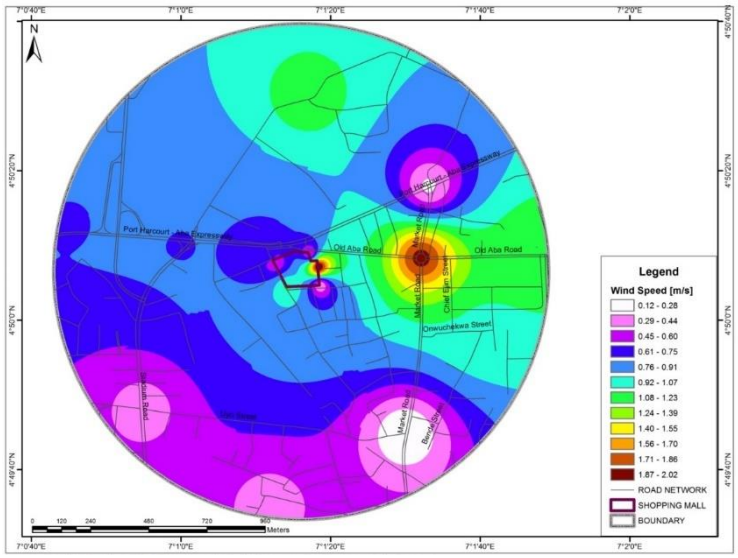


Figure 4.5: Map showing spatial dispersion of the measured wind speed

wind speed of 0.29-0.44 m/s. Highest wind speed was only observed toward Old Aba Road by Market Road ranging from 1.56-2.02 m/s as indicated in figure above.

The prevailing wind direction was the South-Westerly winds as presented in the wind rose below (Figure 4.6). This implies that any released air emissions will be blown towards the North-East direction of the study environment. It is however the period of calm that is of importance in evaluating emissions (8.33%). If the air is calm, pollutants cannot disperse, and then the concentration of these pollutants will build up. On the other hand, when strong, turbulent winds blow, pollutants disperse quickly, resulting in lower pollutant concentrations. In pollution, meteorology calms are associated with inversions (temperature increasing with height). Inversion may result in fumigation; meaning that emissions are trapped at ground level close to their source as against other situations where it is dispersed and diluted much more easily. Inversion is widely known to be frequent during the early

hours of the day. A 30-year mean macro data shows that wind speed over the study environment is generally minimal and this signifies a low to moderate dispersive potential of the local atmosphere.

Table 4.13: Wind Speed for Wind Rose

Wind Direction	Wind Sped (m/s)		
	0 – 1.50	**1.51 – 2.50**	**2.51 – 3.50**
N	0.75 = 12 %	0 = 0 %	0 = 0 %
NE	1.09 = 18 %	2.04 = %	0 = 0 %
NNE	0.75 = 12 %	0 = 0 %	0 = 0 %
E	1.22 = 20 %	0 = 0 %	0 = 0 %
SE	0.68 = 11 %	0 = 0 %	0 = 0 %
SSE	0.43 = 7 %	0 = 0 %	0 = 0 %
S	0 = 0 %	0 = 0 %	0 = 0 %
SW	0.43 = 7 %	0 = 0 %	0 = 0 %
WSW	0 = 0 %	0 = 0 %	0 = 0 %
W	0 = 0 %	0 = 0 %	0 = 0 %
NW	0.31 = 5 %	0 = 0 %	0 = 0 %
NNW	0.37 = 6 %	0 = 0 %	0 = 0 %

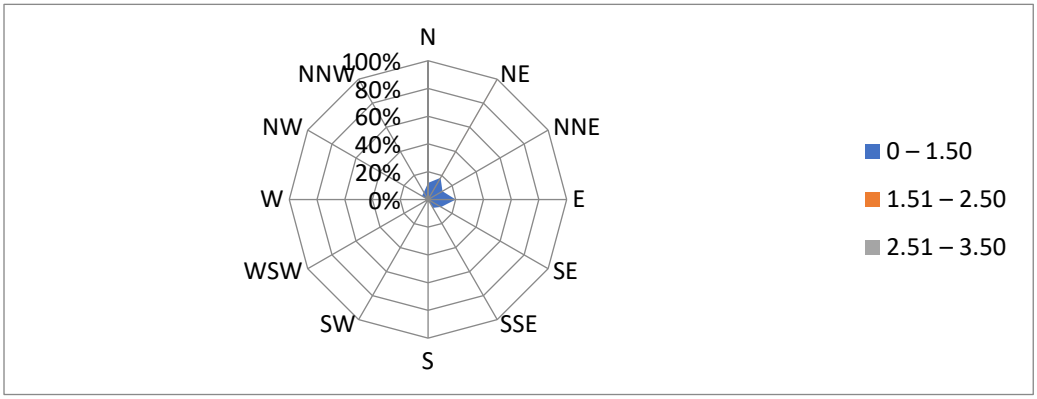


Fig. 4.6: Wind Rose for Proposed Area Based on Microclimatic Data

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

In figure 4.5 above, wind speeds are indicated by colour. Here, the winds blew mostly at the wind speed denoted by the colours. For the blue section of the "spoke" which indicates winds at 0-1.50. The blue section is at 0. This means that winds blew slightly from the north east (NE) and east at 0-1.50m/s for 0 % of the time. For red section, wind speeds between 1.51-2.50 m/s was 0. For green section, wind speeds between 2.51-3.50 m/s was zero.

4.8.6 Noise level

As shown in the dispersion model. Noise level did not exceed FMEnvFMEV limits. Be it as it may, noise level recorded lowest toward south of Market Road and north of the study area ranging from 60.50-67.17 [dB(A)]. Highest concentration of noise was recorded throughout PH-Aba Expressway and Old Aba Road as well as the northern part of the Shopping Mall [80.52-87.19dB (A)]. This may be rightly attributed to the high influx of vehicle. Noise level was observed to be moderate towards the south of the Shopping Mall, Uyo Street and part of Market Road ranging from 76.08-80.51 [dB(A)].

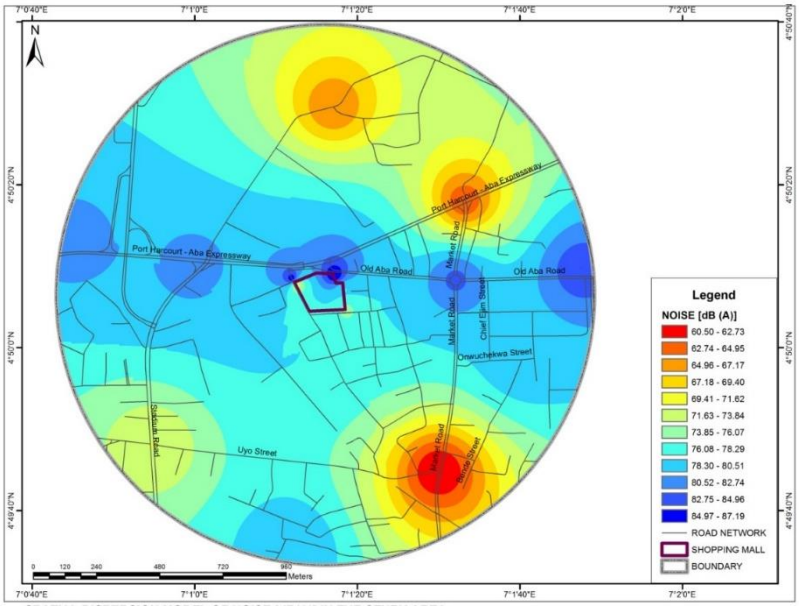


Figure 4.7: Map indicating spatial dispersion of noise level

4.8.7 Air Quality

4.8.7.1 Spatial Dispersion Model of Air in the Study Area

Understanding the spatial distribution of data from phenomena that occur in space is becoming more and more common due to the availability of Geographic Information System (GIS) with user-friendly interfaces. These systems allow the spatial visualization of variables such as air quality parameters in a region using maps. These models however depict the spatial dispersion of air across the study area. Parameters taken into consideration include: NO_2 (ppm), SO_2 (ppm), H2S (ppm), CO (ppm), CO_2 (ppm), NH_3 (ppm), Cl_2 (ppm), HCN (ppm), TVOC (mg/m^3), CH_2O (mg/m^3), $PM_{2.5}$ ($\mu g/m^3$), PM_{10} ($\mu g/m^3$) and CH_4

(ppm). Others as shown above include noise level [dB(A)], temperature (°C), Rel. Humidity (%), Pressure (kpa) and Wind Speed (m/s).

Carbon Monoxide

From the dispersion model, it was observed that CO concentration did not exceed FMEnvFME limit. However, it was noted that toward some sections of PH-Aba Road and perhaps the northern part of the Shopping Mall, CO concentration was moderate, ranging from 4.51-5.69 ppm. The southern parts of the mall experience a significant reduction in CO concentration ranging from 2.76-3.92 ppm. the least concentration was observed towards south and south-eastern part of the study area and extreme east, which covers most part of Market Road, Onwuchekwa street, Old Aba Road and the entire Bende Street.

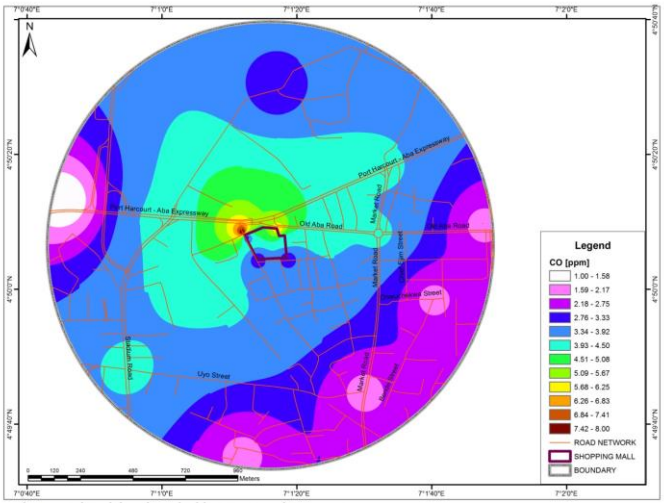


Figure 4.8: Map indicating spatial dispersion of Carbon monoxide (CO)

However, CO is within the FMEnv limit of 10.0 – 20.0ppm. Long term exposure of CO, no matter the concentration, could result in adverse impact on human health which could lead to instant death. The presence of the gas in the ambient air of the study area was largely due to vehicular emissions, domestic and industrial activities.

Carbon Dioide (CO_2)

CO_2 concentration recorded highest towards the eastern part of the study area, specifically around Old-Aba Road Junction by Market Road and PH-Aba Road ranging from 768.72-942.85 ppm. The lowest concentration was observed toward the control points (extreme south, east and west). Within the Shopping Mall, the highest concentration was observed toward the western side within the range of 652.62-710.66 ppm, while the lowest points were towards the north and north-eastern axis of the mall ranging from 478.48-652.61 ppm.

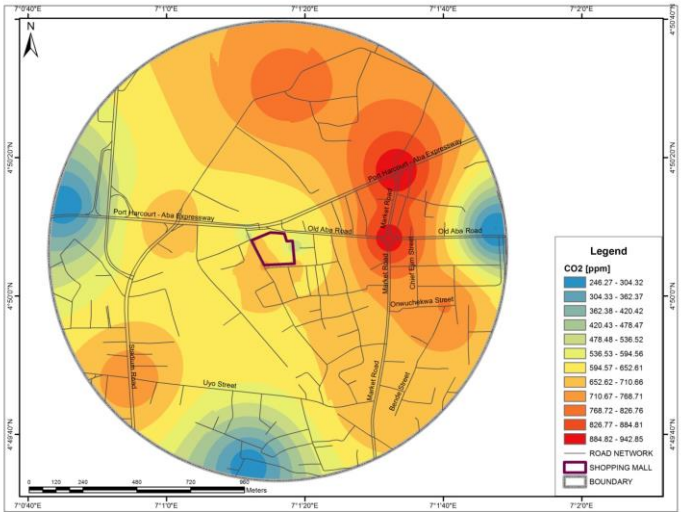


Figure 4.8: Map indicating spatial dispersion of Carbon dioxide (CO_2)

- **Sulphur dioxide**

Peak concentration of SO_2 was recorded northwestern part of the Shopping Mall, west of PH-Aba Road, Stadium Road, Market Road, Bende Street and Onwuchekwa Street ranging from 0.19-0.20 ppm. Lowest concentration centered around east of the Shopping Mall, Market Road by PH-Aba Road axis, south of Uyo Street and the northern part of the study area within the range of 0.10-0.13 ppm. The recorded levels of SO_2 were above the FMEnvFMEnv regulatory limits of 0.01ppm – 0.1ppm for daily average of 8-hourly values in Nigeria. Almost every activity at the project area had the potential to generate considerable amounts of sulfur dioxide.

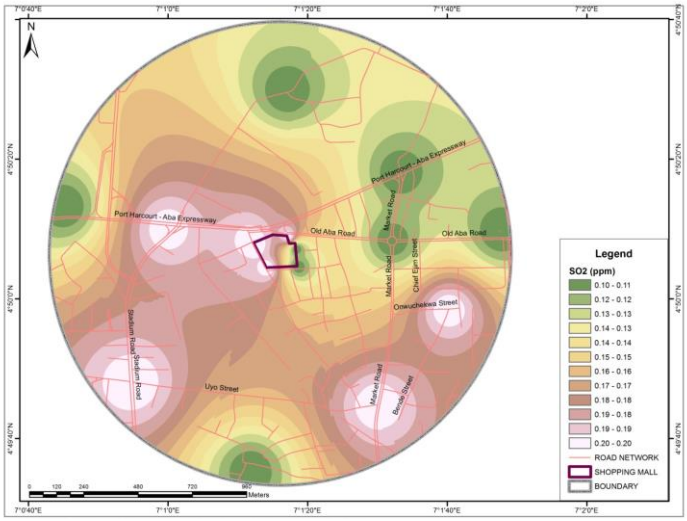


Figure 4.9: Map indicating spatial dispersion of sulphur dioxide (SO_2)

- **Hydrogen sulphide (H_2S)**

H_2S recorded lowest concentration toward the southern part of the Shopping Mall likewise all three control points ranging from 0.00-0.07 ppm. A slight increase in its concentration was observed in the

north eastern side of the mall toward Old Aba Road ranging from 0.09-0.12ppm. Its highest concentration was recorded in the northern part of the study area along PH-Aba Road ranging from 0.16-0.20 ppm. No permissible value for H_2S has been given by Federal Ministry of Environment.

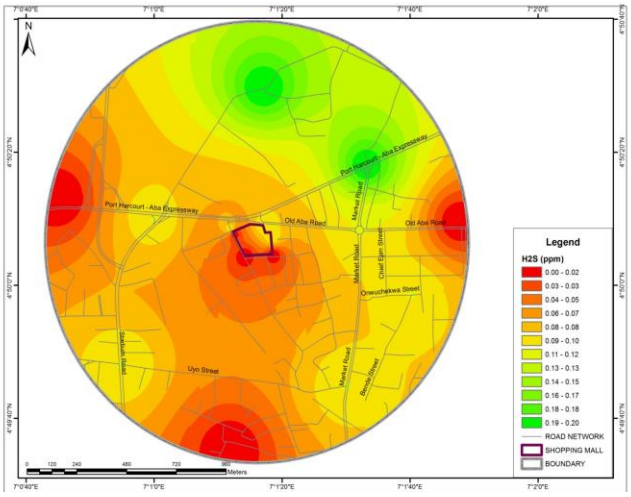


Figure 4.10: Map indicating spatial dispersion of hydrogen sulphide (H_2S)

Nitrogen dioxide

The spatial dispersion model of NO_2 concentration within the study area indicate that NO_2 reaches its highest concentration towards northeastern part of the shopping mall, Old Aba Road axis by Market Road, PH-Aba express by Stadium Road and the extreme north of the study area ranging from 0.14-0.2 ppm. Its lowest concentration was observed at the extreme east of Old Aba Road and south of Uyo Street ranging from 0-0.08 ppm. However, the recorded values were all above the Federal Ministry of Environment's limits of 0.04-0.06ppm. Generators, vehicular traffic, industrial boilers, etc contributed to the emissions of this gaseous pollutant.

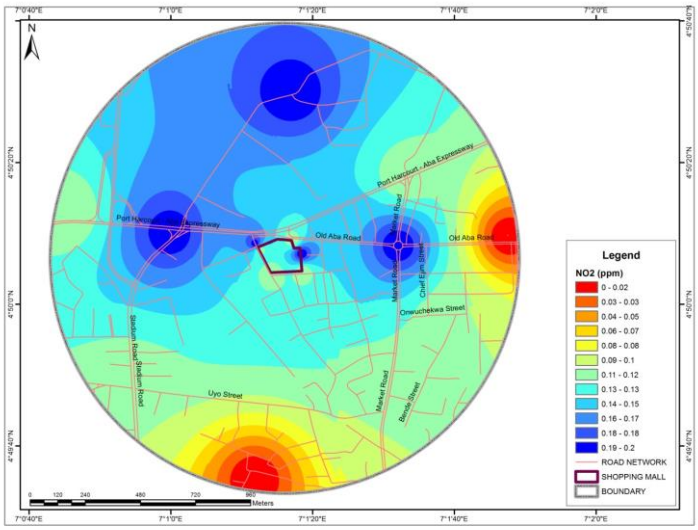


Figure 4.11: Map showing spatial dispersion of nitrogen dioxide (NO_2)

- **Hydrogen cyanide (HCN)**

HCN recorded lowest in the south, east and western part of the study area ranging from 0.17-0.67 ppm. The northern part of the map recorded highest concentration including the Shopping Mall ranging from 1.34-2.00 ppm. However, the FMEnv has no limit for HCN.

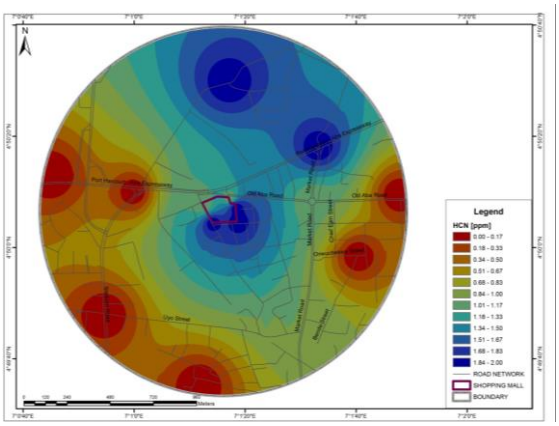


Figure 4.12: Map indicating spatial dispersion of hydrogen cyanide (HCN)

- **Ammonia (NH_3)**

NH_3 (ppm) was observed to have recorded lowest concentration toward North-Eastern part of the Shopping Mall by Old Aba Road and towards the air quality control points. Its highest concentration (5 ppm) was observed north of PH-Aba expressway while towards Stadium Road, Market Road, Bende Street, Onwuchekwa Street, its concentration was in moderation (ranging from 3.51-4.25 ppm). In all, none of its concentration exceeded FMEnv limits.

The recorded levels of ammonia were below FMEnv limits of 200ppm. Detection of ammonia in the study area may be due to vehicular traffic, cow dung, glass cleaning agents, disinfectants, etc., used within the study.

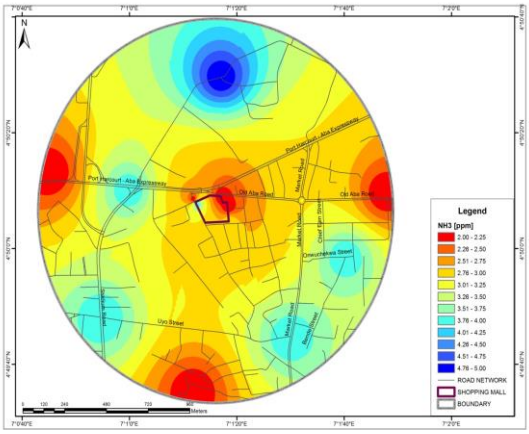


Figure 4.13: Map showing spatial dispersion of ammonia (NH_3)

- **Chlorine (Cl_2)**

Towards west of the study area recorded highest concentration (0.23-0.30ppm) while moderate concentration centre around PH-Aba express by stadium road and extreme east of Old Aba Road ranging from 0.13-0.20ppm. The least concentration was recorded around south of Market Road and extreme north of the study area within the range of 0.03-0.08ppm. It should be noted that the concentration of Cl_2 did not exceed FMEnv limit across the entire study area. Federal Ministry of Environment has not given permissible value for Cl_2. Its presence in the study site might be attributed to transportation, cleaning agent, disinfectant, preservative agents, production or utilization of chemicals, etc.

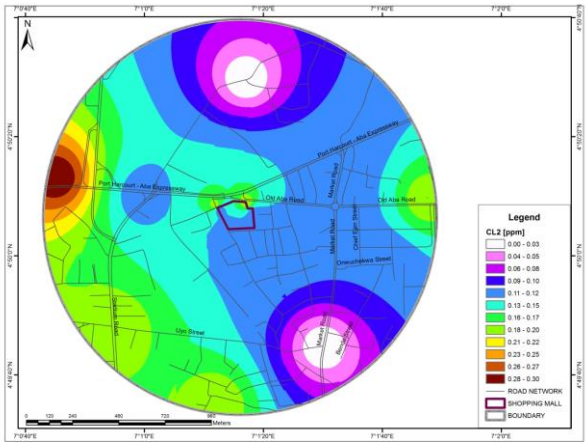


Figure 4.14: Map indicating spatial dispersion of chlorine (Cl_2)

- **Particulate Matter ($PM_{2.5}$ and PM_{10})**
  - **$PM_{2.5}$**

$PM_{2.5}$ indicates moderate concentration (though not exceeding FMEnvFMEV limits) around the Shopping Mall ranging from 37.40-41.70 µg/m^3. Only south and extreme east of the study area recorded the lowest (31.00-35.23 µg/m^3). Its highest concentration was found at the northeastern

part of the Shopping Mall by Old Aba Road and PH-Aba Road by Stadium Road ranging from 39.55-44.93 µg/m^3.

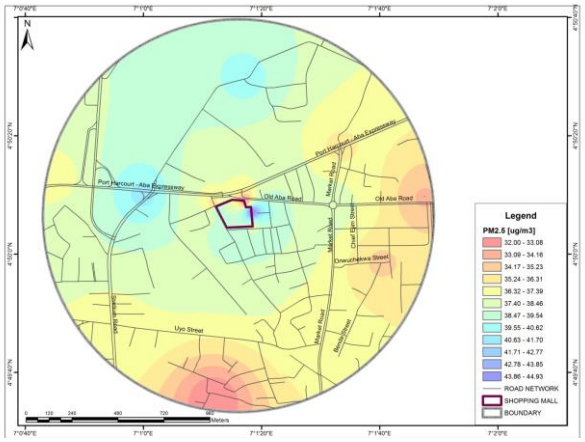


Figure 4.15: Map indicating spatial dispersion of $PM_{2.5}$

- **PM_{10}**

PM_{10} recorded least around the study area boundary which covers part of Stadium Road, Uyo Street, Market Street, Bende Street, Onwuchekwa Street, Old Aba Road ranging from 58.00-65.95µg/m^3. Moderate concentration was found around north of the study area and east of the Shopping Mall by Old Aba Road ranging from 71.93-81.86 µg/m^3.

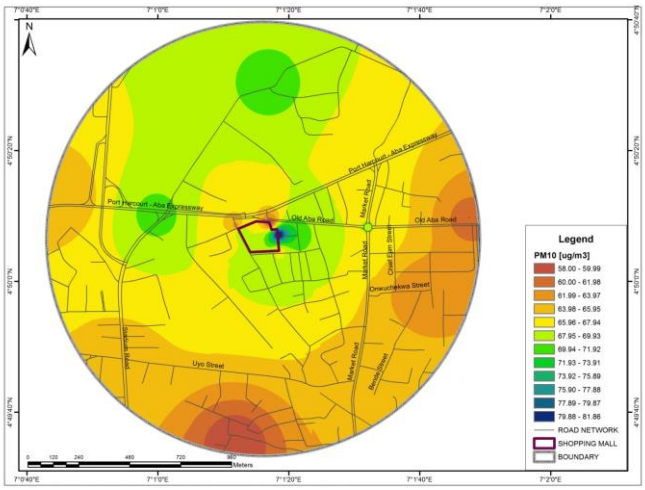


Figure 4.16: Map showing spatial dispersion of PM_{10}

- **Total Volatile Organic Compounds (TVOC)**

TVOC recorded peak concentration toward northwestern part of the shopping mall and south of Market Road ranging from 0.09-0.12 mg/m^3. Lowest reading was only found in both east and west extreme of the study area ranging from 0.03-0.06 mg/m^3.

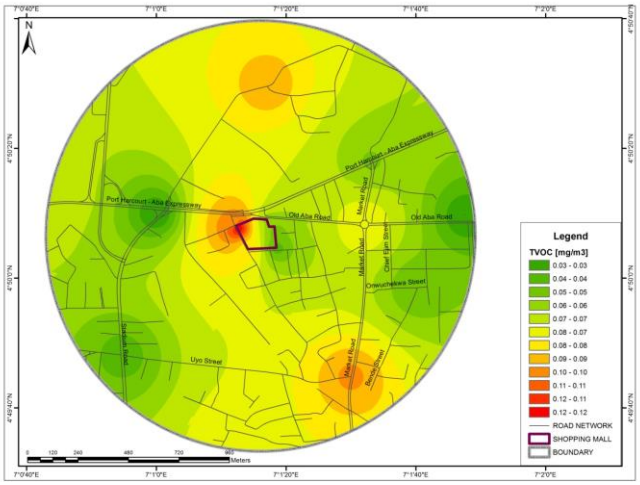


Figure 4.17: Map indicating spatial dispersion of total organic compound (TVOC)

Formaldehyde (CH_2O)

CH_2O have been observed to have recorded a higher concentration in not less than 85% of the entire Shopping Mall ranging from 0.02-0.03 mg/m^3 while towards the boundary was observed to have recorded the least concentration (0.00-0.01 mg/m^3) especially along Stadium Road, Uyo Street, Old Aba Road as well as Market Road.

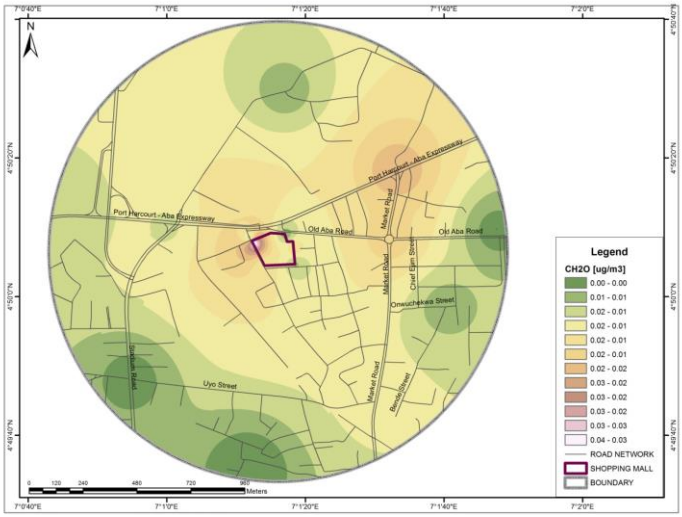


Figure 4.18: Spatial dispersion map of formaldehyde (CH_2O)

Methane (CH_4)

Towards the southern part of the Shopping Mall was observed to have recorded significant higher concentration of CH_4 ranging from 0.31-0.40. This was similarly observed in western part of the study area including Stadium Road, alongside Onwuchekwa Street and East of PH-Aba Expressway. On the other hand, the northern part of the Shopping Mall indicated lower concentration of CH_4 together with north and south of the study area towards Market Road ranging from 0.10-0.25ppm.

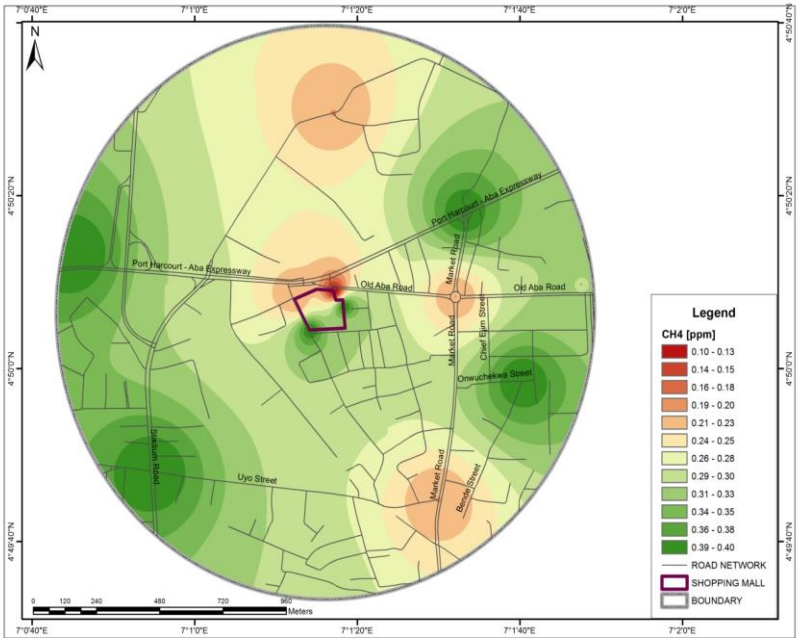


Figure 4.19: Spatial dispersion map of methane (CH_4)

- **Bio-aerosols**
  - **Bacteria**

The lowest viable bacterial counts in the study area as depicted in the model is recorded in extreme west of the study area by PH-Aba Expressway and also at the northern edge of the Shopping Mall by Old Aba road ranging from 5.20×10^5 - 7.49×10^5 cfu/m^3. This bacterial load was moderate in the central part of the study area ranging between 7.50×10^5 - 8.63×105 cfu/m^3. The peak load was recorded in northwestern part of the shopping mall by PH-Aba road within the range of 9.03×10^5 - 9.78×10^5 cfu/m^3.

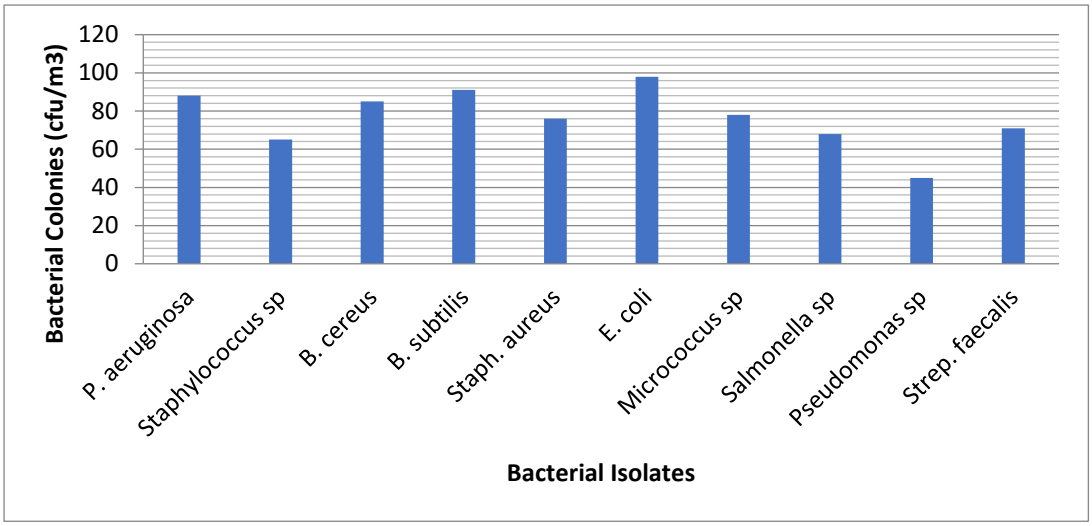


Figure 4.20: Enumeration of bacteria in air

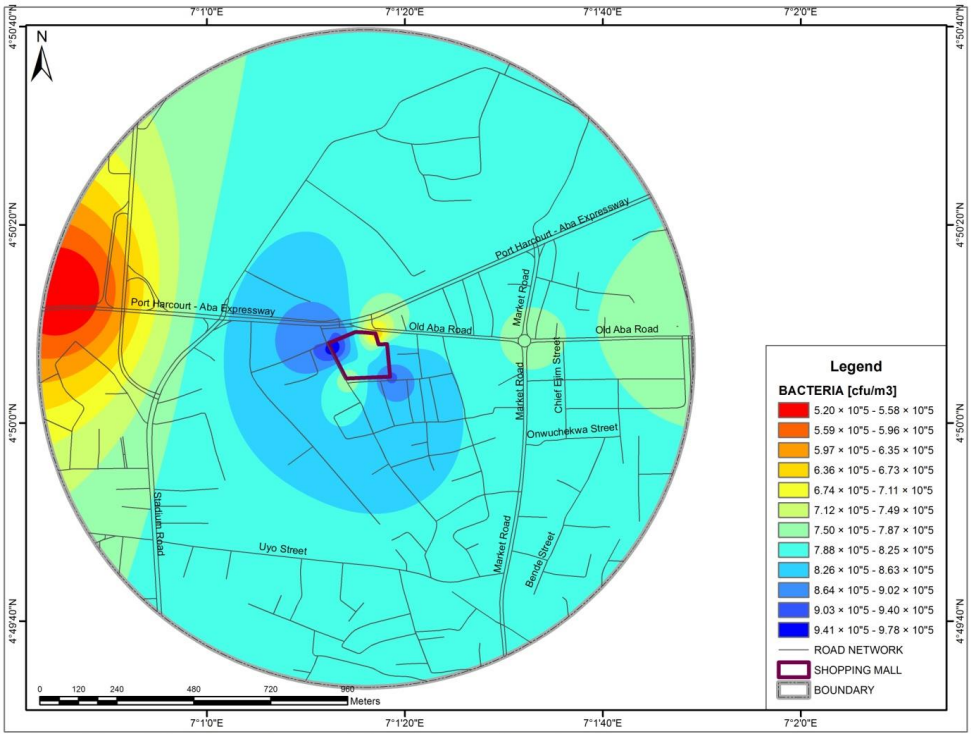


Figure 4.21: Spatial dispersion map of bacteria (cfu/m^3)

Fungi

Fungi isolated in ambient air in the study area as shown in the dispersion model, the highest fungi load was found south of the Shopping Mall and east of the study area including part of PH-Aba Expressway, Old Aba Road and Market Road. These counts ranged from $1.193 \times 10^6 – 1.248 \times 10^6$ cfu/m^3. Lowest concentration was recorded in east of the Shopping Mall by Old Aba Road axis ranging from 1.021×10^6 - 1.116×10^6 cfu/m^3.

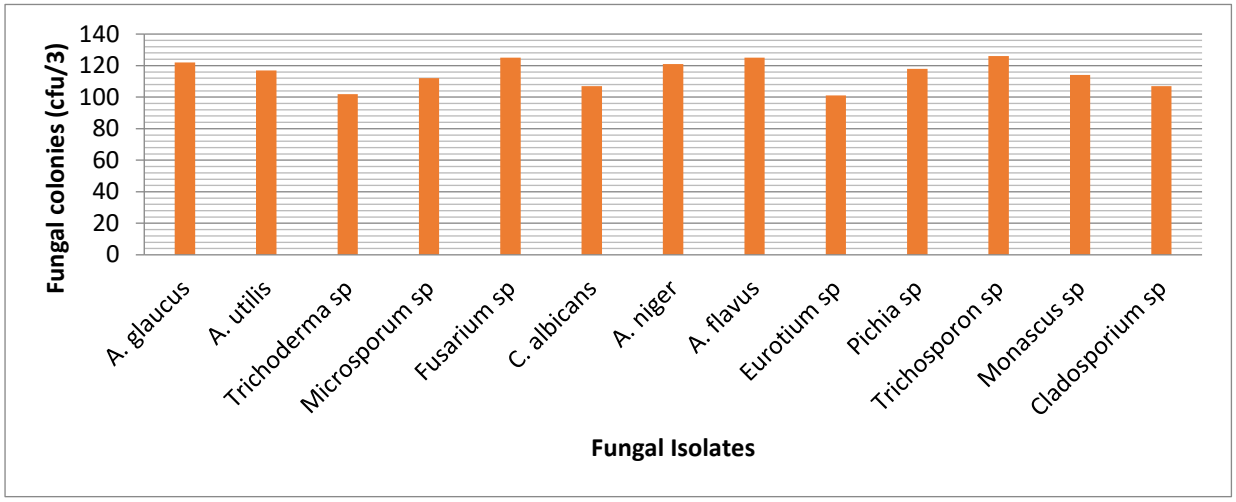


Figure 4.22: Enumeration of fungi in air

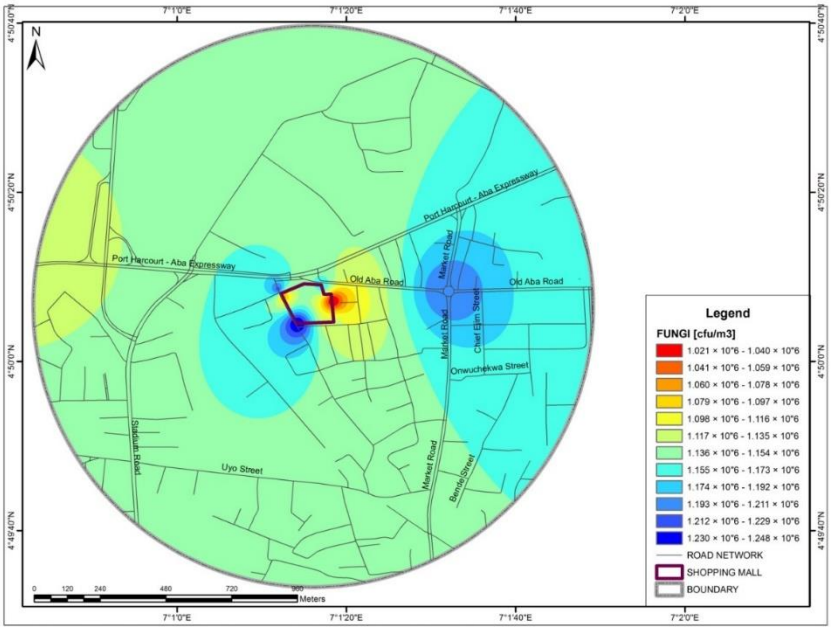


Figure 4.23: Spatial dispersion map of fungi (cfu/m^3)

Heavy Metal Content in Air

- **Lead (Pb)**

  Lead ranged from 1.129 - 1.422 mg/^{3} with the least concentration recorded in both extreme west and east of the study area (part of PH-Aba Road and Old Aba Road). The peak concentration was recorded around the shopping mall ranging between 1.067-1.421 mg/m^3. The middle section of the study area recorded moderate concentration of lead ranging from 0.475-1.066 mg/m^3.

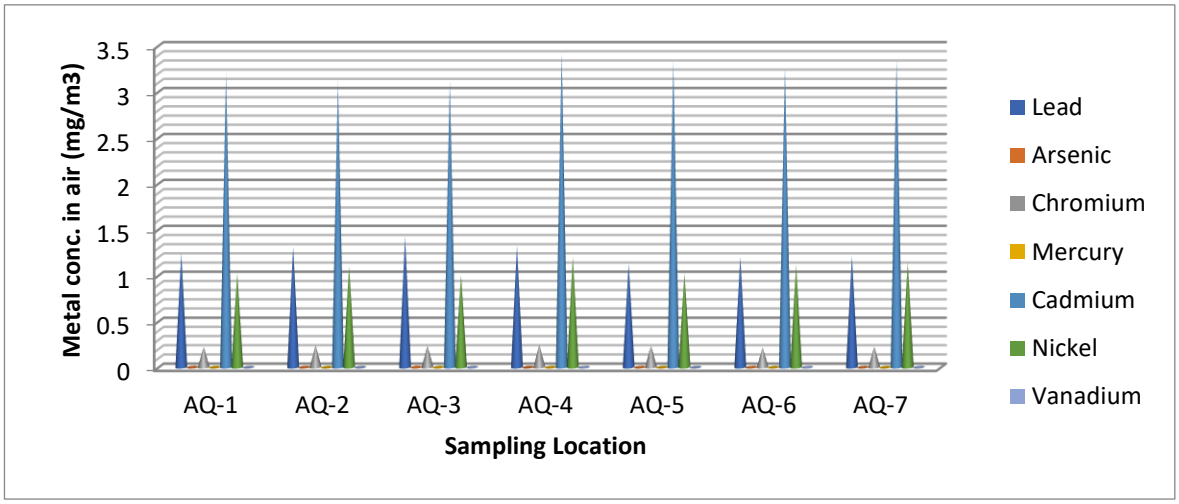


Figure 4.23: Chart showing heavy metal content in air

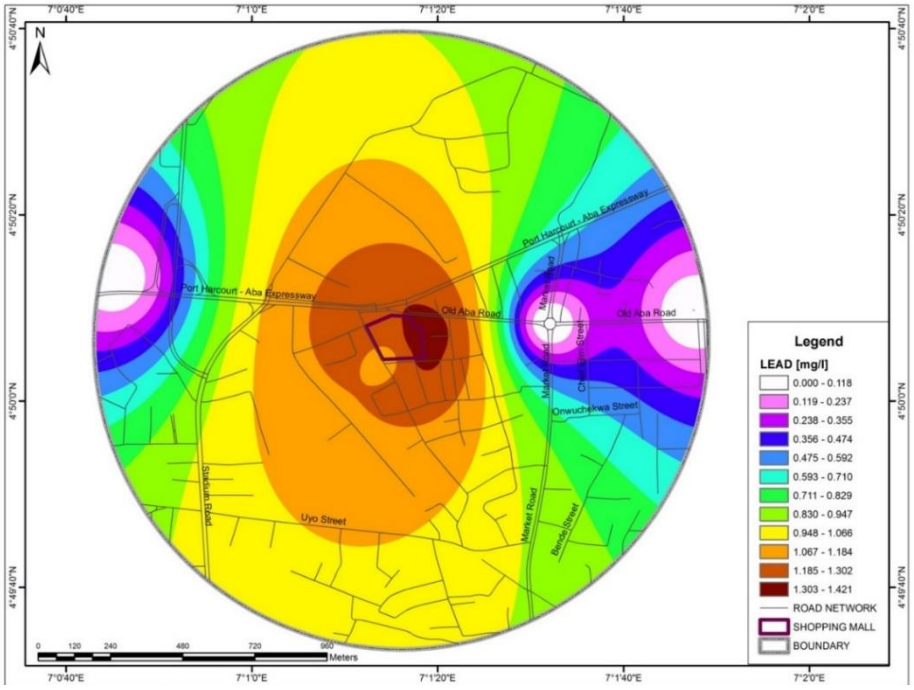


Figure 4.25: Spatial dispersion map of lead (mg/m^3)

- **Arsenic (As)**

Arsenic was observed to have a concentration ranging from 0.005-0.018 mg/m^3. However, the peak concentration was observed around the Shopping Mall ranging from 0.011-0.0018 mg/m^3. Least concentration was recorded at the extreme of the study area which covers part of Old Aba Road, PH-Aba Expressway, Onwuchekwa Road and Market Road. The concentration was moderate in part of Uyo Street, Stadium Road and south of Market Road.

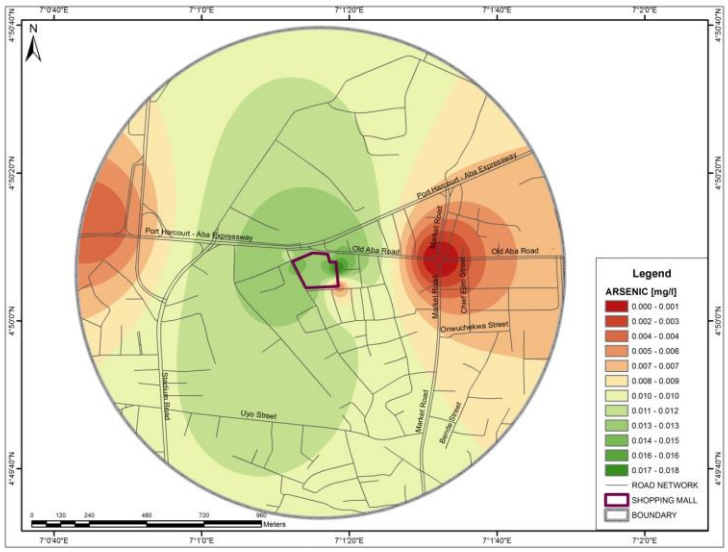


Figure 4.26: Spatial dispersion map of arsenic (mg/m^3)

- **Chromium (Cr)**

The Shopping Mall and other central parts of the study area were observed to have recorded the highest concentration of Chromium ranging from 0.166-0.247 mg/m^3. The least concentration was found around extreme of PH-Aba Road, Market Road, Old Aba Road recording <0.123 mg/m^3.

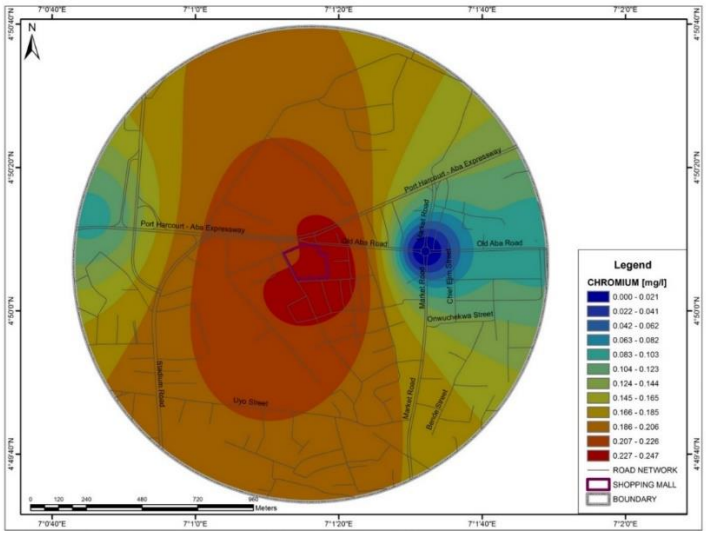


Figure 4.27: Spatial dispersion map of chromium (mg/m^3)

- **Mercury (Hg)**

Mercury was captured in ambient air around the project vicinity. Its peak concentration was recorded around the Shopping Mall ranging from 0.00466-0.00697 mg/m^3 while the least was captured around extreme of PH-Aba Road, Old Aba Road, Market Road and Onwechekwa Street recording below 0.00290 mg/m^3.

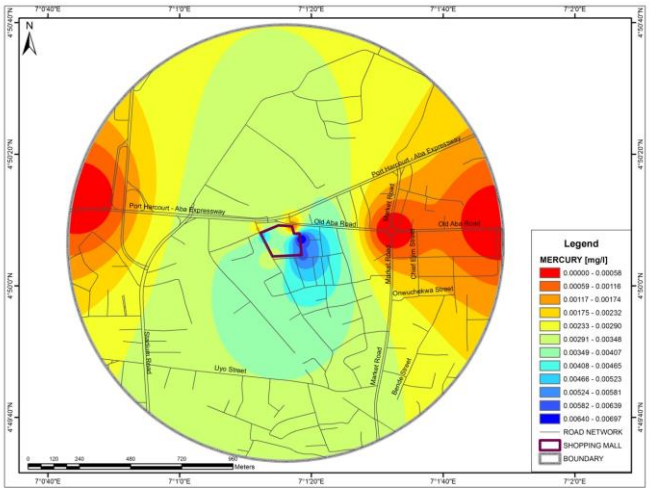


Figure 4.28: Spatial dispersion map of mercury (mg/m^3)

- **Cadmium (Cd)**

Cadmium recorded a significant peak concentration around the Shopping Mall and the middle segment of the study area ranging from 2.281-3.420 mg/m^3. The least concentrations were recorded toward extreme west and south of the study area which covers some sections of Old Aba Road, PH-Aba Road and Market Road ranging from 0.000-1.425 mg/m^3.

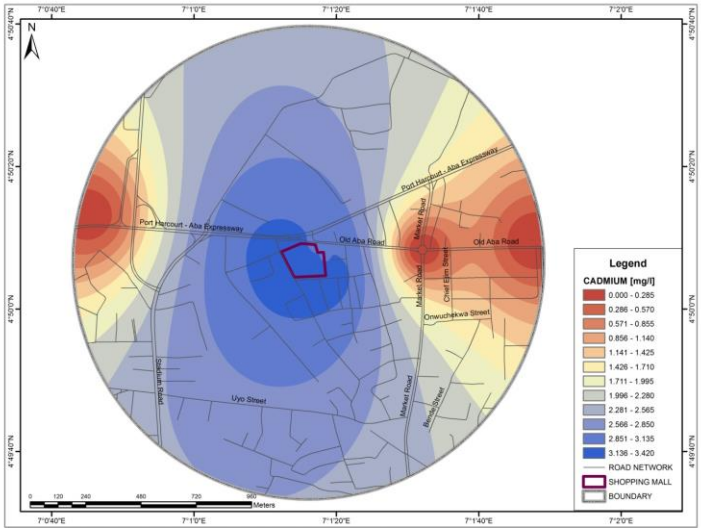


Figure 4.29: Spatial dispersion map of cadmium (mg/m^3)

- **Nickel (Ni)**

The highest load of Nickel was observed within the location of the Shopping Mall which was between 1.000-1.2 mg/m^3. The concentration reduces with increase in distance towards the extreme with the least concentration recorded at the extreme east and west of the study area which was below 0.4000mg/l.

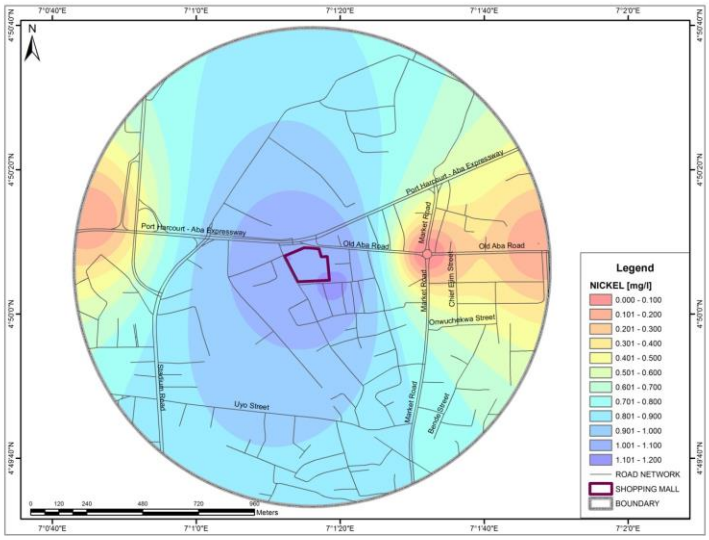


Figure 4.29: Spatial dispersion map of Nickel (mg/m^3)

- **Vanadium (Vn)**

Vanadium recorded a significant variability in its concentration around the study area. Toward the end of PH-Aba Road and Old Aba Road, Vanadium was observed to have recorded the least concentration below 0.005mg/m^3. The highest concentration was found around the Shopping Mall complex ranging from 0.013-0.0.016 mg/m^3. The concentration was in moderation around the central part of the study area ranging from 0.008-0.009 mg/m^3.

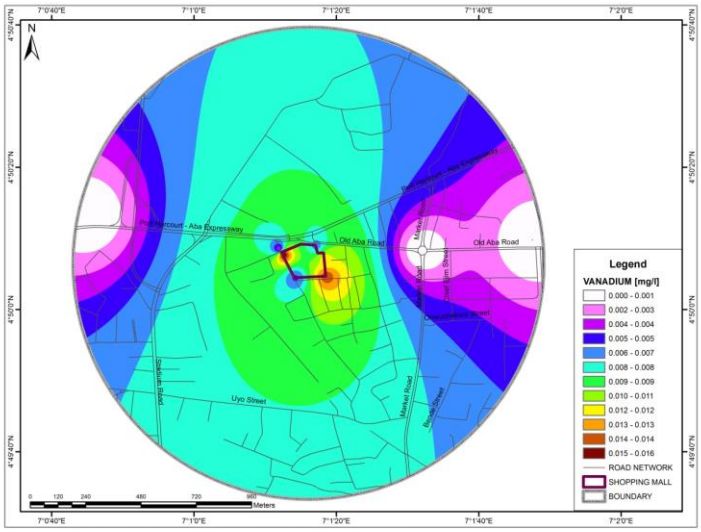


Figure 4.30: Spatial dispersion map of vanadium (mg/m^3)

❖ **Conclusion**

This study has revealed that the study area is laden with microbial contaminants. The level and quality of microbial contamination however varied with the sample location. The high incidence of the microbial isolates may be associated with indiscriminate disposal of solid wastes especially domestic one in the city centers and public drains. Improved waste management approaches may help in curtailing the discharge of microbial contaminants into the atmosphere.

Gaseous air pollutants had been observed at significant levels across the study area. This will have impact on the project. Criteria pollutants such as NO_2 and SO_2 have the potential to combine with water vapour in the atmosphere and precipitate as acid rain. When this happens, the concrete structures and metal surfaces are prone to attack.

4.9 Geoscience

4.9.1 Methodology

The study areas fall within the tertiary sedimentary basin of Niger Delta as shown in figure 4.31. Thus, the methodology adopted for this study includes field studies and high impact approved papers of previous research carried out within the geologic terrain from the Department of Geology, University of Port Harcourt. These researches addressed various aspects such as basin evolution and tectonics, biostratigraphy, sedimentology, sequence stratigraphy etc.

Figure 4.31: Geologic map of Nigeria showing Niger delta basin

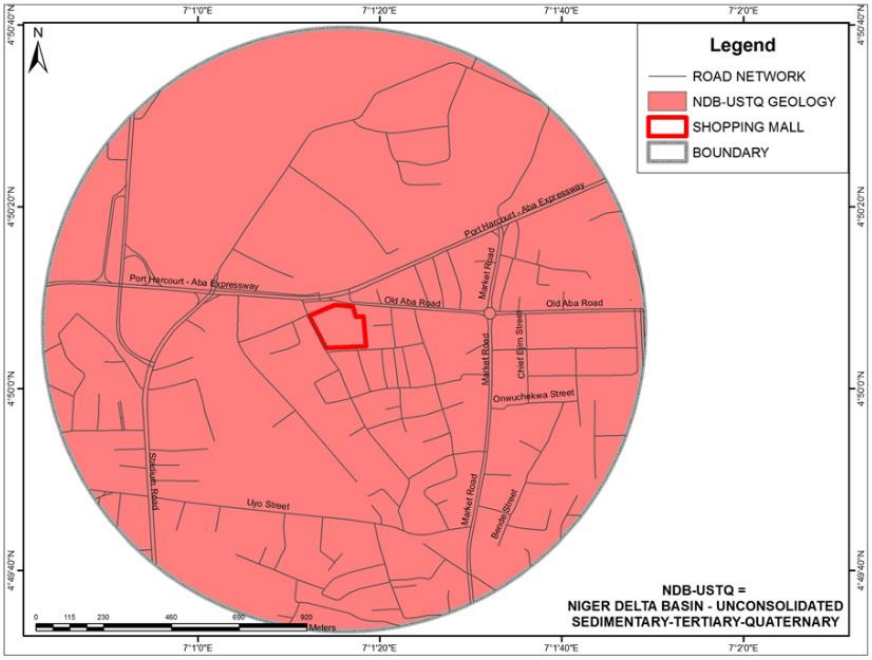


Figure 4.32: Geological formation map within the Shopping Mall complex

4.9.2 Regional Geology

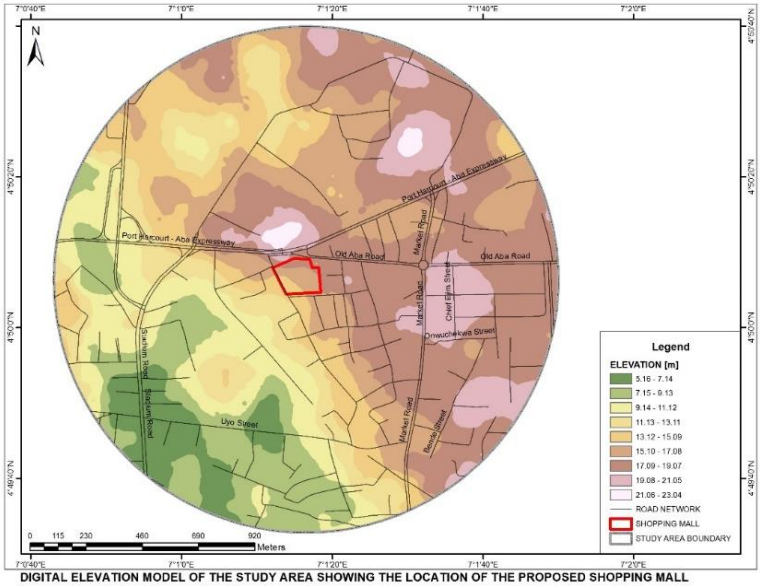
The Tertiary Niger Delta Basin located in southern Nigeria at the inland margin of the Gulf of Guinea and is situated at the southernmost part of the intra-continental Benue Trough as shown in above (figure 4.31). The basin which was formed at a recognized triple junction of the south Atlantic rifting (Delhaya et al, 2009), is bounded by the Calabar Flank to the east, Benin Flank to the west, Gulf of Guinea to the south and to the north by the Anambra Basin and Afikpo Syncline (Tuttle et al. 1999). The Niger delta basin is one of the largest subaerial basins in Africa. It has a total area of 300,000 km^2, and a sediment fill of 500,000 km^3 (Fatoke, 2010).

The evolution of the Niger delta is controlled by pre- and syn-sedimentary tectonics described by Brooks, 1990. The tectonic framework is controlled by cretaceous fracture zones expressed as trenches and ridges in the deep Atlantic. The fracture zone ridges subdivide the continental margin into individual basins, and in Nigeria, form the boundary faults of the cretaceous Benue-Abakaliki trough, which cuts far into the West African shield. The trough represents a failed arm of a rift triple junction which led to the formation of Niger delta basin and is composed of different geologic Formations.

Throughout its history, the delta has been fed by the Niger, Benue and Cross rivers, which between them drain more than 10^6 km^2 of continental lowland savannah. Its present morphology is that of a wave-dominated delta, with a smoothly seaward-convex coastline transverse by distributary channel (Brook J., 1990). The formation of the Niger Delta began in the early Palaeocene times and was as a result, buildup of fine – grained sediment eroded and transported by the River Niger and its tributaries.

4.9.3 Local Geology

The study area has a flat topography and its elevation varies between 15m to 20m above sea level as shown in the figure 4.3332. Thus, no outcrop was observed within the study area.



DIGITAL ELEVATION MODEL OF THE STUDY AREA SHOWING THE LOCATION OF THE PROPOSED SHOPPING MALL
Source: 30m by 30m ASTER DEM Digital Terrain [2020]

Figure 4.33: Topographic map of the proposed project

The study area consists of alluvial and fluvial sediment deposits of sandstone and clay. According to Etu-Efeotor et al, 1990 the Niger Delta is composed of three subsurface lithostratigraphic units (Akata, Agbada and Benin formations overlain by various deposits of Quaternary Age. The Benin formation (2100m thick) is the most prolific aquifer in the region and constitutes over ninety percent (90%) massive, porous sands with localized clay/shale interbeds.

The quaternary deposits (40 – 150m thick) generally consist of rapidly alternating sequences of sand and silt/clay, with the latter becoming increasing more prominent seawards. The Agbada formation underlies the Benin formation and was deposited under transitional environment, makeup of sands and shales. However, increasing clay may occur with depth. Underlying the Agbada formation is the Akata formation, which was deposited, in marine environment. It consists of marine clays, silts and shales with occasional turbidite sand lenses. The formation is rich in organic matter and is the source rock of oil in the Niger Delta. It has a relative thickness of 20,000ft (5882m).

Table 4:14 Geologic units of Niger delta (Short & Stauble 1967)

Geologic Units	Lithology	Age
Alluvium (general)	Gravel, sand, clay, silt	Quaternary
Fresh water back swamp meander belt	Sand, clay, some silt, gravel	Quaternary
Mangrove and salt water/back swamps	Medium fine sands clay & some silt	Quaternary
Active & abandoned beach ridges	Sand, clay and some silt	Quaternary
Sombreiro-Warri Deltaic Plain	Sand, clay and some silt	Quaternary
Benin Formation (coastal plain sand)	Coarse to medium sand with subordinate silt & clay	Miocene
Agbada Formation	Mixture of sand, clay & silt	Eocene
Akata Formation	Clay	Palaeocene

4.9.4 Soil and Flood Potential

The soils of the study area are part of the coastal soils. Edet, A.E. 1993 had earlier stated that coastal soils are composed of coastal sand deposits originally laid down at or near sea level in Oligocene to Pleistocene times. The soils are dark to brown in colour. coarse grained, locally fine grained, poorly sorted, subangular to well rounded (Omatsola, 1990). Olobaniyi et al (2006) stated that the genesis of these soils have resulted from cycles of soil formation which alternated with cycles of erosion in the mid tertiary to Holocene era in Nigeria.

Soil consistency as observed during the field exercise were between wet (slightly sticky and non-sticky) and moist (friable), while soil colour was between black, Dark red and Brown as shown in figure 4.32.

According to Atipko et al, 2018, the soil in the Port-Harcourt are poorly graded and implies a relatively high permeability potential. The high proportion of silty clay size fractions in the soil indicates a considerable amount of compressibility. The strength properties of the soil evaluated based on CBR reveals that the soil materials are suitable for subbase and subgrade materials.

Due to the flat topography and human activities within the study area, the area is prone to flooding and inundation hazards. Low lying areas suffer the most from flooding because during intensive storm rainfall, the basin receives more than it could transfer as surface water in a short period of time (Zekai, 2018).

The closer the urban land use to the main channel stream, the more prone is to flood, and consequently, drainage cross sections that have not been prone to flood hazard before, may become under the threat of flood danger (Akpokodje, 2007). Using rainfall data, soil texture and other factors Chiadikobi et al 2011 conducted flood risk assessment within the study area and the result of the study showed that there is risk of occurrence of potentially damaging floods with increasing rainfall intensity and increase in urbanization.

4.9.5 Soil Characteristics

The soil of the project area belongs to the Entisols soil class (Lindbo and Mannes, 2008; Lindbo, 2012; Broch and Klein, 2017) and is consistent with study reports of the soil in the area (Brady and Weil, 2008). Typical of Entisols, soil of the project area shows no well-defined profile development. The schematic soil profile description of the area is presented in Figure 4.3534. The description was based on United State Department of Agriculture (USDA) classification of soils (1975) and Standard Soil Colour Charts (1967).

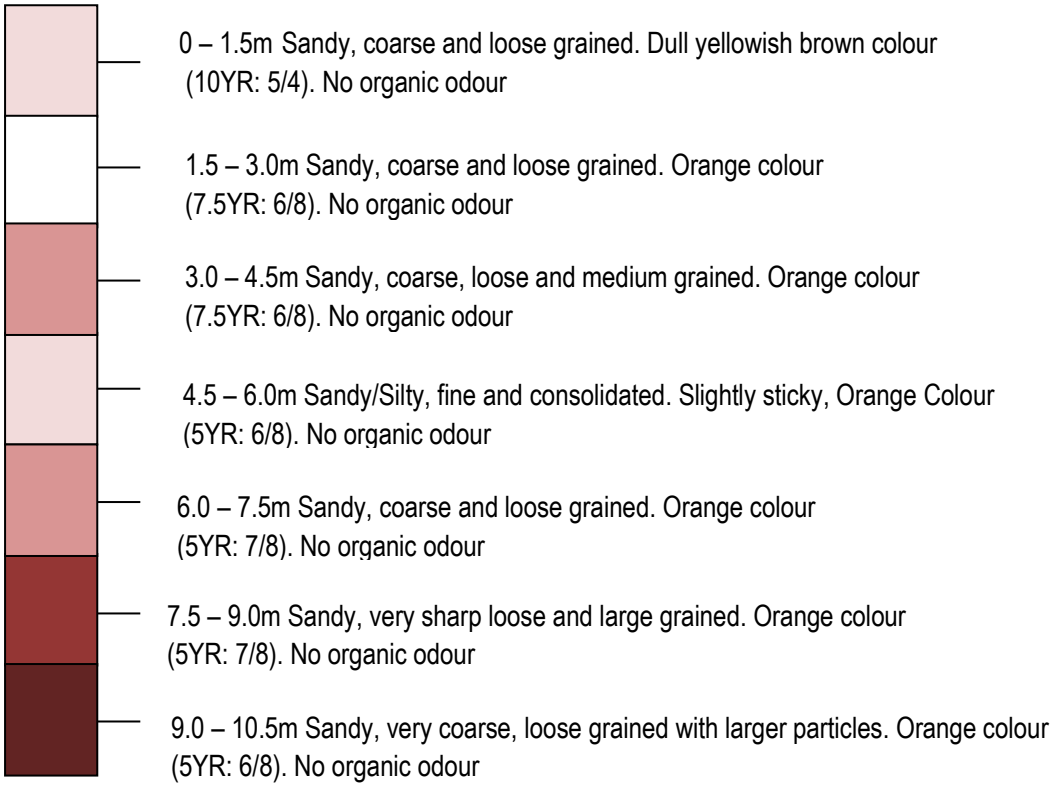


Figure 4.35: Schematic Section of Soil Profile at the Study Area

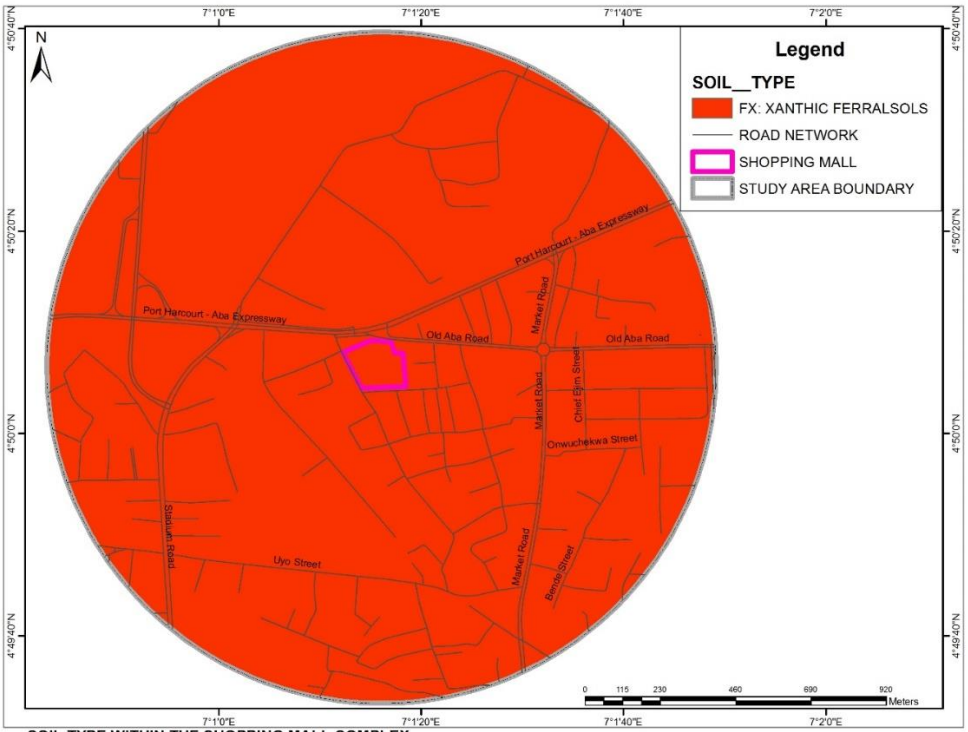


Figure 4.36: Map showing soil type within the project area

Due to the flat topography and human activities within the study area, the area is prone to flooding and inundation hazards. Low lying areas suffer the most from flooding because during intensive storm rainfall, the basin receives more than it could transfer as surface water in a short period of time (Zekai, 2018). The closer the urban land use to the main channel stream, the more prone is to flood, and consequently, drainage cross sections that have not been prone to flood hazard before, may become under the threat of flood danger (Akpokodje, 2007). Using rainfall data, soil texture and other factors Chiadikobi et al 2011 conducted flood risk assessment within the study area and the result of the study showed that there is risk of occurrence of potentially damaging floods with increasing rainfall intensity and increase in urbanization.

4.9.6 Soil Quality

Soil is a complex mixture of organic and mineral content which is constantly being formed by the weathering of rocks. It provides nutrients and an anchor to the roots of plants and is therefore essential to their healthy growth and yield of food and as such, vital for survival and welfare of the people. One of the most severe and widespread problems facing the agriculture industry is the degradation of soil quality due to changes and alteration to various physical and chemical parameters.

4.9.6.1 Soil Sampling

Soil for analysis were collected at geo-referenced points in the study area. All sample collection was carried out using standard procedures recommended by the American Public Health Association

(APHA, 1992). A total of 10 soil samples (8 samples and 2 control) were collected from shopping mall project sites using soil auger into sterile zip locked bags. Samples were transported to the laboratory within 24 hours of collection and air-dried for extraction/digestion for actual assay. Table 4.15 shows the soil sampling location.

Table 4.15: Soil sample Locations

s/n	Soil Sample	Latitude	Longitude
1	SM-SS- 1	4°50'7.73"N	7° 1'18.38"E
2	SM-SS -2	4°50'7.67"N	7° 1'17.78"E
3	SM-SS- 3	4°50'7.14"N	7° 1'18.43"E
4	SM-SS -4	4°50'4.60"N	7° 1'18.64"E
5	SM-SS- 5	4°50'4.43"N	7° 1'14.23"E
6	SM-SS- 6	4°50'7.72"N	7° 1'12.60"E
7	SM-SS-7	4°50'4.52"N	7° 1'16.65"E
8	SM-SS-8	4°50'6.31"N	7° 1'13.28"E
9	SM-C-1	4°50'6.12"N	7° 1'18.57"E
10	SM-C-2	4°50'7.15"N	7° 1'13.67"E

Source: Resourcefield survey, 2020

- **Moisture Content in Soil**

Procedure

1. Weigh moisture sample immediately and record as “wet weight of sample”
2. Dry the wet sample to a constant weight, at a temperature not exceeding 239º F (115º C) using the suitable drying equipment.
3. Allow the sample to cool.
4. Weigh the cooled sample again, and record as the “dry weight of sample”

Calculation

The moisture content of the sample is calculated using the following equation:

$$\%W = \frac{A - B}{B} \times 100$$

Where:

%W = Percentage of moisture in the sample,

A = Weight of wet sample (grams), and

B = Weight of dry sample (grams)

Report the moisture content to the nearest tenth of one percent.

Porosity

Procedure

- Fill one measuring cup to 200 ml with sand, the second cup with 200 ml of clay and the third with 200 ml with small pebbles.
- Fill a graduated cylinder to 100 ml with water.
- Slowly and carefully pour the water into the first cup until the water just reaches the top of the sand.
- Pour slowly so no water spills out of the measuring cup. Record exactly how much water was used.
- Use the formula below to calculate the percent porosity for the sand:
- Repeat the same procedure with the clay and the pebbles.
- Record the results in a table similar to the one shown

Table 4.16: Porosity analysis

Soil Type	Total sample volume	Amount of water added to sample	Porosity
Sand	200 ml		%
Clay	200 ml		%
Pebbles	200 ml		%

Porosity = (Amount of water added to sample ÷ Total sample volume) x 100

Permeability

Procedure

- Fill one graduated cylinder to the 500 ml mark with gravel, one with sand, and one with a gravel and sand mixture.
- As one lab partner begins pouring water into a cylinder, another starts the stopwatch. When water reaches the bottom of the cylinder stop the watch and note the time.
- Measure the height in centimeters of the cylinder from the bottom to the 500 ml mark. Use these figures to determine the flow rate in centimeters per second (cm/sec).
- Repeat for the other two cylinders and record your data in the chart below.

Bulk Density

i. Drive Ring into Soil

- Using the hand sledge and block of wood, drive the 3-inch diameter ring, beveled edge down, to a depth of 3 inches.

- The exact depth of the ring must be determined for accurate measurement of soil volume. To do this, the height of the ring above the soil should be measured. Take four measurements (evenly spaced) of the height from the soil surface to the top of the ring and calculate the average. Record the average on the Soil Data worksheet.

ii. Remove 3-inch Ring
- Dig around the ring and with the trowel underneath it, carefully lift it out to prevent any loss of soil.

iii. Remove Excess Soil
- Remove excess soil from the sample with a flat bladed knife. The bottom of the sample should be flat and even with the edges of the ring**.**

iv. Place Sample in Bag and Label
- Touch the sample as little as possible. Using the flat bladed knife, push out the sample into a plastic sealable bag. Make sure the entire sample is placed in the plastic bag. Seal and label the bag.

v. Weigh and Record Sample
- Weigh the soil sample in its bag. [If the sample is too heavy for the scale, transfer about half of the sample to another plastic bag. The weights of the two sample bags will need to be added together. Enter the weight (sum of two bags, if applicable) on the Soil Data worksheet.
- Weigh an empty plastic bag to account for the weight of the bag. Enter the weight (sum of two bags, if applicable) on the Soil Data worksheet.

vi. Extract Subsample to Determine Water Content and Dry Soil Weight
- Mix sample thoroughly in the bag by kneading it with your fingers.
- Take a 1/8-cup level scoop subsample of loose soil (not packed down) from the plastic bag and place it in a paper cup (a glass or ceramic cup may be used).

vii. Weigh and Record Subsample
- Weigh the soil subsample in its paper cup. Enter the weight on the Soil Data worksheet. Weigh an empty paper cup to account for its weight. Enter the weight on the Soil Data worksheet.

viii. Dry Subsample
- Place the paper cup containing the subsample in a microwave and dry for two or more four-minute cycles at full power. Open the microwave door for one minute between cycles to allow venting. Weigh the dry subsample in its paper cup and enter the weight on the Soil Data works.

4.9.6.2 Results and Discussion

4.9.6.2.1 Physico Chemical Results

The physico chemical parameters of soil samples within the study area is summarized in Table 4.17(see appendix 21.2 for detailed result).

Table 4.17: Summarized of physico chemical parameters of soil samples

Parameter	Range	Mean	SD	FMEnv/WHO Limits
Permeability (%)	33.4-53.2	41.705	4.77	-
Porosity (%)	57.7-78.5	67.565	5.79	-
Bulk density (mg/kg)	0.2-1.8	0.96	0…56	-
% Sand	45-71	58.3	9.39	-
% Silt	25-48	35.75	7.67	-
% Clay	2-10	6	2..58	-
pH	4.29-5.78	5.463	0.4	6-8
Conductivity (µS/m)	231.6	114.8	344.2	-
Moisture content (%)	41.7-47.2	44.385	1.4	-
Nitrate (mg/kg)	9.4-12.8	11.23	1.06	-
Phosphate (mg/kg)	2.08-4.22	3.24	0.69	-
Sulphate (mg/kg)	4.03-5.25	4.423	0.39	500
Calcium (mg/kg)	28.1-39.2	34.55	3.22	-
Magnesium (mg/kg)	5.7-8.9	7.195	1.02	-
Potassium (mg/kg)	1.1-1.8	1.49	0.23	-
Sodium (mg/kg)	2.11-4.12	2.974	0.62	-
THC (mg/kg)	<0.001	<0.001	<0.001	30
Vanadium (mg/kg)	<0.001	<0.001	<0.001	-
Nickel (mg/kg)	0.01-0.2	0.084	0.06	35
Iron (mg/kg)	105.3-142.1	125.37	9.19	45
Lead (mg/kg)	0.0005-0.0024	0.0014	0.0006	85
Copper (mg/kg)	2.14-2.48	2.29	0.1	45
Zinc (mg/kg)	7.07-8.27	7.6	0.5	140

Source: Resourcefield survey, 2020

Table 4.18: Microbial characteristics of soil samples

Parameter	SS_1		SS_2		SS_3		SS_4		SS_5		SS_6		SS_7		SS_8		Control 1		Control 2	
	TS	SS	TP	SS	TP	SS	TP	SS	TP	SS	TP	SS	TP	SS	TP	SS	TP	SS	TP	SS
THB (cfu/g)	2.5 × 10^5	3.1 × 10^5	2.2 × 10^5	2.7 × 10^5	3.4 × 10^5	3.7 × 10^5	3.2 × 10^5	3.8 × 10^5	2.8 × 10^5	3.3 × 10^5	2.4 × 10^5	2.5 × 10^5	4.1 × 10^5	3.6 × 10^5	3.2 × 10^5	3.9 × 10^5	3.8 × 10^5	2.1 × 10^5	1.8 × 10^5	2.4 × 10^5
THF (cfu/g)	4.2 × 10^5	3.4 × 10^5	3.3 × 10^5	2.4 × 10^5	4.5 × 10^5	3.2 × 10^5	3.5 × 10^5	4.1 × 10^5	3.7 × 10^5	3.4 × 10^5	3.3 × 10^5	2.8 × 10^5	3.8 × 10^5	2.7 × 10^5	4.4 × 10^5	4.0 × 10^5	4.3 × 10^5	3.6 × 10^5	2.2 × 10^5	1.3 × 10^5
HUB (cfu/g)	1.6 × 10^5	1.1 × 10^5	2.3 × 10^5	1.2 × 10^5	2.5 × 10^5	1.2 × 10^5	2.7 × 10^5	1.8 × 10^5	2.6 × 10^5	2.0 × 10^5	2.4 × 10^5	1.2 × 10^5	2.7 × 10^5	1.5 × 10^5	2.1 × 10^5	1.2 × 10^5	2.2 × 10^5	1.1 × 10^5	1.3 × 10^5	1.0 × 10^5
HUF (cfu/g) (cfu/g)	3.6 × 10^5	2.7 × 10^5	3.8 × 10^5	2.1 × 10^5	3.3 × 10^5	1.8 × 10^5	3.8 × 10^5	2.3 × 10^5	2.1 × 10^5	1.8 × 10^5	3.2 × 10^5	2.3 × 10^5	3.1 × 10^5	2.2 × 10^5	3.5 × 10^5	2.4 × 10^5	2.7 × 10^5	2.1 × 10^5	3.8 × 10^5	2.7 × 10^5

Table 4.19: Microbial Characteristics of Soil Samples

Sample Code	Microorganisms identified	
	Bacteria	**Fungi**
SS_1	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_2	*Bacillus brevis, Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Enterobacter faecium*.	*Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida* albicans, Chrysogenum sp, *Alternaria* sp.
SS_3	*Clostridium* sp, *Staphylococcus aureus*, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus subtilis*, *Escherichia coli*, *Enterobacter faecium*.	*Saccharomyces* sp, *Aspergillus fumigatus*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans*, **Candida tropicalis*
SS_4	*Staphylococcus aureus*, *Micrococcus* sp, *Actinomyces* sp, *Pseudomonas aeruginosa*,	*Penicillium* sp, *Aspergillus fumigatus*, *Pichia* sp, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_5	*Achromobacter* sp, *Bacteroids* sp, *Acinetobacter* sp, **Bacillus* sp.	*Geotricum* sp, **Penicillium* sp, *Aspergillus niger*, **Candida* sp,
SS_6	*Staphylococcus aureus*, *Micrococcus* sp, *Pseudomonas aeruginosa*,	*Aspergillus fumigatus*, *Fusarium* sp, *Aspergillus niger*, *Candida albicans*.
SS_7	*Proteus* sp, *Micrococcus* sp, *Pseudomonas aeruginosa*, *Enterobacter aerogenes, Clostridium* sp.	*Fusarium* sp, *Aspergillus niger*, **Candida tropicalis*.
SS_8	*Klebsiella* sp, **Micrococcus* sp, **Pseudomonas* sp, *Bacillus brevis*, *Enterobacter faecium*.	**Penicillium* sp, **Candida tropicalis*, *Aspergillus niger*, *Fusarium* sp, **Candida albicans.*

*Hydrocarbon degrader

- **Moisture Content**

The moisture content of soil also referred to as water content is an indicator of the amount of water present in soil. By definition, moisture content is the ratio of the mass of water in a sample to the mass of solids in the sample, expressed as a percentage. Soils normally contains a finite amount of water, which can be expressed as the "soil moisture content." This moisture exists within the pore spaces in between soil aggregates (inter-aggregate pore space) and within soil aggregates (intra-aggregate pore space). Normally this pore space is occupied by air and/or water. If all the pores are occupied by air, the soil is completely dry. If all the pores are filled with water, the soil is said to be saturated.
The moisture content of the soil ranged from 41.7 – 47.2 % with the mean of 44.385±1.4 %. No recorded WHO/FMEnv permissible limit exist for moisture content.

- **Permeability**

The permeability is a measurement of how easily liquid flows through a material (or soil). Both porosity and permeability are important to ground water. The permeability of the soil ranged from 33.4 – 53.2 % with the mean of 41.705±4.77 %. WHO/FMEnv permissible limit do not exist for soil permeability.

- **Porosity**

The porosity of a material is a measurement of how much of its volume is open space (also called pore space). Porosity is usually expressed as a percentage of the material's total volume. The porosity of the soil ranged from 57.7 – 78.5 % with the mean of 67.565±5.79 %. No WHO/FMEnv permissible limit available for the porosity of soil.

- **Bulk Density**

Bulk density is the weight of soil for a given volume. It is used to measure compaction. Generally, the greater the density, the less pore space for water movement, root growth and penetration, and seedling germination. The bulk density of the soil ranged from 0.2 – 1.8 mg/kg with the mean of 0.96±0.56 mg/kg. WHO/FMEnv permissible limit no available.

- **pH**

This is an indication of the acidity or alkalinity of the soil. A pH of 0 to 6.9 is increasingly more acidic while from (pH) 7.1 to 14 is increasingly more alkaline; pH 7 is a neutral point. A strongly acid soil shows intensive leaching, low exchangeable basic cation content and slow microbial activity. A strongly alkaline soil indicates non-leached soil with low nutrient content and may lead to reduced plant growth or even death to the plant (Brady and Weil, 2008).
The pH values of the soil of the project area ranged from 4.29 - 5.78 with the mean of 5.463±0.4, which is below WHO/FMEnv permissible limit of 6-8. This indicates a predominantly acidic soil which is consistent in all locations and with previous studies conducted in the study area. Generally, the soils of the area vary from the order Oxisols to Ultisols which are strongly acidic, extensively weathered soils of tropical and subtropical climates. Oxisols are excessively weathered with few original minerals left un-weathered and are known to have dominant iron and aluminium oxide. They are mostly sandy soil at the surface and are also acidic. They develop mainly in the tropical and subtropical climates (Brady and Weil, 2008).

Soil Nutrients

The nitrate, phosphate and sulphate ions (NO_3^-, PO_4^{3-}, and SO_4^{2-}) are the ionic and utilizable forms of nitrogen, phosphorus and sulphur, which are essential plant nutrients present in the soil. Nitrogen is most often the limiting element in plant growth and is a constituent of chlorophyll, plant proteins, and nucleic acids. Also, phosphorus compounds form an essential part of nucleo-proteins in plant cells and these control cell division and growth. Soils usually have low total plant available phosphate supplies because mineral phosphate forms are readily not soluble. Sulphur on the other hand, occurs in proteins and is required for plant vitamin synthesis. In acidic soils, sulphur comes from mineralization of organic matter, particularly weathered soil.

The nitrates, phosphates, and sulphates levels in soils of the project area. The results obtained showed no significant variation. It also compared well with results of similar studies in the region. The ranges for nitrate, phosphate and Sulphate were 9.4 – 12.8 mg/kg with the mean of 11.23±1.06 mg/kg; 2.08 – 4.22 mg/kg averaging 3.24±0.69 mg/kg; and 4.03 – 5.25 mg/kg with the mean of 4.423±0.39 mg/kg respectively.

In figure 4.3735, nitrate accounted for 64 % of the soil nutrient followed by sulphate 22 % and the least phosphate 14 %.

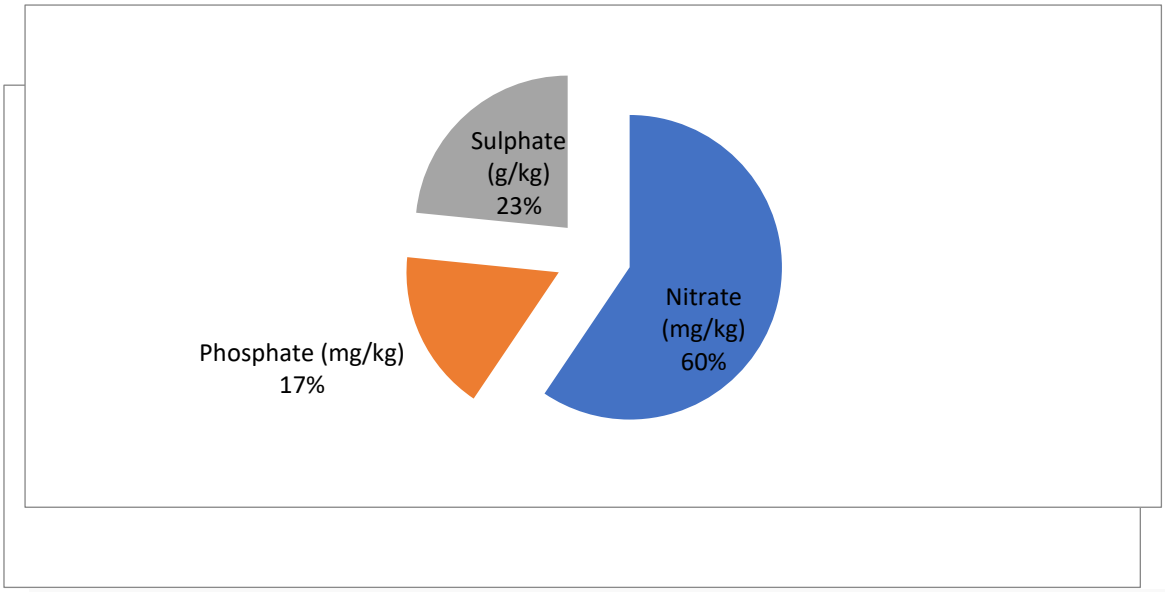


Figure 4.37: Soil nutrients

Particulate Size Distribution

Soils are composed of particles of varying aggregates. The soil particles sizes comprise sand (the coarse), silt and clay (the smallest) fractions. The relative proportion of the soil separates in a particular soil determines its texture. The texture in turn determines the water intake rates (absorption), water storage, the ease of tilling, and the amount of aeration as well as influences the soil fertility. The name and sizes of soil particle classes are provided in Table 4.20 below as defined by the United State Department of Agriculture (USDA) and International Society of Soil Science (ISSS).

Table 4.20: Classification of Soil Particle Sizes

Particle Fraction Name	USDA (mm)	ISSS (mm)
Gravel	>2	>2
Very Coarse Sand	1 – 2	-
Coarse Sand	0.5 – 1.0	0.2 -2.0
Medium Sand	0.25 -0.50	-
Fine Sand	0.10 -0.25	0.02-0.20
Very Fine Sand	0.05 – 0.10	-
Silt	0.002 – 0.05	0.002 – 0.020
Clay	<0.002	<0.002

Source: Boyd *et al* 2002

Data obtained for PSD indicated that the soils of the sample area were predominantly sandy loam with silt on the surface and sandy-silt to clay on the sub-surface. The colour varied between dull reddish brown and reddish grey. These percentages represent a conservative ratio of 1:1:3.5 for clay, silt and sand respectively. These results are however consistent with the values recorded in previous soil study of the area.

- **Cation Exchangeable Capacity**

CEC is a measure of the ability of the soil to adsorb cations. Plants are primarily able to take up the ionic form of nutrients via their roots. Many of these nutrients are taken up as cations (remember, these are positive ions). Most soils have at least some ability to hold onto cations at negatively charged sites, called exchange sites, on soil particles. The cations are held loosely to the edges (adsorbed) such that they can be easily replaced with similarly charged cations. The total amount of the cations that the soil can hold adsorb is the cation exchange capacity (CEC). Measurement: CEC is measured as milliequivalents (meq) per 100g of soil or centimoles (cmol) per kg.

The exchangeable cations: magnesium, potassium, sodium and calcium are positively charged ions usually absorbed by electrostatic or columbic attraction to soil surface colloids. The plant nutrients calcium, magnesium and potassium are supplied to plants in large measures in exchangeable forms (Brady and Weil, 2008). Calcium deficiency in plants is indicated by deformation of young leaves and death of grow out points while magnesium deficiency is indicated by yellowing of older leaves between veins while younger leaves die and fall off.

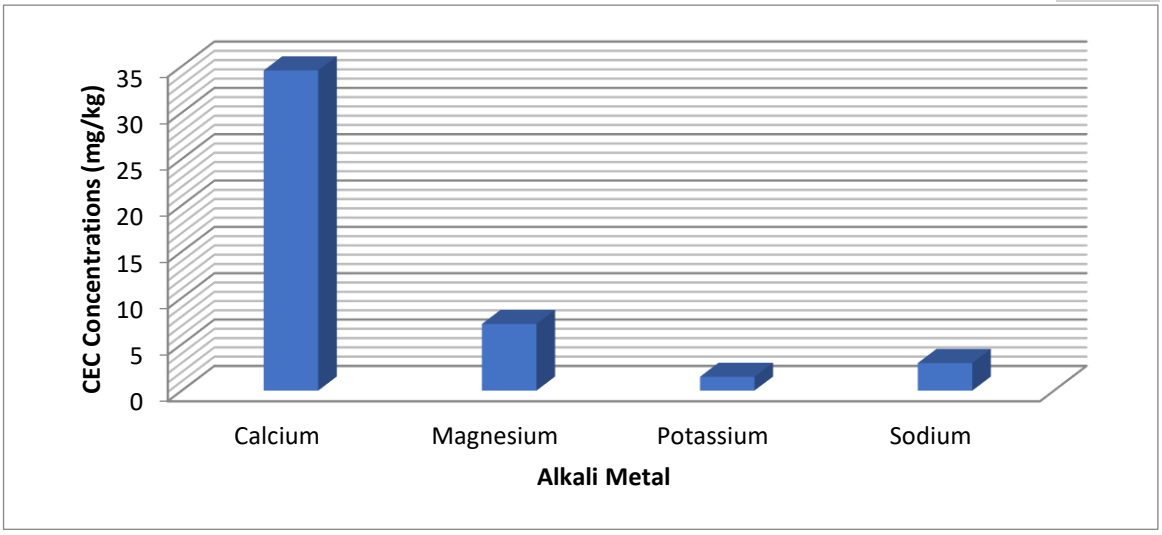


Figure 4.38: Mean Concentrations of Soil Exchangeable Cations

- **Magnesium**

The concentration of magnesium recorded in the soil ranged from 5.7 mg/kg - 8.9 mg/kg with the mean of 7.195±1.02 mg/kg. Soils values obtained were fairly consistent across the study area. No recorded WHO/FMEnv permissible limit available for magnesium.

- **Potassium**

The potassium in soils of the study area ranged from 1.1 mg/kg to 1.8 mg/kg with the average of 1.49±0.24 mg/kg. The potassium levels were consistent across the sampling stations, and also with the reported values recorded within the region. WHO/FMEnv permissible limit do not exist.

- **Sodium**

The sodium concentrations in soils of the study area ranged 2.11 mg/kg - 4.12 mg/kg with the average of 2.974±0.62 mg/kg. WHO/FMEnv permissible limit do not exist.

- **Calcium**

The concentrations for the soil of the area ranged from 28.1 mg/kg 39.2 mg/kg averaging 34.55±3.22 mg/kg. WHO/FMEnv permissible limit do not exist.

Generally, the exchangeable cations concentrations were consistent with recorded values in similar environment within the region. However, the implementation of the proposed project will not affect the exchangeable cations in the project site. Hence, no foreseeable effect on the baseline concentrations of the exchangeable cations in the area is envisaged.

- **Heavy Meatals**

The heavy metals (As, Cu, Fe, Pb, Mn, Hg, Ni, V, Zn) constitute a large class of organic and inorganic compounds that are both essential and toxic to human and the environment. In agriculture, they are referred to as micronutrients, stressing their low requirement in the soil and their importance for plant growth. These metals often form soluble compounds in soil and contribute some various measures to the fertility of soil and growth of plants. They are also known to accumulate in plants and animal

tissues where they cause various physiological problems. The phenomenon by which they accumulate in tissue is known as bio-accumulation, and this process is of utmost importance in environmental management.

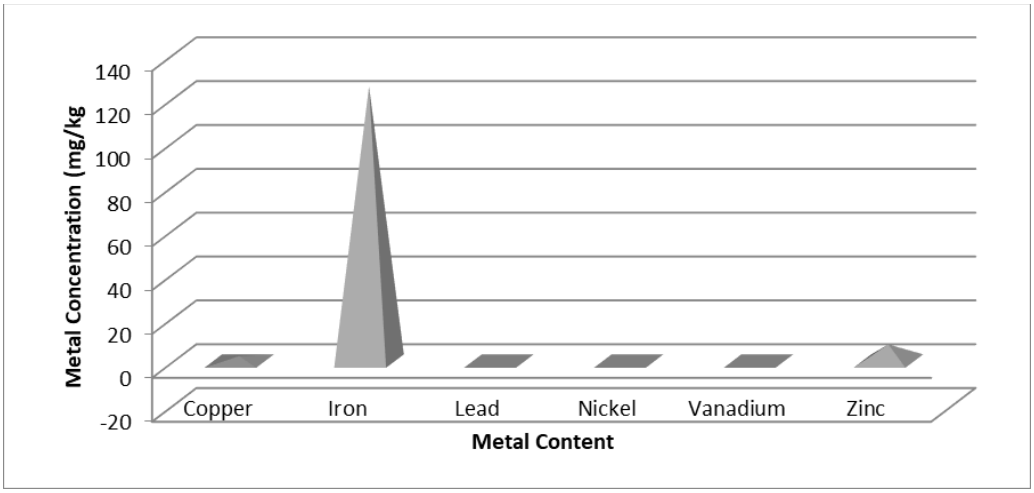


Figure 4.39: Mean concentrations of heavy metals in soil samples

Some case studies on bio-accumulation include the early 1970's Minamata disease, which revealed the potential for bio-magnification of mercury and other heavy metals in living tissues (Leke *et al*., 2011), and Ita-ita disease caused by accumulation of cadmium in human tissue, also Chinwe *et al*. (2010) showed that some spent lead shot ingested by swans in Ireland ended up in the nucleus of the kidney cells (Lokhande *et al*., 2011). These concentrations are consistent with previous studies in the region soils, soils.

4.9.6.2.2 Soil Microbiology

Generally, soil biology is the scientific study of life in and on the soil. This entails the study of various kinds of micro-organisms; those studied are bacteria and fungi, which are most important organic matter decomposers in the soil. They form symbiotic and mutual relationships in which two different organisms live together and benefit from each other. The summary of microbial organisms of the study area is presented in Table 4.18 above**.** Total heterotrophic bacteria (cfu/g) ranged from 1.8×10^5 - 4.1×10^5; Total heterotrophic fungi (cfu/g) ranged from 1.3×10^5 and 4.5×10^5; Hydrocarbon utilizing bacteria (cfu/g) ranged from 1.0×10^5 - 2.6×10^5, and Hydrocarbon utilizing fungi (cfu/g) ranged from 1.8×10^5 - 3.8×10^5. 39 genera of microorganisms were isolated, out of which 20 were bacteria and 19 fungi.

4.9.7 Hydrogeology and Hydrology

Geologically, the site is underlain by the coastal plain sands, overlain by firm – stiff clay/sandy clay sediments belonging to the pleistocenic formation. The area essentially reflects the influence of movements of water runoff in their search for lines of flow to the sea with consequent deposition of transported sediments as shown in figure 4.4038

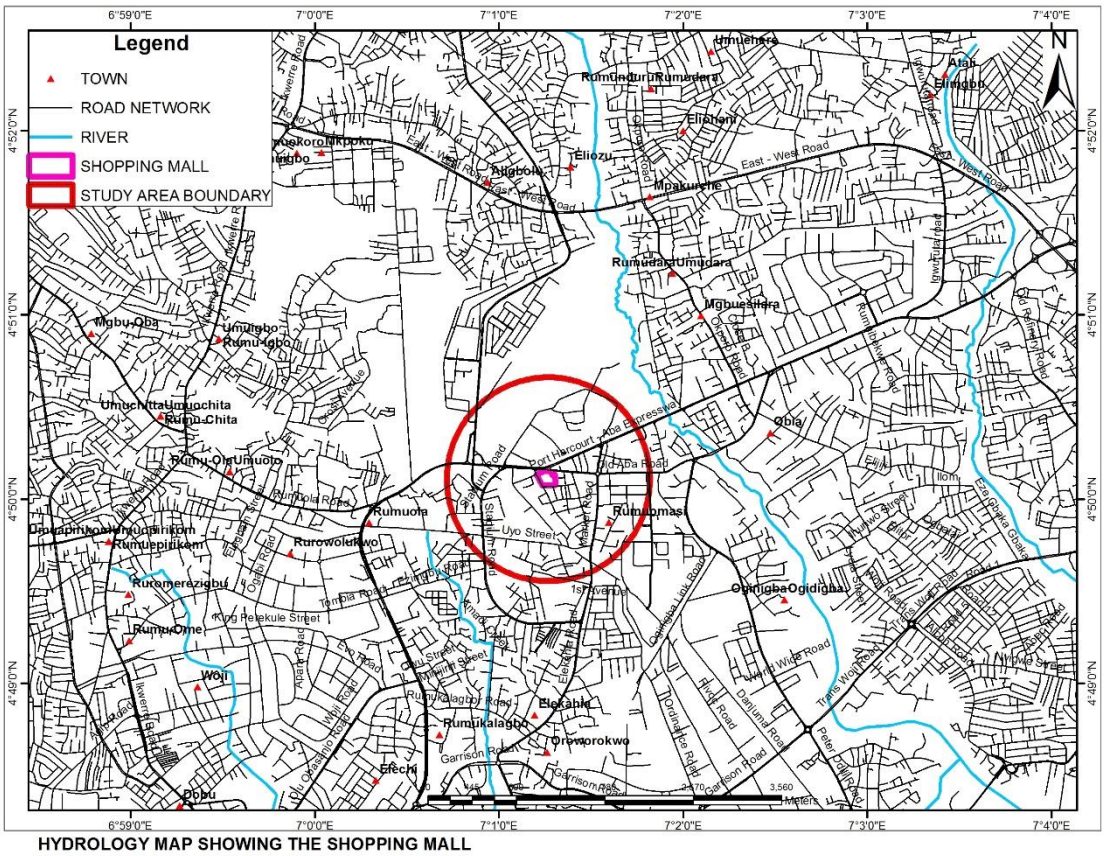


Figure 4.41: Hydrology map showing the proposed shopping mall

Given the permeability of sands (from medium to high), they are excellent reservoir rock. The clayey intercalations, when present acts as aquitard or aquiclude, depending on the thickness, areal continuity and permeability of the layer. The litho-stratigraphic succession described above indicates the existence of a powerful alluvial aquifer hosted in sandy deposits. Given the variability of the sedimentary deposition and energy of the surface waterway flows, the existence of two types of aquifers (Multilayer and Monolayer aquifers) can be hypothesized.

A multi-layer aquifer is made up of several overlapping water bearing layers, hydraulically separated by less permeable clayey layers. Figure 4.42 gives an example of an alluvial aquifer of the multi-layer type, with continuous impermeable strata which defines a hydraulic separation.

The sedimentary Formations hosts several strata hydraulically separated by impermeable strata as seen in the figure 4.4239 by the various piezometric loads with hypothetical measuring pipes positioned at various depths. Thus, a Monolayer aquifer is made up of one sedimentary body in which there is absence of less- permeable separation strata; the sedimentary body hosts a single water-bearing layer. In this case, the hydraulic loads measured at different levels are identical. In the case of

multi-layer aquifer, the supply to the 1st aquifer is given by the direct recharge produced by rainfall in the area where the clayey cover is absent and by the exchange with surface waterways. The groundwater circulation of the 1st aquifer is strictly connected to the fluvial regime.

Depending on the season, the Niger river may drain or be drained by the groundwater of the 1st aquifer. The mono-layer aquifer is fed by direct recharging due to rainfall and by the exchange with the surface waterways.

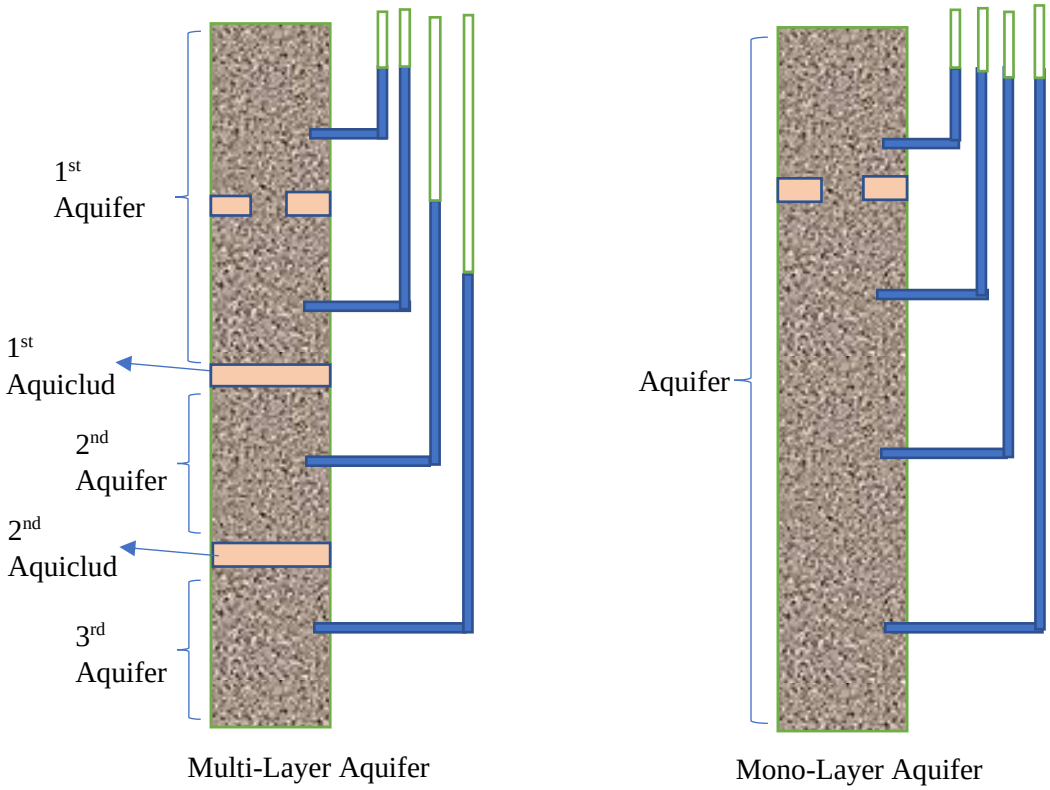


Figure 4.42: Examples of Multi-layer and Mono-layer Aquifer

According to Owamah et al, 2018, the constant head method was used to determine the hydraulic conductivity of the soil due to its sandy nature from five sample boreholes. *The* hydraulic conductivity values obtained for borehole 1 to borehole 5 were$1.5x10^{-1}$, $2.4x10^{-1}$, $3.5x10^{-1}$, $3.5x10^{-1}$, and $3.5x10^{-1}$cm/sec respectively.

These high hydraulic conductivity values indicate fine to medium sandy soil. The implication of high hydraulic conductivity values is that the aquifer system within the study area is prolific (Etu-Efeotor, 2000).

4.9.8 Ground Water Quality and Contamination

Ground water samples were obtained from 5 boreholes. These include 3 stations as sampling point in close proximity to the study area and 2 stations as control point as shown in Table 4.21 and these were analysed for physico-chemical and microbiological properties.

Table 4.21: Ground water sampling locations.

Sample code	Northing	Easting
SM-GW- 1	4°50'5.86"N	7° 1'17.57"E
SM-GW- 2	4°50'5.82"N	7° 1'15.38"E
SM-GW- 3	4°50'7.95"N	7° 1'18.17"E
SM-GW-C1	4°50'7.75"N	7° 1'15.10"E
SM-GW-C2	4°50'8.71"N	7° 1'14.13"E

Source: Resourcefield survey, 2020.

4.9.8.1 Sampling Methodology and Results

The boreholes were sampled using Niskin bottle. The Niskin bottle was flushed with distilled water before used at every station.

4.9.8.2 Ground Water Physicochemical

The results of the physical and chemical characteristics of ground water sample obtained from the boreholes within the spatial influence of the project area are summarized in Table 4.22 (see appendix 21.3 for detailed result).

Table 4.22: Physicochemical Characteristics of Groundwater Samples

Parameter	Min	Max	Mean	WHO Limit	FMEnv Limit
Color (Pt Co Units NCASI)	1.1	1.8	1.42	5-15	-
pH	6.75	6.82	6.788	6.5-8.5	6.5-9.0
Temperature (oC)	26.5	27.6	27.02	-	-
Turbidity (NTU)	0.53	0.62	0.568	5	5
Salinity (ppt)	0.0071	0.0074	0.0073	-	-
Hardness (mg/l)	12.6	14.6	13.84	250	250
Conductivity (µS/cm)	14.2	14.7	14.48	1000	400
Dissolved Oxygen (mg/l)	0.19	0.25	0.224	5	>4.0
Biological Oxygen Demand (mg/l)	<0.01	<0.01	<0.01	-	-
Chemical Oxygen Demand (mg/l)	<0.01	<0.01	<0.01	-	150
Total Hydrocarbon Content (mg/l)	<0.01	<0.01	<0.01	-	-
Phosphate (mg/l)	0.11	0.18	0.148	-	-
Sulphate (mg/l)	0.33	0.47	0.402	250	250
Nitrate (mg/l)	0.31	0.37	0.338	10	10
Total Dissolved Solids (mg/l)	7.1	7.35	7.24	1000	1000
Total Suspended Solids (mg/l)	0.22	0.26	0.238	-	-
Copper (mg/l)	0.0005	0.0021	0.001	1	0.01
Iron (mg/l)	0.23	0.28	0.258	0.36	0.36

Parameter	Min	Max	Mean	WHO Limit	FMEnv Limit
Lead (mg/l)	<0.001	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.53	0.75	0.63	3	<1.0
Cadmium (mg/l)	0.0002	0.0007	0.0004	0.003	<1.0
Chromium (mg/l)	<0.0001	<0.0001	<0.0001	0.05	0.05
Potassium (mg/l)	0.01	0.05	0.028	-	-
Barium (mg/l)	0.02	0.06	0.042	-	-
Faecal Coliform (cfu/100ml)	0	0	0	0	0
Total Coliform (cfu/100ml)	0	0	0	0	0
Total Heterotrophic Bacteria (cfu/ml)	12	16	14	100	100

Sources: Resourcefield survey, 2020

- **pH**

Water pH is widely used to express the intensity of acidity or alkalinity of water. The pH plays an important role in all chemical reactions associated with formation, alteration and de-solution of minerals in water. Recorded pH values for groundwater ranged from 6.75 – 6.82 with the mean of 6.788±0.03.

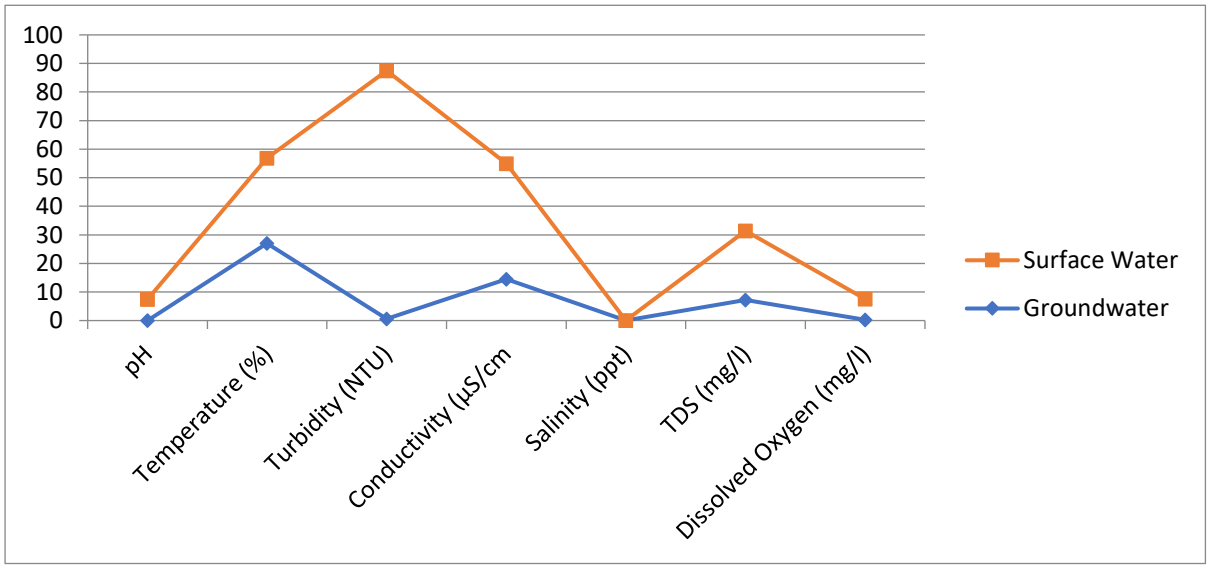


Figure 4.4340: Mean concentrations of fast changing water quality parameters

- **Temperature**

Temperature refers to degree of hotness or coldness and it can be measured in degree Celsius. Temperature is also important because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Water, particularly groundwater, with higher temperatures can dissolve more minerals from the rocks it is in and will therefore have a higher electrical conductivity. Temperature exerts a major influence on biological activity and growth.

Temperature governs the kinds of organisms that can live in rivers and lakes. Temperature values for groundwater ranged from 26.5 – 27.6 °C with the mean of 27.02±0.5 °C.

- **Turbidity**

Turbidity is of general concern in water due to aesthetic considerations, filterability and disinfection. As turbidity level increases, the aesthetic value decreases, and the filtration of water is rendered more difficult and costly, reducing the effectiveness of disinfection procedure. Turbidity values for groundwater ranged from 0.53 – 0.62 NTU with the mean of 0.568±0.03 NTU. The recorded values of turbidity for groundwater were lower than the WHO and the FMEnvFMEnv limits of 5 NTU, but higher than the stated limits in surface water samples.

- **Total Dissolved Solids (TDS)**

Total dissolved solids (TDS) are the aggregate of dissolved mineral salts in water. Excess TDS is of concern due to their potential for causing unfavorable physiological reactions in humans and livestock. TDS is a good indicator of the mineralized character of water (KWW, 2001). TDS values ranged from 7.1 – 7.35 mg/l with the mean of 7.24±0.11 mg/l. These concentrations were acceptable for potable water quality as they were below the FMEnvFMEnv and WHO limits of 2000 and 1000mg/l respectively.

- **Salinity**

Salinity is the total of all non-carbonate salts dissolved in water, usually expressed in parts per thousand (1 ppt = 1000 mg/L). Unlike chloride (Cl^-) concentration, you can think of salinity as a measure of the total salt concentration, comprised mostly of Na^+ and Cl^- ions.
Salinity values ranged from 0.0071 – 0.0074 ppt with the mean of 0.0073±0.0001 ppt. Neither WHO nor FMEnvFMEnv has assigned permissible limit for salinity in drinking water.

- **Total Suspended Solids (TSS)**

Total Suspended Solids (TSS), also known as non-filterable residue, are those solids (minerals and organic material) that remain trapped on a 1.2 µm filter (U.S.EPA, 1998). Suspended solids can enter groundwater through runoff from industrial, urban or agricultural areas. Elevated TSS can reduce water clarity, degrade habitats, clog fish gills, decrease photosynthetic activity and cause an increase in water temperatures (MMSD, 2002). TSS has no drinking water standard. TSS values ranged from 0.22 – 0.26 mg/l with the mean of 0.238±0.01 mg/l.

- **Conductivity (EC)**

Solids can be found in nature in a dissolved form. Salts that dissolve in water break into positively and negatively charged ions. Conductivity is the ability of water to conduct an electrical current, and dissolved ion are conductors. Electrical conductivity values ranged from 14.2 – 14.7 µS/cm with the mean of 14.48±0.23 µS/cm. These values are consistent with recorded values in the region (Periyasamy and Rajan, 2009). However, there is no WHO recommended limit for conductivity in drinking water.

- **Hardness**

The hardness of water is caused by dissolved metallic ions, primarily calcium and to a lesser extent magnesium ion, and is often expressed as an equivalent quantity of calcium carbonate. Magnesium in association with the sulphate ion may have laxative effect, to which the human body can adapt to in time (WHO, 2010). There is no evidence in man that drinking hard water causes any adverse health effects (WHO, 2004).

The hardness concentrations ranged from 12.6 - 14.6 mg/l with the average of 13.84±0.78 mg/l. However, levels of hardness were within the WHO and the FMEnvFMEnv limits in drinking water. The results also showed that there was no significant variation in the samples.

- **Total Hydrocarbon Content (THC)**

The concentrations of the THC in the water samples of the study area were less than the equipment detection limit of 1.00mg/l. There is no recommended WHO limit for THC in drinking water.

- **Biochemical-Oxygen Demand (BOD)**

The measured value of BOD level (<0.01) was less than equipment detection level. There is however, no recommended WHO limit for BOD in drinking water.

- **Chemical Oxygen Demand (COD)**

Chemical oxygen demand (COD) describes the amount of oxygen required to breakdown chemical substance in industrial effluent. The measured COD level was less than equipment detection level. There is no recommended WHO limit for COD in drinking water.

- **Nutrients**

Nitrates, phosphate and sulphate are important plant nutrients; however, they are undesirable in drinking water. Sources of nutrients in groundwater are domestic/industrial effluents, agricultural (fertilizer use) and leachates from industrial and domestic refuse dumps.

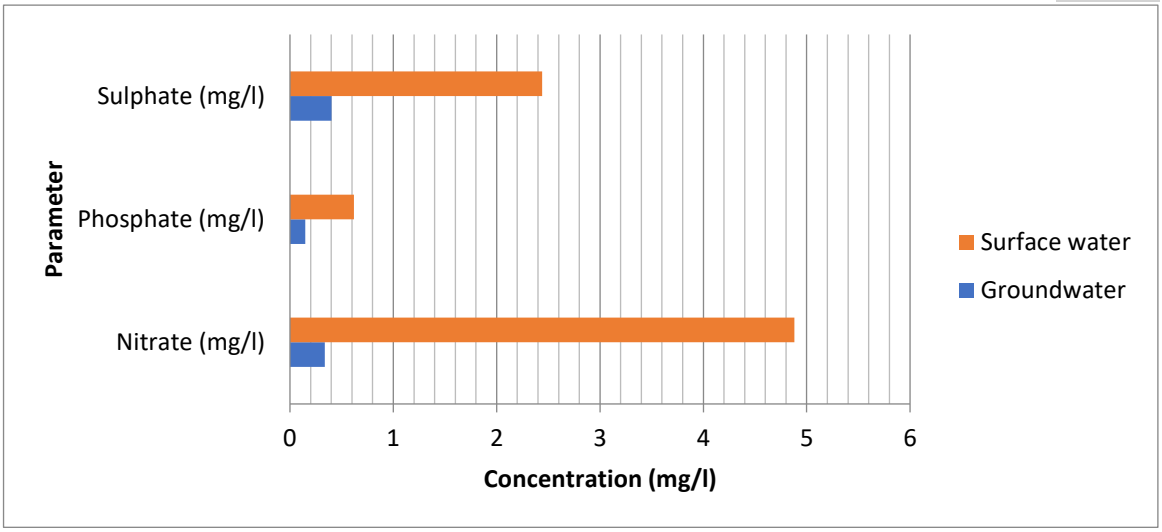


Figure 4.44: Mean concentrations of nutrients in water samples

- **Nitrate**

Nitrates are toxic when present in excessive amount in drinking water and in some cases cause methano-globinaemia in bottle fed infant. This problem does not occur in adults but there is a possibility that certain forms of cancer might be associated with very high nitrate concentrations (WHO, 2010). The nitrate concentrations ranged from 0.31 - 0.37 mg/l with the average of 0.338±0.02 mg/l. These values are below the WHO and the FMEnvFMEnv recommended limit for potable water quality of 10.0 mg/l.

- **Phosphate**

The phosphate concentrations ranged from 0.11 - 0.18 mg/l with the average of 0.148±0.03 mg/l. However, both WHO and FMEnvFMEnv have no recommended limit for phosphate in drinking water. These values also compared well with recorded concentration in the region (Periyasamy and Rayan, 2009).

- **Sulphate**

Excess of sulphates in drinking water may result in inhibition of certain biological processes, and ultimately lead to death in humans and livestock (Lokhande *et al*., 2011). Again, sulphate ion has laxative properties. The sulphate concentrations ranged from 0.33 - 0.47 mg/l with the average of 0.402±0.05 mg/l. The concentrations were within the WHO recommended limit for drinking water quality of 250mg/l.

- **Heavy Metals**

The availability of heavy metals (such as iron and manganese) in potable water is controlled by physical and chemical interactions. These interactions are affected by factors like pH, temperature, type and concentration of available legands and chelating agents, as well as type and concentrations of the

metal ions. Concerns over heavy metals in drinking water relate to their toxicity, bio-accumulation and hazards to human and animal health (Kikuchi *et al*., 2009; Seshan *et al*., 2010).

The heavy metals: Pb., Cr, were not detected in the water samples., except Fe, Cu, Ba and Zn, and their concentrations were below their respective regulatory limits. except Fe that was

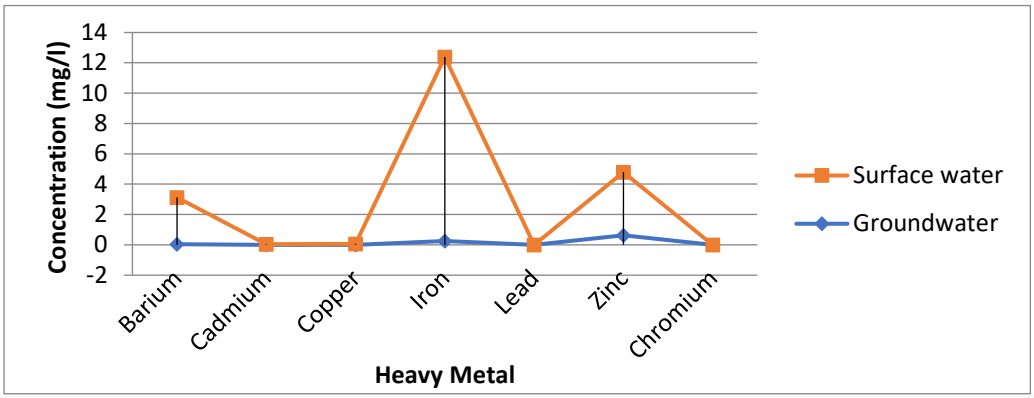


Figure 4.42: Mean heavy metals concentrations in water samples

above permissible limits in surface water samples. The equipment detection limits for the various heavy metals analyzed were as follows in mg/l: Arsenic = 0.001, Mercury = 0.0002, Selenium = 0.001, Lead = 0.01, Copper = 0.05, Chromium = 0.001, Cadmium = 0.002, Manganese = 0.10, Iron =<0.05 and Zinc = 0.05, some of them were detected in the samples, and were within the WHO/FMEnv permissible limits. limit. This implies that the measured parameters (heavy metals) were all within their respective WHO/FMEnv limit for groundwater.

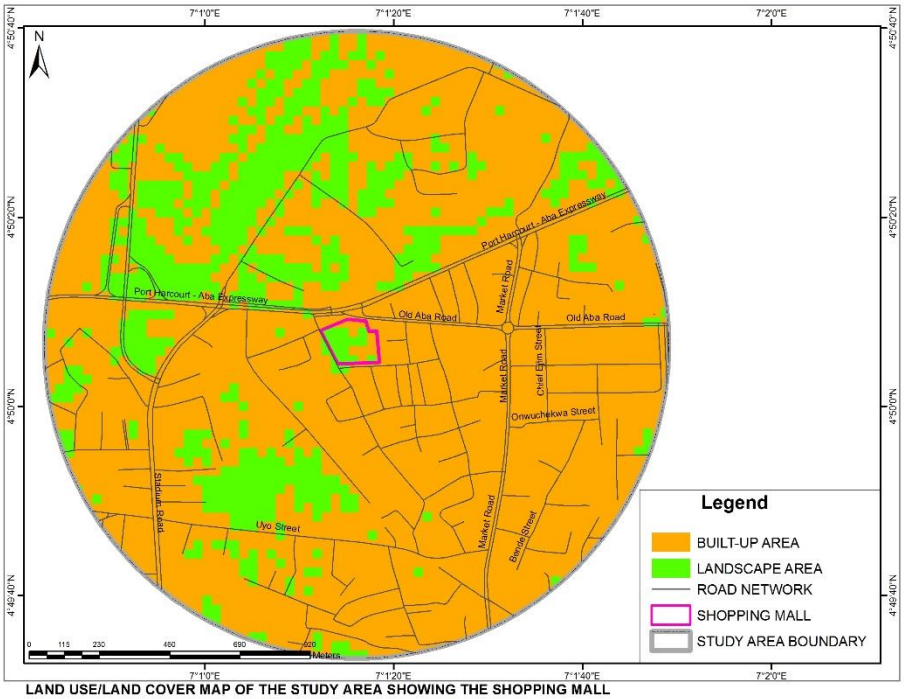
4.9.8.3 Water Microbiology

The coliform groups of organisms (total and faecal coliform) are the primary bacterial indicator used in determining the potability or otherwise of particular water quality should not contain any of all the coliform group of organisms. Ideally, drinking water should not contain any microorganisms known to be pathogenic and should also be free from bacteria indicative of pollution with excreta (faecal pollution). Pathogens and indicator organisms include *Faecal streptococci* (Enterococci) and *E. coli*. The detection of faecal (thermo tolerant) coliform organisms, in particular *Escherichia coli.* provides definite evidence of faecal pollution. Total plate count was used to determine the total microbial load and other suspended particles in the sampled water. It gives an aggregate of the total number of micro-organisms contained in a water sample. However, the presence of these organisms and other suspended particles might be objectionable to consumers. However, there was no microorganism isolated in groundwater samples

4.10 Land use

Land use within the study area is largely affected by large extent of human activities such as industrialization, municipal and agricultural activities. High municipal human activities, which is at its peak within the area has resulted to visible reduction in agricultural activity of the study area. The

notable land use within the study area included fuel stations, shopping mall, shopping plaza and road infrastructure network as shown in the Plate 4.2.



LAND USE/LAND COVER MAP OF THE STUDY AREA SHOWING THE SHOPPING MALL
Source: Landsat 8 USGS Imagery of Rivers State [30m by 30m Resolution]

Figure 4.43: Land use Map of the study area

4.11 Socio-economic Baseline

Socio-economic and community health impact assessment tools for this study were designed to integrate the desires and aspirations of the project host community with those of the project proponent. In line with the ESIA objectives, wide consultations were held, and the community's aspirations were also recorded. This socio-economic baseline survey conducted seeks to determine the socio-cultural, demographic, and quality of life of the population around the project site. Structured questionnaires, interviews, and group discussions were used primarily to obtain necessary information from households and other target groups. Other sources of information included similar studies, existing records in the local government, and other public institutions.

4.11.1 Scope of the Study

The study was conducted in Rumuomasi community in Obio/Akpor LGA of Rivers State. The study covered the socio-cultural resources of this community, demographic issues including population and growth, age and sex distribution, and adult literacy. Others were such indicators of the quality of life of the residents as the quality of housing, access to potable water, availability of functional infrastructural amenities, livelihood activities and patterns, and income levels. Health facilities and their patronage, disease prevalence and disease vectors, water and sanitation, and nutrition were also

studied. Additionally, the study discusses the perceptions, concerns, and expectations of members and residents of the study area.

4.11.2 Demographics

- **Population Size, age distribution, and Growth**

Rivers State is an *oil*-producing state of Nigeria, located in the region known as the South-South geo-political zone with a population of 5,198,716, making it the sixth-most populous state in the country.

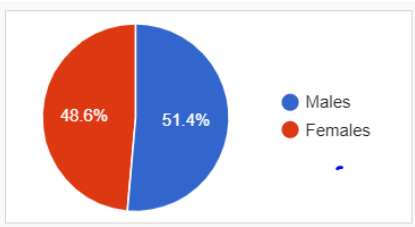
The Capital of Rivers State is Port Harcourt and it is also called Pitakwa. Port Harcourt is the largest city of *Rivers State*, *Nigeria*. It lies along the *Bonny River* and is located in the *Niger Delta*.

The area that became Port Harcourt in 1912 was part of Fishing settlements (fishing ports) also called Borokiri in Okrika language and the farmlands of the Diobu village group of the *Ikwerre*, an ethnic group in the larger *Igbo nation*. The *colonial administration of Nigeria* created the port to export coal from the collieries of *Enugu* located 243 kilometers (151 mi) north of Port Harcourt, to which it was linked by a railway called the Eastern Line, also built by the *British*.

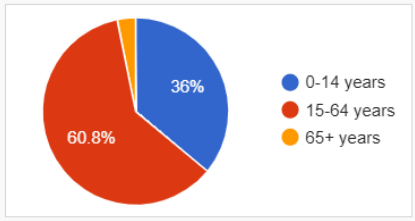
In 1956 *crude oil* was discovered in commercial quantities at *Oloibiri, an Ijaw settlement*, and Port Harcourt's economy turned to petroleum when the first shipment of Nigerian crude oil was exported through the city in 1958. Through the benefits of the *Nigerian petroleum industry*, Port Harcourt was further developed, with aspects of modernization such as *overpasses*, *city blocks*, taller and more substantial buildings. Oil firms that currently have offices in the city include *Royal Dutch Shell* and *Chevron*.

There are several institutions of tertiary education in Port Harcourt, mostly government-owned. These institutions include *Rivers State University*, *University of Port Harcourt*, Kenule Besor Wiwa Polytechnic, *Captain Elechi Amadi Polytechnic*, *Ignatius Ajuru University*, and *Rivers State College of Health Science and Technology*. The current mayor is *Victor Ihunwo*. Port Harcourt's primary airport is *Port Harcourt International Airport*, located on the outskirts of the city.

Obio/Akpor is a local government area is the project affected LGA and also in the metropolis of *Port Harcourt*, one of the major centres of economic activities in *Nigeria*, and one of the major cities of the *Niger Delta*, located in *Rivers State*. The local government area covers 260 km2 and at the 2006 Census held a population of 464,789. Its postal code or ZIP code is 500102. Obio/Akpor has its headquarters at *Rumuodomaya*. Obio/Akpor is bounded by *Port Harcourt (local government area)* to the south, *Oyigbo and Eleme* to the east, *Ikwerre and Etche* to the north, and *Emohua* to the west. It is located between latitudes 4°45'N and 4°60'N and longitudes 6°50'E and 8°00'E.



Gender (C 2006)	
Males	2,673,026
Females	2,525,690

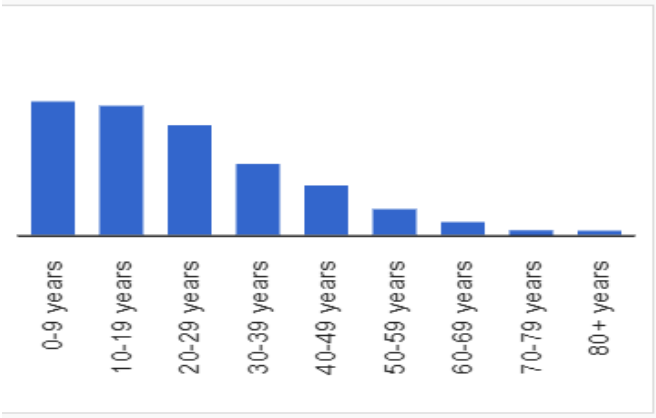


Age Groups (C 2006)	
0-14 years	1,871,982
15-64 years	3,160,996
65+ years	165,738

Figure 4.44: Population Structure of Rivers State (NPC: 2006)

Table 4.23: Projected population of the project affected LGA (using 2006 NPC population figure and 3.0% population growth)

Year	Obio/Akpor Local Government Area
2006	464,789
2007	478,732
2008	493,093
2009	507,885
2010	523,121
2011	538,814
2012	554,978
2013	571,627
2014	588,775
2015	606,438
2016	624,631
2017	643,369
2018	662,670
2019	682,550
2020	703,026



Age Distribution (C 2006)	
0-9 years	1,262,446
10-19 years	1,214,221
20-29 years	1,036,110
30-39 years	681,847
40-49 years	472,846
50-59 years	265,117
60-69 years	149,058
70-79 years	67,059
80+ years	50,012

Figure 4.45: Age Distribution of Rivers State (NPC: 2006)

Household Composition, Structure, and Size

The size of families differs from community to community, influenced in large measure by the cultural attitude of the people, the economy of the settlement, and educational status/awareness of the resident population amongst other factors. A total of 3,919,364 households were enumerated during the preparation of the Niger Delta Regional Master Plan Development with an average household size of 7.46, but with more than 70% of them having an average of 8 occupants. Large households were found more prevalent in rural areas (NDDC 2006).

The typical household unit in the study area has a head and several members. In many cases, the head is the father and members include his wife, children, and wards. The wards are often children of relations and, in some cases, friends. These are usually fed and generally catered for from the resources of the household. Members of the household are not necessarily related biologically. The household could also be composed of members who are not related but have agreed to live together under a common household head. This latter type of household group is not common in the study area.

From questionnaire responses, the mean household sizes obtained were 6.4 for the surveyed areas.

Dependency Ratio

The dependency ratio shows the proportion of the economically dependent segment of the population (children aged 0-14 years and the elderly, 65 years and above) to the economically active (those aged 15-64 years). It is an indication of the burden of providing for the dependent in the economy. It is assumed that the potential workforce (those aged 15-64 years) bear the economic burden of the dependent. The higher the dependency ratio, the lower the labor input per capita. In the project affected LGA, the dependency ratio obtained is about 0.8. The ratio obtained is indicative of a low economic burden and it implies that significant portions of the resources of the community

are not dedicated to the care of children and the elderly. Typically, this would mean less investment in the provision of education, health, social welfare, and other services required by these two groups.

- **Fertility, Mortality and Life Expectancy**

Groups interviewed during FGDs indicated that factors that enhance fertility among them include general acceptance of the marriage institution, relatively early sexual activity and marriage, and polygamy. Fertility is best measured by the Total Fertility Rate (TFR) which is an indication of the total number of children a woman is estimated to have in her reproductive lifetime. The existence of precise estimates of the TFR values for this LGA could not be ascertained and no values were available, but the National Bureau of Statistics (NBS) estimates the value for South-South geo-political region is 4.1 while the national average is 5.7 (Annual Abstract of Statistics, 2016).

These values of TFR show that the rate of fertility in the South-South states is lower than the national average. Another measure of fertility is the Crude Birth Rate (CBR) which the NBS estimates at about 37.37 per 1000 in Rivers State and 42 per 1000 as the national CBR. (The Nigerian Statistical Fact Sheets on Economic and Social Development, 2016). These rates indicate that, relatively, the region does not have high fertility.

Available mortality measures include the Neonatal Mortality Rate (NMR), Infant Mortality Rate (IMR), and Under Five Mortality Rate. The NMR, IMR, and Under Five Mortality Rate for the Niger Delta states are 53 per 1000, 120 per 1000, and 176 per 1000, respectively. The national averages are NMR 48 per 1000, IMR 100 per 1000 and Under Five Mortality Rate 201 per 1000 (Annual Abstract of Statistics, 2016). The NMR and IMR indicate that there are more deaths among neonates and infants in the Niger Delta states than what obtains generally in Nigeria. However, Under Five Mortality is lower in the Niger Delta region than the average in Nigeria.

Table 4.24: Under 5 Mortality and Maternal Mortality Ratio (MMR) per 100,000 in the various geopolitical zones of Nigeria

Geopolitical Zones	Number Under 5 Mortality per 1,000 children	Number Maternal Mortality Ratio (MMR) per 100,000 women
North West zone	269	1549
North East zone	260	1026
South West zone	176	286
South South zone	103	165

Source: UNICEF Child Malnutrition and Mortality in Nigeria Report, 2013

Life Expectancy estimates for Rivers State is the same as the national estimates. The World Health Organization (WHO) in its World Health Statistics 2016 estimated that life expectancy for men in Nigeria is 42 years and 47 years for women.

- **Educational characteristics of respondents**

Education is a key determinant of the lifestyle and societal status an individual enjoys. Studies have consistently shown that educational attainment has a strong effect on health behaviours and attitudes. Education in Nigeria has evolved over a long time, with a series of policy changes. As a result, there have been increases in the enrolment of children and the number of educational institutions both in the public and private sectors. The 1976 National Policy on UPE gives every child the right to free primary education. Later the 6-3-3-4 systems were introduced with 6 years for primary, 3 for junior secondary, another three years for senior, and 4 years for the university/polytechnic education respectively. Subsequently, the national literacy programme for adults was launched, followed by the establishment of nomadic education to address the needs of children of migrant cattle herders and fishing people in the riverine areas. With the inception of the present democratic dispensation in 1999, the Universal Basic Education (UBE) was again launched, making it compulsory for every child to be educated free up to the junior secondary school level.

A large proportion of the sampled population has received some formal educational training indicating a sufficiently literate society. Almost an equal proportion (38.9% and 42.7%) of the sampled population reported possessing tertiary and post-primary (secondary) educational qualifications. Some 14.5% have primary education, while approximately 3.5% have no formal education (NFE). The proportion of the educated population that indicated possessing some technical/vocational educational training amounted to 14%, indicating the availability of some employable skills in the project affected community.

A National Literacy Survey (2010) conducted by the National Bureau of Statistics in Nigeria estimates the adult literacy rate as 56.9 percent, with huge variations between states (Lagos 92.0 % and Borno only 14.5%), regions (urban 74.6 % and rural 48.7%,) and sex (male 65.1% and female 48.6%). More importantly, statistics from the Federal Ministry of Education indicate that only 500,000 of the 40 million adult illiterates are enrolled in adult learning classes. There are also 3.5 million nomadic school-

aged children with only 450,000 of them accessing any form of schooling. Nigeria is further saddled with the largest number of out-of-school-children estimated at over 7 million (10 percent of the global total). The Nigerian Government recognizes that literacy education will help equip individuals with the knowledge, skills, and attitudes needed for economic self-sufficiency, poverty reduction, and sustainable development, and is therefore making efforts to address the illiteracy challenge.

Rivers State has a higher literacy rate compared to most states in the South-South geopolitical zone. Its male literacy as of 2006 was 52.3% while the female literacy rate was 47.7%, putting the state above the national average.

Rivers State has been long recognized as an educationally advantaged State as was confirmed by the human development index (HDI) report of the UNDP (2006). The State's overall HDI of 0.615 was found highest in the Niger Delta and the educational index of 0.636 came second only after that of Akwa Ibom (UNDP 2006, The Guardian of September 2, 2006). Statistical estimates have put the proportion of children attending primary school in the Niger Delta region at 80 percent (which compares favourably with the estimated national average of 54 percent) (UNDP 2006). The adult literacy level of the population is 78.7%.

Table 4.25: Education-Current conditions in the Niger Delta states

STATE	Adult Literacy (%)	Attainment of Primary School (%)	Attainment of Secondary School (%)	Attainment of post-secondary education (%)	No. of Jobs in Sector 2000 (Teachers)
Abia	84.1	39.6	43.6	16.8	7276
Akwa Ibom	76.3	54.4	44.4	8.3	13,683
Bayelsa	78.7	38.8	49.3	11.9	3,515
Cross River	82.2	44.6	42.8	12.6	11,425
Delta	77.4	37.9	43.6	18.5	15720
Edo	69.7	49.3	38.8	11.9	10959
Imo	79.3	46.1	42.7	11.2	14,145
Ondo	78.8	45.0	44.2	10.8	12342
Rivers	79.9	33.3	49.5	17.1	4,011
The Region	78.7	43.3	43.2	13.5	95076

Source: Niger Delta Regional Development Master Plan (NDDC 2006)

Migration Trend

There were no existing records and actual figures on migration in the study area, however, it was possible to examine and determine the trend and pattern. Many residents indicated they were born in the community of their residence or had lived in them for more than ten years. Those who were born in or had lived in the community for more than ten years were considered non-migrant while those who had lived for less than ten years were considered migrants. The result shows that 80% of

respondents were non-migrant. This trend was not entirely unexpected given that the community is an urban area. However, there were also indications that some household members had relocated over the years for various reasons. The most common reasons for relocation were marriage, school, and work, and the most affected age groups were those between 10 and 44 years. Those who relocated went mostly to other cities in Nigeria, like Asaba, Onitsha, Kaduna, Abuja, and Lagos.

- **Language, Marriage, and Family**

The people of the study area are dominantly of Ikwerre extraction, natively known as Iwhuruọha ethnic extraction. They are considered a part of the larger Igbo ethnic group, although many Ikwerre does not consider themselves Igbo, a distinct ethnic nationality. They speak Ikwerre, an Igbo dialect, now considered a separate language in the Igboid family, as a result of the quest for Ikwerre's recognition as a separate ethnic nationality.

The Ikwerre exists in well-delineated clans, with each clan having its paramount king. The Ikwerre does not have an overall paramount ruler or king, but designated kings, rulers, or leaders are mostly approved by their constituents. However, all paramount rulers in Ikwerre are united in what is known as Ogbakor Ikwerre, which was formed in 1963 as an umbrella socio-cultural organization of the Ikwerre people

According to a theory of Ikwerre origin held by some Igbo scholars, they would be descendants from an Igbo migration from Awka and Orlu areas towards the south. Igbo scholars take the Ikwerre as part of the Southern Igbo. Amadi, an Ikwerre scholar, says that the Igbo origin theory has support even among the Ikwerre themselves, with Ikwerre as descendants of migration of Arochukwu Igbo, and Okpo Nwagidi being the leader of the Ikwerre tribe. Before the civil war, there had been dissident voices that claimed that Ikwerre could have migrated from Owerri, Ohaji, Ngwa, and Etche areas of Igboland.[14] But when Port Harcourt was conquered by Nigeria during the Biafran War and the Igbo people from other parts of Igboland fled the territory, a UN report says that the Ikwerre decided to claim that the Ikwerre were non-Igbo for convenience. The Ikwerre are recognized officially as a separate group in the 1979 Nigerian Constitution.

Recently, the Benin theory of origin has become more widely accepted among the Ikwerre. The Benin theory has so many versions. The first suggests that Ikwerre was the third son of Akalaka, the father of Ogba and Ekpeye who migrated from an area in the multiethnic Benin empire in the 15th century. It is said that Iwhuruohna, the progenitor of the Ikwerre, had seven sons which became the Ikwerre asa.

Another version holds that Akalaka migrated with Ochichi who settled at Elele and was the father of Elele, Isiokpo, Egbeda, and Omerelu. The Benin theory is rejected by many Ikwerre who believe that the Ikwerre did not migrate from Benin or descend from one progenitor. The Ikwerre is far larger than the Ogba and Ekpeye groups. The Akalaka legend originally mentioned the Ogba and Ekpeye as the only descendants of Akalaka but the inclusion of Ikwerre has gained ground as of recent time. Ikwerre people do not share any linguistic or cultural grounds with the Benin people.

The assumption of Benin's origin of Ikwerre could also be traced to the wars and raids of the Aboh kingdom on Ogba land, with the help of the Benin officers which triggered a migration of Ogba and Ekpeye people into what is today's Ikwerre land. These people met existing communities there. Rumuekpe, Ibaa, Ndele, and the Odegu clan are communities that could have possibly be founded by this migration. A section of the Obio clan is said to have migrated from the Aboh (Ukwuani) area of Delta state which was under the influence of the Benin Empire in the 16th century.

The Aro first came into the Ikwerre area through Ozuzu-Etche, settling at Isiokpo, Igwuruta, Omagwa, etc. As expected of pre-literate African societies, the history of the people is wrapped in myth and mystery. This presupposes that historians may have to resort to oral tradition for the justifiable/credible reconstruction of the people's history. From the post-colonial dispensation to the present, professional historians and other personals have attempted to reconstruct the history of the people. For instance, the works of Elechi Amadi, especially The Concubine, The Great Ponds, The Slave (novels), and Isiburu (a verse play) are a literary attempt at reconstructing a semblance of the Ikwerre society in the pre-colonial era.

In the absence of valid historical records, historians accept oral tradition as a primary source of writing African history, the defects associated with this method notwithstanding. The history of the origin of the people is traceable to the waves of migrations from the lower Niger and delta regions.

Ikwerre people are found in the Niger Delta region of Nigeria. They are within the rainforest belt which receives high annual rainfall. Some parts are blessed with creeks that crisscross Rivers State. There is also abundant raffia forest. These features, coupled with adequate sunshine, have made the soil in Ikwerre adequate for the cultivation of palm produce, cassava, yams, vegetables, etc. and the distillation of palm wine into gin (kai kai, ogogoro, akamere, manya beknu).

The Riverine Ikwerre villagers engage in fishing in addition to the general occupations of farming and trading. The marriage institution is accepted and revered in the study area. Marriages are contracted between adult males and adult females; there are no accounts of either same-sex or juvenile marriages. Monogamy and polygamy are practiced but local sources say that polygamy is on the decline. Traditional Marriage in Ikwerre is highly revered just like every other ethnic group in Nigeria. It involves the man going for a formal introduction called “Door Knocking.” This is done by the groom who takes a few elders of his family to the girl’s family for the introduction. Palm wine and dry gin (okamme) are brought as gifts by the man during the introduction.

The traditional marriage which follows is always elaborate and the traditional attires are elegant. Men adorn a loose-end wrapper on top of etibo (flowing shirt) with a hat to match. Hand staff/walking stick completes the men’s attire while the females adorn wrapper with some traditional top. Beads are an essential part of the females’ dressing. It is worn on the head, neck, and wrists. There are no known marriage restrictions based on religion or culture in the study area.

Festival wrestling is an important part of people’s culture. During the wrestling competition, different types of drums are used, such as Ikwiriku, Ekwenkalu, Ngele, Mbamba, which are of different types, shapes, and sizes. The wrestling competition aims to throw down the opponent. Whoever does this, wins. If they are unable to throw each other, they are said to have equalized (Ogba-oga). Wrestling is

one of the most celebrated cultures of the Ikwerre people, especially in the Elimgbu community of Obio/Akpor Local Government Area of Rivers State of Nigeria. Wrestling is dialectically known as " Egelege " both in Elimgbu and Otah and other parts of the Ikwerre communities. It is one of the physical calisthenics that tends to foster unity amongst the people. The idea is to situate the (Egelege) wrestling contest as a typical traditional theatre.

Other cultural activities include the Eregbu cultural dance, Ekpo, and Ekpe masquerades are also important features of their tradition. The Ikwerres also have a lot of cuisines such as oha soup, okpotoro and okasi soup, vegetable soup, periwinkle soup, and others. Periwinkles (isam) are important parts of their dishes.

The family is recognized as a very important social unit and both nuclear and extended families exist in the community. The typical nuclear family is headed by the father, with the mother and children. The extended family includes members who are not biological offspring of the same parents but relations. A nuclear family where the father was dead could be headed by the mother if the children are juveniles or by the eldest son if he is a grown man and able to bear the financial responsibility of taking care of the family. The extended family is always headed by a male member.

Considering that the community is used to non-indigenous residents, members can communicate in Pidgin English and the community in some way have an accommodating social attitude. This attitude could be valuable for the proposed project, given that itinerant workers and camp followers would be attracted to the community and this kind of social attitude would foster healthy cross-cultural exchanges. This can also help in some way to limit conflicts that arise when people of different cultural backgrounds live together, thereby reducing the potentials for tension and social upheavals during the project.

- **Social Structure and Organization**

Membership of socio-cultural groups (CDCs, women's groups, youth groups, CBOs, cultural groups, and social welfare groups) by household members is quite common. The roles played by these groups are distinct and significant. A group like the Community Development Committee (CDC) is set up purely to perform local administrative roles and also to liaise between the community and all external bodies, and other communities. Similarly, a lot of the social clubs and CBOs actively participate in improving the welfare conditions of their members. The cultural groups mainly performed at cultural festivals, thereby ensuring the preservation of their cultural heritage.

Apart from these socio-cultural groups, the community is also made up of compounds. This structure that incorporates compounds allows the compounds some level of autonomy in their daily administration. The compounds are made up of extended families and their affairs are directly overseen by their appointed chiefs.

- **Traditional Governance**

The traditional structure comprises the traditional ruler assisted by chiefs and Community Development Committee (CDC) executives with youth and women groups.

The traditional heads are elected from eligible males. Eligibility is determined by age (minimum of 30 years) and standing/integrity. Occupants hold office for life except where they are deposed by the community or the government. They could be deposed by the community or government if they are believed to be working against the community's interest if they committed a heinous crime or became incapacitated by ill health. The Chiefs are appointed by their respective compounds to oversee the affairs of the compounds and represent them in community matters. They also have the role of advising the traditional heads. Chiefs are also all adult males and they remained in office for life, except removed by the compound. Each council of chiefs has a Chairman.

The CDC is headed by a Chairman and assisted by a Secretary in the day to day running of the committee. They are often referred to as community Chairman and Secretary. Membership of the CDC executive is by election among adult males from the compounds. Members of the CDC serve a fixed term of four years. The CDC is the administrative organ that has responsibility for the day-to-day running of the community, liaison with external bodies and agencies, and development planning. They report directly to the traditional head. Other groups that make up the traditional administrative structure include the women and youth and both report to the CDC. Both are also headed by executive committees which include the President, Vice President, Secretary, among others. The executive committees are elected. The youth executives serve for one or two years, the women leaders usually do not have a fixed term in office. All adult female members of each community are eligible for membership in the women's group in the study area. Membership of the youth groups is similarly open to adult community members of both sexes who are between 18 and 40 years.

The roles of these organs of society are clearly defined and there were no indications of role conflicts. These organs could play significant roles in information dissemination and community mobilization before, during, and after the proposed project.

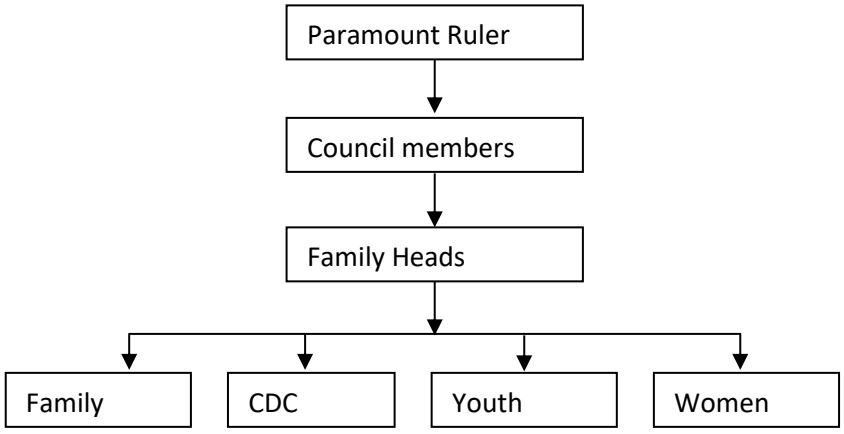


Figure 4.46: Hierarchy of Leadership/Governance in the Study Area

Roles of Women and Youth in Community Development

The women and youth groups play important roles in the community and serve to bring their members together as well as intervene in their welfare. The women's primary role is to advise the CDC and the council of Chiefs on matters concerning women in the study area. During the survey, it was noted that culturally women could not, lead the community, head the key organs of traditional administration, seat, or participate with the men in making community decisions. They had their separate meetings and their decisions were transmitted to the CDC and traditional councils. This cultural inhibition is a clear indication of gender inequality in the study area. Gender inequality across Rivers State was captured by the use of the Gender Empowerment Measure (GEM) which is an indicator of the opportunities women have in any socio-economic environment. GEM measures gender inequality in the three areas of political participation, economic participation, and control of economic resources. The GEM value for Rivers State is quite low at 0.25, higher than the Niger Delta regional average of 0.22, but at par with the national average (Delta Facts, 2016).

The youth, on the other hand, has become a strong force in the community. Their roles include ensuring internal and external security, enforcing law and order, and development planning. Youth leadership, especially the President and Secretary are regularly invited to community meetings with the traditional councils and CDC, where decisions about development and security are taken. They are also responsible (with the CDC) for liaison with companies and other organizations that have any business in the area.

Lifestyle and Social Indulgent Practices

Lifestyle and practices raised and discussed during FGDs and interviews included, drinking alcohol, cigarette smoking, and the use of hard drugs, prostitution, teenage pregnancy, and child labor. Residents confirmed that the use of spirits and alcoholic beverages is quite rampant among them. Most residents, of both genders, had been drinking since their teenage and several since they were children. The local gin 'kai-kai' which is most popular is brewed in the area, and therefore, is quite readily available. Cigarette smoking is also quite common among teenage and adult males. Most residents also believe that some of the youth smoke hemp.

Teenage pregnancies, on the other hand, are experienced quite commonly in the community. Child labour, another of the social vices, is not common. Children usually assist their parents in running their shops. This type of work does not attract any salaries or wages.

Respondents expressed fears that the proposed project would further encourage some of these vices if construction workers and camp followers take up residence among them. Drinking, smoking, use of hard drugs, teenage pregnancies, and prostitution were particularly mentioned by respondents.

Belief Systems and Practices

Rivers State, with its diverse ethnic and linguistic groups, is also very rich in culture and the arts. Several cultural bonds exist among ethnic groups, particularly in music, dances, plays, and masquerades which are very dependent on socio-cultural and religious backgrounds.

Christianity with long historical origin is predominant among the Delta Igbos, herein includes the Ikwerre ethnic group as in other parts of Rivers State, although there are strong influences from traditional religious beliefs. It is safer to say that the religious persuasions of the majority of the population are " '' mixed''. For the practicing Christians, religious houses, i.e., churches of various denominations and sects of Christendom abound in the area, including those of the orthodox and Pentecostal denominations, dominated by the Pentecostal Church with gigantic structures as is seen in almost all the streets of the study area.

The most cultural heritage of the people remains their festivals, which are tied to their way of life and livelihood, i.e. the seasons. Culturally, therefore, the subsisting festivals relate to either the fertility of the land and waters or the blessings of the ''gods''. Their celebrations, therefore, coincide mostly with the beginning of the farming/planting and harvest seasons. As a Christian community, Easter and Christmas celebrations are part of their cultural heritage. There is a wide variety but the same commonality of festivals still celebrated by the PACs, with marked periods of celebrations and some, have serious strictures attached to them. These annual festivals are considered important for warding off evil, promoting fertility in marriages, and profitable enterprise with farming and other activities. The reality on the ground, however, is that traditional worship is rooted in the culture of the community and even acclaimed Christians participate in the festivals at different levels of commitment.

Other belief systems revolve around the communal social life of the inhabitants in the affected community. Social maladies such as incest, adultery, stealing fighting with cutlass, bottles, or guns and in the bush or mating with a woman in the bush are amongst the customs and beliefs, which are seriously frowned at. Violators are dealt with by either being physically beaten up and subjected to some punishment or asked to pay some fine, including the appeasement of the offended deity and/or ancestors.

FGDs revealed that 93% of the people are adherents to the Christian faith, while 5% and 2% are traditional worshippers and Muslims respectively.

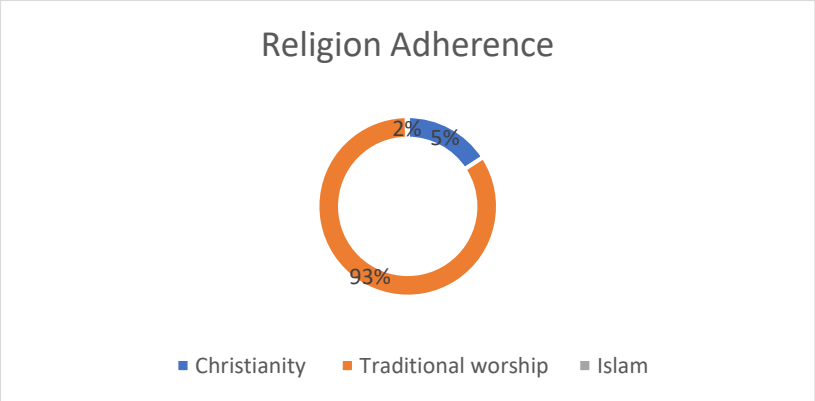


Figure 4.47: Religion adherence in the study area.

There are no communal restrictions on religious beliefs and worship. Residents are at liberty to pursue their religious beliefs and interests. The study area has a shrine call Uhuile. Uhuile means the face of the land and it is the only surviving shrine in the area. The shrine looks abandoned and gradually becoming a dumpsite.

Plate 4.3: Uhuile shrine in Rumuomasi community

- **Conflict Management and Security**

Throughout the world, dispute is a common phenomenon in human relations. Covertly or overtly, humans tend vested interest. Therefore, at any point one individual or group crosses the prescribed or perceived boundaries of the accepted cordial relationship, dispute ensues. Without overstating the obvious, the concept of dispute resolution is predicated on the assumption that an equitable society can only be brought about by an equitable decision. Conflict is one of the inevitable phenomena of every human society. However, what exemplifies the greatness or quality of life in any society is how much society can administer their affairs.

The study area is part of the Niger Delta region which has experienced several conflicts with violent outcomes. In particular, there was the issue of militancy in the region. The conflicts that gave rise to militancy involved the youth more than any other group. Many of them have become violence-prone and even social misfits. The youth will be a group to watch and also dialogue within the course of the proposed Shopping Mall construction project in the area.

Conflicts do not always have violent outcomes; in fact, many conflict situations are resolved daily. In the study area, such non-violent conflicts also arise and there are traditional ways of resolving them. The community has various organs of society traditionally involved in resolving conflicts. These organs include the social organizations to which household members belong to, like the women organizations, the compound chiefs, and the CDC. However, at the apex of the traditional conflict resolution process in the community is the traditional leadership. Their decisions on intra communal conflict issues are usually binding on all parties.

Family crises are first reported to the most elderly person in the family who settles them, but should he fail to achieve the needed peace, the case is referred to the members of the traditional council. The traditional council invites all the parties involved, listens to them, and passes judgment. People found guilty are punished with penalties ranging from payment of fine and public apology, depending on the gravity of the crime committed. Formal law enforcement agencies are rarely contacted to adjudicate on contentious communal issues. They are only called in when traditional conflict resolution mechanisms do not achieve desired effects.

4.11.3 Quality of Life

- **Settlement Pattern and Housing Conditions**

In general, the study area is relatively large to medium-sized. Going by NPC's definition of a town as a settlement with a population of 20,000 or more, the study area is qualified as a town.

The community has the characteristics of both linear and nuclear settlements. The linear characteristics derive from the concentration of houses along the main streets and lanes in the area. The nuclear characteristics derive from the clustering of houses. Houses are built in clusters which in some cases may identify family lineages and kindred groups. Development and limited access to land have generally encouraged this clustering of houses. Spacing between houses is not definite and could range from one or two meters to about six meters.

The houses are quite diverse in their design and construction materials. Some houses have modern designs and they are built with utilities like kitchen, toilet, and bath, in-house. These modern houses are also constructed with stable and permanent materials like cement blocks and roofed with corrugated iron and aluminium sheets. A majority of the houses in the area are family bungalows, tenement (rooming) houses, and duplexes. Housing attributes in the study area is presented in Table 4.26.

Plate 4.4: Housing types in the study area

Table 4.26 Housing Attributes in Rumuomasi

Housing Attributes	%
Type of House	
Family bungalow	27.0
Tenement house	30.0
Storey building	39.0
Flats	4.0
	100.0
Construction Material (Roofing)	
Thatch	0.0
Corrugated iron sheets (zinc)	15.0
Asbestos	5.0
Aluminium	80.0
	100.0
Waste Disposal (Refuse)	
Dumping in open space	15.0
Dumping in the bush	85.0
	100.0
Waste Disposal (Sewage)	
Water closet	77.0
Pier Toilet	23.0
	100.0
Sources of Water for Domestic Use	
River/Creek	0.0
Rain	3.0
Borehole	97.0
	100.0
Energy Source for Household Cooking	
Firewood	2.0
Kerosene	43.0
Cooking gas	55
	100.0
Energy Source for Household Lighting	
Kerosene	45.0
Public electricity	25.0
Private electricity generator	30.0
	100.0

Source: Resourcefield fieldwork, 2020

Livelihood Activities

The identified activities are mainly commerce and provision of services like petty trading, artisanship practices, and employment in the civil/public services. The largest proportion of household members in the community are engaged in trading. Artisanship practices inclusive of electrical repairs, tailoring, etc are significant in the study area. Civil/public service employees in the community are limited mostly to Local Government workers, teachers, and health workers. Others are inclusive of a few residents who are employed in oil companies and those involved in contracting.

There are small household-based shops for the sale of groceries, and supermarkets, where durable and non-durable consumer items are sold and bought. Consumer services like barbing and hairdressing salons, motor vehicle and bicycle repairing, laundries, etc, are also present in the area. Many restaurants cater to the needs of the area. Small grocery stores are a ubiquitous feature of the main streets of the area.

Employment Situation in Households

Unemployment was experienced in several households in the community. Results obtained from the discussion and interview sessions indicated that 72% of households across the community had one or two unemployed members. Unemployment was determined as being ready and looking for work but unable to secure one in the last 6 months preceding this study and only household members who were 15-64 years and not full-time students were considered.

Household Expenditure Patterns

The major items of expenditure in the households are food, health care, purchase of household items including utilities (kerosene, petrol, etc), transportation, and clothing.

Table 4.27: Items of expenditure

Items of expenditure	Percentages
Clothing	10%
Transportation	12%
Health	18%
Household Items	20%
Food	40%

Source: Resourcefield surveyfieldwork, 2020

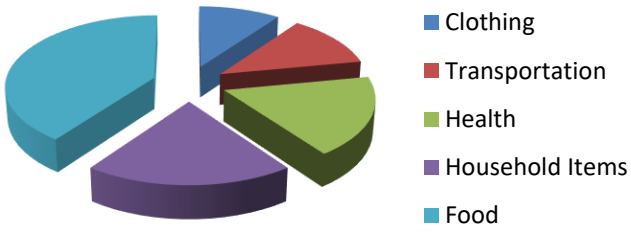


Figure 4.48: Household Expenditure Pattern

The major food items are mainly those that are not grown locally, beef, and also beverages. Expenditure on health care by households is quite significant because most households take their sick members to expensive hospitals to access functional orthodox health care facilities. Apart from these household members also spend considerable sums of money on drug purchases from drug stores ('chemists') in the study area.

Households also spend considerably on the purchase of kerosene for their lanterns and cooking stoves, and petrol for their private electricity generators. Expenditure on food and health accounts for 58% of total household expenditure. Community sources across the study area generally affirmed that for most households, expenditure on food, accessing higher education services, obtaining health care, purchase of household items, transportation and clothing account for between 70% and 80% respectively of their monthly earnings.

- **Health Facilities and Services**

The study area has both orthodox and non-orthodox health care providers and facilities. Distribution of these facilities and services including the status of general basic infrastructures across the study area is presented in Table 4.30.

The General Hospital in the area provides first aid, serves as an HIV/AIDS counseling center and treatment for other ailments, as well as immunization services for children and women of childbearing age. The antigens they give include BCG, OPV, DPT, Measles, TT, YF, and HBV.

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

In all the study area, there are Traditional Birth Attendants and those who provide herbal remedies. In most cases, these groups do not offer their services on a full-time basis. Those who practice treatment with herbs, in particular, offer advice on herbs and roots within the environment which they believe bring relief to certain ailments.

Table 4.30: State of Infrastructural Facilities in the Study Area

Community	Infrastructural Facilities							
	Roads	**Telecoms**	**Water**	**Education**	**Health**	**Electricity**	**Market**	**Police**
Rumuomasi	Connected to Port Harcourt Metropolis by a good asphalt road network with paved streets and lanes	GSM services by all major service providers.	Borehole	1 public primary school; 1 public secondary school. Over 20 private primary and secondary schools	General Hospital, PHC, and multiple private clinics	Connected to PHEDC	Rumuomasi daily community market	Police outpost

Source: Resourcefield fieldwork, 2020

Utilization of Health Services

The patronage of available orthodox and non-orthodox health care service providers in the study area is presented in Table 4.31.

Table 4.31: Patronage of Health Services in the Study area

Available Health Care Service Providers	Frequency (%)
Hospitals/Health Centres	32.0
Chemists/Drug Stores	48.0
Herbalists/Traditional Medicine Practitioners	7.5
Churches/Spiritual Healing Homes	12.5
Total	100.0

Source: Resourcefield Fieldwork, 2020

Traditional Birth Attendants (TBAs) are very popular with women of childbearing age. The staff of the Primary Health Centre in the Rumuomasi community noted that even when some of the women attend an antenatal clinic in the orthodox facility, they prefer to give birth with TBAs, and they attribute this to the preference for the traditional body massage given by TBAs after child delivery. The utilization rate of the PHC is relatively low at 32% by respondents. The services of herbalists and spiritual healing homes are not common among the residents of the community. Given these conditions and the level of patronage of drug stores, it is possible to deduce that many residents indulge in self-medication.

Water and Sanitation

The sources of water used in households in the study area include water from rainwater, well and water from public and private boreholes. In the surveyed area many households avoid the use of rainwater as a result of their belief that rainwater is being polluted by gaseous emissions from flares from oil and gas activities in and around their community. For this reason, also, the use of rainwater is mostly limited to the washing of clothes and other things and not for cooking.

Waste Management Practices

Refuse is, unfortunately, mostly deposited by the roadside and medians by households, for eventual collection and disposal by Rivers State Waste Management Agency. Similarly, two methods of sewage disposal practices are the use of pier system toilets and water closet toilets. About 91% of households in the study community dump their refuse in open space awaiting the government to evacuate, while 32% use the pit toilets.

There are six designated solid waste dumpsites as shown in Figure 4.4948(a) and Table 4.32 (a). The compactors and trucks that collect the wastes from the various points in the city dump them in any of these sites.

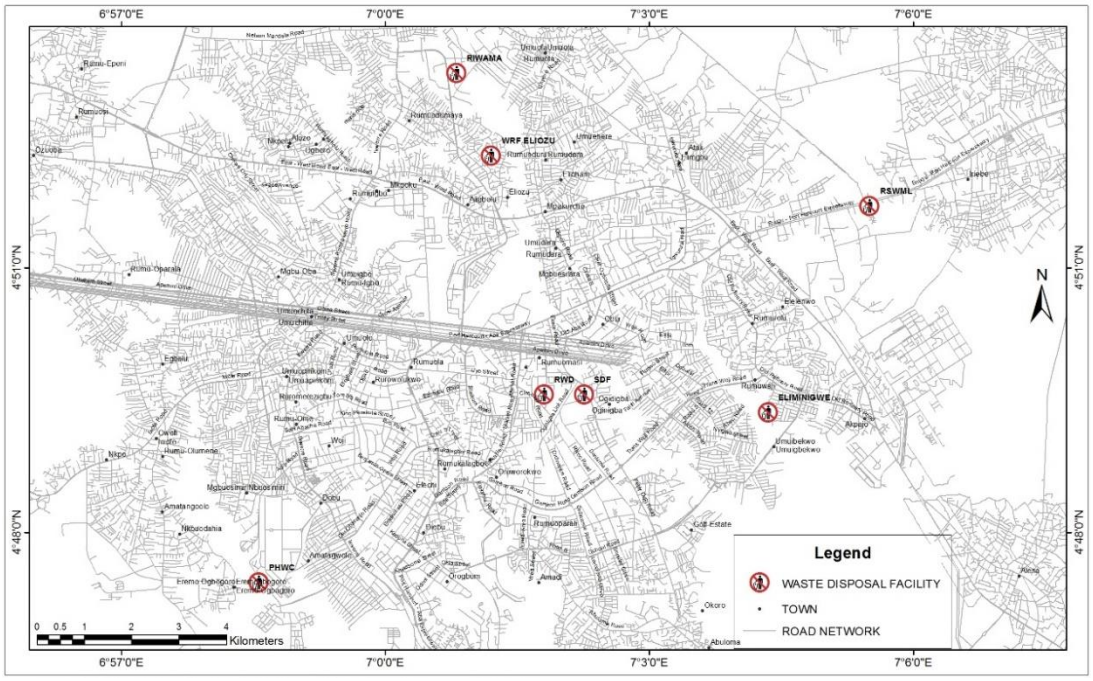


Figure 4.49(a): Six Designated Solid Waste Dumpsites in Port Harcourt

Table 4.32(a): Seven Designated Solid Waste Dumpsites in Port Harcourt

S/N	Name	Location description
1	Rivers State waste management landfill (RSWML)	Obigbo by Enugu –PH expressway
2	RIWAMA refuse dumpsite	Allu
3	RWD	Rumuomasi, PH
4	Waste Receptacle facility (WRF), Eliozu	Off new Airport Road, Aligbolu, PH
5	Rivers State sewage management facility (PHWC wastewater treatment plant)	Eagle Island, PH
6	SDF	184C Trans-Amadi layout road, Trans-Amadi, PH.
7	Eliminigwe Phase 2, Waterside	Rumuwaji, PH

Plate 4.5: Existing Waste Disposal Practices in the area

a&b - - Indiscriminate waste dumping on the median;

c- Designated waste collection facility on East-West Road.

D - Waste collection and disposal compactors delivering waste at RIWAMA refuse dumpsite, Aluu).

The common refuse and sewage disposal practices in the study area are not modern, hygienic, or safe. Considering the terrain of the community, most of these wastes eventually end up in the water bodies around the area or are carried downstream and deposited in other communities. Although those that are easily biodegradable (including sewage), decompose and also provide nutrients for plants and fishes, they are still sources of pollution and constitute a health hazard. Those that are not easily degradable (especially metals and plastics) are always visible and obvious pollutants and litter around the environment.

- **Nutrition**

The average household in the study area can provide two meals daily for its members. The meals consist predominantly of carbohydrate and protein. Commonly available sources of protein are fish and seafood, especially periwinkles, oysters, prawns, and crayfish. These proteins are always available in the soups with which garri (the staple and most common food) is eaten. Other foods eaten include yam, rice, cocoa yam, sweet potato, and beans. Although during interviews several residents complained about the nutritional value of the meals, they can provide for their households, medical records from the visited health centers did not collaborate that malnutrition was a common ailment in the community.

- **Prevalent Diseases and Disease Vectors**

Interviews in households and with health workers in the proposed project community revealed that the most frequently reported diseases are malaria, diarrhoeal diseases, and respiratory tract infections (RTI).

Disease vectors identified in the area are presented in Table 4.33. The commonest is the mosquito which transmits Plasmodium which causes malaria in humans. Others are house flies and rodents. The environment around the project community provides the necessary breeding grounds for these disease vectors.

Table 4.33: Common Disease Vectors in the Study Area

Disease Vector(s)	Common Habitat	Parasite(s) Transmitted and Disease(s) Caused
Mosquito (Anopheles and Culex).	Stagnant water	Plasmodium causes malaria.
Housefly and Latrine fly (Musca domestica and Fannia canicularis).	Toilets, refuse heaps, and dumps	Diarrhoeal diseases.
Tsetse fly (Glossina sp).	Toilets, refuse heaps, and dumps	Trypanosoma causes sleeping sickness.
Rats	A variety of places including houses drains, Toilets, refuse heaps, and dumps	A variety of diseases including laser fever, although there was no report of laser fever in the period before and after the study.

Source: Resourcefield fieldwork, 2020

- **HIV/AIDS Prevalence and Awareness**

Sub-Saharan Africa is one of the hardest-hit regions by the HIV/AIDS pandemic. Presently, it is hosting about 24.5 million people living with the virus. The medico-social consequences of this high HIV/AIDS prevalence in the region cannot be overemphasized. It has contributed to high orphan rates, high numbers of HIV positive infants, high rates of opportunistic infections, high school drop-out rates, societal discrimination, and stigmatization. Nigeria with over 160million people is the most populous country in Africa and ranked fourth-worst affected by HIV/AIDS in the world based on the total number of cases reported (NACA, 2011). The HIV prevalence in Nigeria indicates a fluctuating trend from 1.8% in 1991 to 5.8% in 2001, before a decline to 5% in 2003 to 4.4% in 2005, 4.6%, and 4.1 as at 2010 end. (NACA, 2011).

There is a low prevalence of HIV/AIDS among the population. According to the national sentinel study on HIV/AIDs (2011), Rivers state where the project is situated has a prevalence of 4.1-6.0%. This figure is not too far from the national average (4.4%) and corresponds to the lower tier of prevalence in Nigeria. It is noted however that a good amount of awareness education and advocacy on the disease and its prevention is ongoing and from interviews, these are beginning to yield the desired results.

The federal and state governments spend billions of naira yearly to create awareness on the grave negative effects of the scourge. This awareness seems to be yielding positive results in the area as over 99% of the respondents claim to know about HIV/AIDS and its means of transmission and prevention. Collaborating this, drug vendors locally referred to as chemists in the area said there is an increase in the number of condoms sold daily. However, the FGD revealed that a quarter of respondents acknowledged that they often had unsafe sex with high-risk partners.

- **Knowledge, Practices, and Behaviour on Sexually Transmitted Infections (STIs) and General Health**

Previously called venereal diseases (VDs), sexually transmitted infections (STIs) or Sexually Transmitted Diseases (STDs) are diseases primarily transmitted by sexual contact. They can be classified according to the causative agents (bacteria, viruses, chlamydia, parasites, fungi). Its incidence is increasing globally with both poor socio-economic and socio-cultural factors playing significant roles besides other factors such as industrialization and urbanization, labour migration, ignorance, and contraception.

Table 4.33 shows unmarried respondents engaged in sexual activity. From this table, 25.7% had a sexual relationship with persons they were not married to, while 74.3% did not.

Table 4.33 Extra-Marital Partners

Extra-Marital Partners		**Total**
Yes	No	
25.7%	74.3%	100.0

Source: Resourcefield survey, 2020

Table 4.34 Awareness of Sexually Transmitted Infections (STIs)

Awareness of Sexually Transmitted Infections		**Total**
Yes	No	
100.0	0.0	100.0

Source: Resourcefield survey, 2020

- **Physically and Mentally Challenged Persons**

Some surveyed households (1%) in the area have cases of physically/mentally challenged individuals, the majority of whom do not attend schools. No government or non-governmental organization (NGO) assistance has ever been offered to them, and their families/kindred who do not have enough to cater for them. This group of persons is however not discriminated against since they are familiar faces who reside with their kith and kin who largely understand them. They are however cautioned and restricted when they get out of hand occasionally.

- **Commercial Sex Trade**

Questionnaire analysis, FGD, and informal interaction in the area revealed that commercial sex trade is practiced. Without a doubt, the trade would boom especially during the construction phase of the project given that the workforce is usually predominantly male who work away from home and their women.

- **Land Ownership and Tenure**

Land in the project community is primarily owned by families. Ownership rights over lands are handed down from one generation to another within the extended family. Such inherited land is put to any use as desired by the owner(s). These are the lands on which family members build their houses and are allocated for businesses. Land could be bought from owners who were willing to sell. Apart from the family, individuals and organizations also owned some land.

Any intentions to obtain land for corporate or industrial use are initiated through the CDC and various councils of chiefs which are in the best position to offer proper guidance concerning ownership. This condition is important whether the required land is owned by family, individuals, and organizations. This approach to obtaining land helps avoid intra/ inter-communal conflicts over ownership of any land that may be required for any project.

4.11.4 Infrastructural Base

- **Classification of Infrastructure**

Infrastructure is classified as physical, social, and institutional. Physical forms include; transportation facilities (roads, railways, bridges, ferry services, canals, and foot-paths); storage facilities (silos), warehouses, cribs, open-air facilities, etc); processing facilities (machinery, equipment, building, etc.); irrigation, flood control, and water resources development facilities; and soil conservation facilities.

Social infrastructure comprises housing, leisure and recreational facilities, health facilities (hospitals, dispensaries, maternities, and health centers, etc); educational facilities (primary schools, teacher training colleges, secondary schools, technical schools, vocational schools, adult educational facilities, etc); and utilities (electricity, water supply, sanitation facilities, etc.). The main components of the institutional infrastructure are co-operative societies; farmer's unions/groups, community development projects, financial institutions; agricultural extension, research and training facilities; and post and telecommunications facilities (post offices, postal agencies, telephones, etc.).

Available Infrastructure and Their Functional Status

Public access to the project affected community is by roads. The project area has paved internal link streets and lanes. Additionally, telecommunication services from GSM service providers are received in all parts of the community.

Education facilities in the LGA consist mainly of public primary, junior and senior secondary schools and an array of private schools. The infrastructures in many of the schools are inadequate. The students' desks and chairs are broken and insufficient, classrooms are also insufficient, and some of their ceilings, windows, doors, and floors are broken. Most of the schools do not have decent utilities like toilets and they also do not have equipped libraries and laboratories. The student to teacher ratio in the public primary schools is high, as much as 50:1. Teachers in secondary schools are not enough to cover all the subject areas, and subjects like Mathematics, Physics, Introductory Technology, Agricultural Science, English Language, and Home Economics are often taught by teachers who did not study these core subjects in the universities.

The cumulative effect of these inadequacies is a lack of interest in schooling among many children in the area despite the free education policy of the state government. Parents who are interested in their children being properly educated and who can afford the cost send their children and wards to private schools in the area. Local sources estimate that 2% to 3% of children of school age are not in school because of truancy or have dropped out.

There is generally a dearth of functional orthodox health facilities in the entire study area. The basic problems of government hospitals and PHC are inadequate staffing, broken down and unmaintained equipment, and lack of drugs. The situation is such that households generally do not have confidence in them and would rather 'consult' drug stores or take their members requiring medical attention to a private hospital.

Public water and electrification are very much dysfunctional in the community. Several water boreholes have been constructed in the community but most of them are not working largely because the water produced is deemed unfit for consumption by community residents, usually because of colouration. Similarly, electricity in the area is generally characterized by a frequent blackout and poor voltage.

In terms of trading opportunities, the surveyed community can boast of small, functional but poorly infrastructures a makeshift marketing facility that deals with foodstuff basically from which the people may procure their essential needs and daily community market.

Plate 4.6: Private primary and secondary schools in the area

Vulnerable Groups

Some groups in the community have been identified as potentially vulnerable to the likely impacts of the proposed project. Their vulnerability derives from several different factors, including the inability to cope with certain envisaged changes in the society and economy. A key vulnerable group is adolescent youths. Within this group, it is also possible to differentiate between the adolescent male and the adolescent female. For the male adolescent, there is a tendency to abscond or drop out of school to seek casual employment at the project site. This temptation to drop out of school is re-enforced by the state of educational institutions, particularly the poor staffing which makes schooling uninteresting. The adolescent male will be faced with a situation of giving in to peer pressure and groups that encourage truancy and school dropout if these groups come into the community as itinerant workers or camp followers.

The teenage girl on the other hand is faced with managing her sexuality in an environment where there will be considerable exposure to sexual excesses and the continuous advances by older and more experienced working-class males whose income would be an effective instrument to lure the girls. Again, with this group, there will be the likelihood of school dropout and teenage pregnancy. Teenage pregnancy had in some societies led to the stigmatization of the girls. Many of the teenage mothers may not be able to return to complete their schooling or embark on any academic pursuits, even after they would have given birth to their babies.

Another vulnerable group is the elderly. In any economy, the elderly usually requires special attention which includes health care and welfare, but the required facilities for the provision of these social services are not available across the study community.

Additionally, widows and single mothers will have an uphill task providing for their households in an environment where there are construction workers who earn salaries higher than what generally obtains in the community.

Socio-economic Indices Interrelationships

Socio-economic baseline situations in the community have significant multispectral links. In Table 4.35, key socio-economic conditions, their sectoral links, and implications, as identified in the study, are summarized.

Table 4.35: Socio-Economic and Health Indices Linkages

Key Environmental Factors.	Associated Sectors and Conditions.	Socio-economic and Health Outcome.	Required Intervention.	Monitoring Indicators.
Poor Infrastructural Framework.	Water-lack/limited access to safe potable water. Education-lack of facilities and materials. Inadequate staffing. Health-lack of access and equipment. Inadequate staffing.	Incidence of diarrheal diseases and other forms of water-borne diseases; Poor diagnoses and inadequate health intervention; Incidence of avoidable deaths. Poor academic performance; lack of interest in schooling; low student enrolment; poor school attendance; increased unemployment and miscreant behaviour. Lack of access to functional facilities for residents.	Provision of safe potable water in all settlements; rehabilitation of existing water facilities. Improved staffing and regular training of education and health staff and provision of equipment (laboratories, libraries, diagnostic equipment) in education and health facilities.	The number of treated boreholes provided in the community. The number of subject areas for which there are adequately trained teachers in public schools. Increased school enrolment. Functional laboratories. Functional public library. The number of essential medical equipment (eg X-ray and ECG) and Personnel to man them in the hospitals and health centers.

Key Environmental Factors.	Associated Sectors and Conditions.	Socio-economic and Health Outcome.	Required Intervention.	Monitoring Indicators.
Domestic Waste and Sewage Management; and Indoor Air Pollution.	Housing-Poor design (no provisions for utilities). Poor construction materials (use of non-durable walling materials).	Pollution of the rivers and physical environment as sewage and waste is discharged into the environment; harm to aquatic life; health problems for humans. Indoor pollution from smoke (stoves and lamps); spread of respiratory problems.	Regulate and enforce the use of water closets or covered pit toilets in houses, by LGA. Regular sanitary inspection by LGA health inspection staff. LGA approval of only properly designed houses with durable construction materials and with the proper and adequate location of utilities like toilet, bath, and kitchen.	The number of properly designed houses approved and construction monitored by LGA.
Gender Equality	Public Administration-traditional practices that limit women's participation in communal decision making.	Limited opportunities for women.	Without requiring a change in the composition of traditional decision-making bodies, certain offices in the CDU can be reserved for women like those of CDU Vice-Chairman or Secretary. This will facilitate their participation in communal decision making.	The number of women playing prominent roles in CBOs, and the number of women in the CDU.

Key Environmental Factors.	Associated Sectors and Conditions.	Socio-economic and Health Outcome.	Required Intervention.	Monitoring Indicators.
Human Capital Development.	Technical Education-lack of facilities. Micro Finance- Poor access to credit; non-availability of venture capital. Employment-existence of high unemployment rates in the community.	Inadequate technical manpower and limitations on the economy (very few skilled workers); limited employment opportunities; low investments; stifling of entrepreneurial ability; low living standards.	Introduce, equip, and staff technical education units within existing schools. Enlighten business persons about the importance of financial services in growing their business. Identify and eliminate bottlenecks in the lending process.	Number and utilization of credit for start-up ventures, and to grow existing investments.

Source: Resourcefield survey, 2020

4.12 STAKEHOLDERS ENGAGEMENT

4.12.1 Introduction

Principle 10 of the Declaration of the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (Brazil, 1992) emphasizes that environmental issues are best handled with the participation of all concerned citizens, at the relevant level. Agenda 21 adopted by United Nations Conference on Environment and Development (UNCED) recognized the important role of public participation in environmental impact assessment (EIA) in achieving sustainable development (item 23.2 of Agenda 21). The World Summit on Sustainable Development in Johannesburg (South Africa, 2002) developed further these provisions. The principles promoted by these conferences are fully integrated into the provisions of the UNECE Convention on Environmental Impact Assessment in a Transboundary Context, which came into force in 1997 (hereinafter referred to as the Convention). When project proponents enable the public to participate in decision-making, they help meet society's goal of sustainable and environmentally sound development. Public participation in environmental decision-making and, in particular, in EIA, may lead to some benefits in these processes. As a result of public participation, the process of decision-making, up to and including the final decision, becomes more transparent and legitimate. Public debate on proposed activities among all interested groups at an early stage of decision-making may prevent or mitigate conflicts and adverse environmental consequences of the decisions with impacts.

The proponent considers consultation as a major feature of its operations; the thrust of the consultation programme for the shopping mall project is to promote mutually beneficial relationships with all the stakeholders through close contacts and regular consultations and also to notify the stakeholders of the nature, scale, and timing of the proposed project, thereby eliminating any fears or apprehension. The process was also used to facilitate information gathering between the EIA consulting team/proponent and the other stakeholders. The consultation exercise commenced at the very early stage of the environmental impact process and it is planned to continue throughout the project duration.

The Stakeholders Engagement process has been designed to comply with regulatory requirements set out in Nigerian environmental legislation and, where possible, implement international good practice guidelines, for example, those of the IFC. The process provides stakeholders with an opportunity to evaluate the proposed project and to submit comments for enhancing project benefits while minimizing the project's adverse effects. The Stakeholder Engagement process aims to achieve the following:

- To ensure that stakeholders are well informed about the proposed project;
- To provide stakeholders with sufficient opportunity to engage and provide input and suggestions on the proposed project;
- To verify that stakeholder comments have been considered and addressed;
- To draw on local knowledge in the process of identifying environmental and social concerns associated with the proposed project, and to involve stakeholders in identifying ways in which these can be addressed;

- To comply with the local legislative requirements; and
- To incorporate international good practice.

4.12.2 Public Consultation process

The methodology employed for the public consultation process considered the following aspects:

- The Nigerian legislative requirements;
- International Stakeholder Engagement practice guidelines;
- Local cultural requirements such as language proficiencies;
- Social sensitivities associated with the proposed project; and
- The geographical location of community.

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

The Stakeholder/Public Engagement methodology is summarised and depicted graphically in Figure 4.50; the same approach was used during the Scoping and ESIA phases.

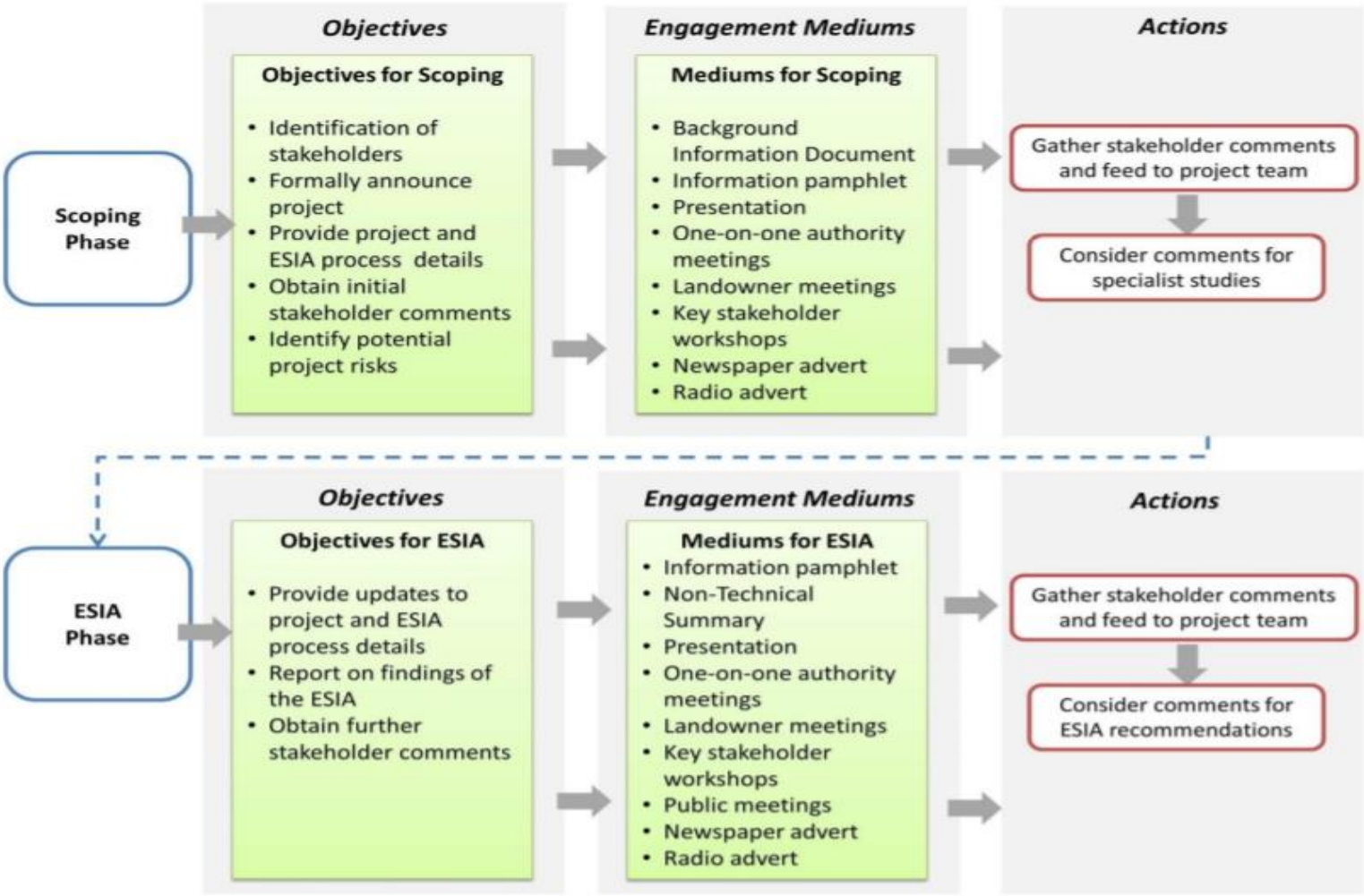


Figure 4.50: Stakeholders engagement methodology

4.12.3 levels of Consultation

Two levels of consultations, as are generally recognized in the ESIA process, were held. These are institutional and Project Affected Community (PACs) involvement. The subject of this section relied heavily on both, though with emphasis on PACs involvement, ie. getting the public, host community, all other stakeholders that may be directly or indirectly affected by the project to participate in assessing the project.

The public forum with Project Affected Community, NGOs, and CBOs, youth groups, Women organizations, religious organizations, and traditional bodies held between 24-29 August 2020 in the project-affected community and traditional rulers in attendance and also with major institutional stakeholders on 27 August 2020 in Port Harcourt.

In all the consultation meetings, a brief on the project concerning the following was given by the ESIA consultant.

- Purpose of the Public Fora
- Background to the project
- Project description
- Benefit description
- The benefits of the project
- Environmental Management
- Community Affairs and relations.

At the end of the presentation, participants were given ample opportunity to ask questions and/or make comments on the project. They were unanimous in praising the proponent for considering them suitable to host the project and promised to accord the proponent all the needed support.

Identification of Stakeholders

The proponent's policy makes it mandatory to consult with stakeholders and relevant authorities in all activities. In preparing this ESIA report the consultation process is implanted at three (3) levels: The first level of consultation identifies the social and economic issues in the project area and ensures visible management commitment to addressing them. This level starts with the project conception.

The second level streamlines the issues and makes plans for specific actions. This level recognizes various phases of engagements among project proponent, host community, village council, women/men's groups, and youth organization. The third level ensures regular communication with stakeholders throughout the project's life; the second and third levels of consultation commence at project inception and continue through the life span of the project.

The key stakeholders identified and consulted for the proposed construction of shopping mall at Port Harcourt are:

i. Federal Ministry of Environment
ii. Federal Ministry of Works and Housing (Controller)
iii. State Coordinator, National Environmental Standard Regulation Enforcement Agency (NESREA), Rivers State Office
iv. Nigerian Civil Aviation Authority (NCAA)
v. Nigerian Airspace Management Agency (NAMA)
vi. Port Harcourt Electricity Distribution Company (PHEDC)
vii. GOC, 6 Division, Nigerian Army, Port Harcourt
viii. Sector Commander, Federal Road Safety Corps (FRSC), Rivers State Command
ix. Commandant, Nigeria Security and Civil Defense Corps (NSCDC), Rivers State Command
x. Commissioner of Police, Nigeria Police Force (NP), Rivers State Command
xi. The Director, Directorate of State Service (DSS), Rivers State Command
xii. Rivers State Ministry of Works
xiii. Rivers State Ministry of Environment
xiv. Rivers State Ministry of Lands & Physical Planning
xv. Rivers State Ministry of Women Affairs
xvi. Rivers State Ministry of Urban Development
xvii. Rivers State Ministry of Employment and Empowerment
xviii. Rivers State Ministry of Health
xix. Rivers State Ministry of Transport
xx. Rivers State Waste Management Agency (RIWAMA)
xxi. The Director, Vehicle Inspection Office, VIO, Port Harcourt
xxii. The Chairman, Obio Akpor Local Government Council
xxiii. Rumuomasi Community
xxiv. The Chairman of Nigeria Society of Engineers (Rivers State Chapter)
xxv. The Chairman, Nigeria Union of Road Transport Workers (Port Harcourt branch)
xxvi. The Chairman, Road Transport Employers Association (Rivers State Chapter)
xxvii. The Association of Environmental Impact Assessment of Nigeria (AEIAN)
xxviii. Institute of Natural Resources and Environmental Studies (INRES), University of Port Harcourt
xxix. Institute of Natural Resources and Environmental Studies (INRES), University of Port Harcourt
xxx. National Inland Waterways Authority (NIWA), HQ, Lokoja
xxxi. The Commanding Officer, NAF Base, Port Harcourt

In the course of planning, the project proponent has established a close working relationship and a sense of partnership with those key stakeholders and the host community and shall maintain these throughout the project life.

Table 4.36: List of Project Stakeholders and Engagement Activities

Stakeholder Group and interest in the project	Stakeholder Name	Stakeholder Level				Engagement Activity	
		International	National	Regional	Local	Meeting	Letter
Government Authorities: National, the regional, and local government of primary political importance to the Project with permitting requirements that must be met by the Project.	Federal Ministry of Environment (FMEnv)		X			X	X
	Ministry of Niger Delta Affairs		X			X	X
	Federal Ministry of Lands and Survey		X			X	X
	Federal Ministry of Works and Housing		X			X	X
	Rivers State Ministry of Environment			x		X	X
	Obio /Akpor LGA				X	X	X
	Federal Ministry of Environment				X	X	X
	Rivers State Ministry of Rural Development		X			X	X
	Office of the Surveyor-General of the state			x		X	X
	Nigeria Police, Rivers State Command			x		X	X
	NCDSC, Rivers State Command			x		X	X
	Rivers State Ministry of Health, Rivers State			X		X	X
	FRSC, Rivers State Command		X			X	X
	Rivers State Ministry of Works			X		X	X
	Rivers State Office of the Secretary to the State Government			x		X	X
	Rivers State Government		X			X	X
	Department of State Services (DSS)		X			X	X
Local Community	Rumuomasi				X	X	X
Non-Government and Community Based Organisations (NGOs and CBOs)	NSE		X			X	X
	AEIAN		X			X	X

Table 4.37: Schedule of Meetings and Interviews

Groups Met	Date	Issues Discussed
Members of Rumuomasi community leaders	25/08/2020	Traditional governance, belief systems, conflict management procedures, social structures, infrastructural network, livelihoods, environmental problems, and community efforts at solving them, perceptions and concerns about the proposed project, suggested mitigation and enhancement measures, community, needs, and development prospects.
Rivers State Ministry of Environment	27/08/2020	Regulatory requirements and involvement
Federal Ministry of Environment, Port Harcourt	27/08/2020	Regulatory requirements and involvement

Source: Resourcefield fieldwork 2020

Plate 4.7: Consultation with Rivers State Authorities and FMEnv Teams in the office of The FMEnv controller in Port Harcourt.

Table 4.38: Consultation Schedule

Stakeholder Group	Stakeholder Name			
		Done	Ongoing	To be consulted
Government Authorities: National, the regional, and local government of primary political importance to the Project with permitting requirements that must be met by the Project.	Federal Ministry of Environment (FMEnv)	X	X	X
	Ministry of Niger Delta Affairs	X		
	Federal Ministry of Lands and Survey	X	X	
	Federal Ministry of Works and Housing	X	X	
	Rivers State Ministry of Environment	X	X	
	Obio Akpor LGA	X	X	X
	Rivers State Ministry of Rural Development	X	X	
	Office of the Surveyor-General of the state	X		X
	Nigeria Police, Rivers State Command	X		X
	NCDSC, Rivers State Command	X		X
	Rivers State Ministry of Health, Rivers State	X		X
	FRSC, Rivers State Command	X	X	
	Rivers State Ministry of Works	X		X
	Rivers State Office of the Secretary to the State Government	X		X
	Rivers State Government	X	X	X

Stakeholder Group	Stakeholder Name			
		Done	Ongoing	To be consulted
	Department of State Services (DSS)	X	X	
Local Community	Rumuomasi	X		X
Non-Government and Community Based Organisations (NGOs and CBOs)	NSE	X		
	AEIAN	X		

4.12.4 Public Disclosure

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

The notification will provide:

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

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

- FMEnv offices in Abuja;
- Rivers State Environmental Protection Agency (or the Rivers State Ministry of Environment) in Port Harcourt; and
- Obio Akpor Local Government headquarters.

Once the draft EIA report has been submitted to the FMEnv, it will likely be subjected to a review by a panel of experts constituted by FMEnv. The panel would likely comprise experts from within FMEnv as well as external specialists included for their expertise on the specific environmental or social topic. Following the review period, the findings will be presented to the panel, likely to be in the form of a public hearing. The project will then need to take appropriate actions to address these findings and comments received from the panel members on the EIA report. This may include additional studies; revision to the EIA report text to correct or clarify content; or development of additional mitigation measures or management actions.

Upon satisfactory completion of the actions required to address the findings, the draft EIA report will be finalized and the FMEnv will issue the EIA certification/authorization.

Outcomes of community's Consultation

The concerns expressed by the host community are listed below, evidence of consultation with host community and other stakeholders are also presented in appendix 4 in form of attendance. Some of the photographs taken during socio-economic and community consultation are presented in this section too. At the project consultation/field data gathering meetings with various community stakeholders, community leaders, and members and FGDs several questions, issues and concerns were raised and certain expectations were also discussed by community members across the project impact community.

Community's Concerns

- Environmental damage: The people fear that the construction activities will destroy the vegetation, cause turbidity in the rivers and affect the water that is used by households for drinking and other purposes.

- Social problems: Introduction and increase in vices like drug use and prostitution, teenage pregnancy, school dropout, and insecurity during project construction.

- Health problems: Increase in the occurrence of STDs and HIV/AIDs.

- Payment of compensation: All compensation due to families and community for loss of property should be adequately paid before the commencement of the project.

Community Expectations

Expectations of the community consist mainly of human capital development and the development of infrastructural facilities. They include the following:

- Creation of employment opportunities for residents of the community.
- Empowerment of community members through skills acquisition, an award of contracts, and provision of scholarships.
- Infrastructural development in community in terms of provision of potable water, electricity, functional orthodox health care facilities, renovation, and equipping schools, and erosion control projects.

Plate 4.8: SE team leader address the community leaders speaking duirng in Rumuomasi community

Plate 4.9: The prince of Rumuomasi community consultation in the area

4.12.5 Institutional consultation

Major stakeholders were also consulted for this project on the 27 August 2020 at Hotel DMATEL in Port Harcourt, Rivers State.

Table 4.39: Specific Expectations from Stakeholders elicited during consultations

ORGANISATION/ GROUPS	Role In Project	Information got from the meeting
FMEnv, NESREA, RSMEnv, and Obio Akpor LGA	Regulators defined in the EIA Act	✓ Adequacy of measures ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations
Rivers State Min of Lands Office of Surveyor-General, Rivers State Physical & Regional Planning	✓ Acquisition of Land ✓ PAP Entitlements ✓ Approval of Building Plans	✓ The land acquisition process for the public project ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations
Nigeria Police, DSS, and NSCDC	Security and intelligence	✓ The process to ensure the security of personnel, equipment and materials are secured during project Implementation
Federal Road Safety Corps Rivers State Fire Service Vehicle Inspection Office	Ensure traffic flow during mobilization and construction Ensure adequacy of fire preventing and fighting resources	✓ Required permits ✓ Transport management requirements etc ✓ Fire management requirements
Rumuomasi community	Host Community (Land, security, etc)	✓ Concerns, fears, and expectations
Rivers State Environmental Protection Agency Rivers State Waste Management Agency	Infrastructure, amenities, and services upgrade and expansion	✓ Adequacy of measures ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations
Rivers State Ministry of Works	To determine the capacity of existing road networks	✓ The design capacity of the road and bridges
NGOs, CBOs (NSE, AEIAN) Academia	Observance and EIA process witnessing	✓ Adequacy of measures ✓ Commitment to support the project or otherwise ✓ Suggestions and recommendations

Table 5.4: Initial Consultations' Findings

Stakeholder Group	Issues	Solutions
Government authorities	Employment and local benefits	• The Project should provide employment opportunities for local community who are willing and ready to work as construction workers. • Encourage the community to work together for long term benefits for all community members.
	Resettlement	• There is a need to pay compensation to property owners who will be affected by the proposed Life Camp construction.
	Waste	• Develop comprehensive plans for water use and wastewater discharge.
	Scope of the EIA	• The EIA should address the potential health impacts of the project on local community.
Local community	Employment and local benefits	• Opportunities in terms of employment and procurement, particularly for local community and the appointment of CLOs from the project community
	Community H&S	• The Project will need to plan for the community health risks related to the construction and operation of Life Camp.
	Livelihoods and resettlement	• The Project needs to thoroughly understand the livelihoods within the area of influence to understand the impacts of the project on local community.

Plate 4.10: A cross-section of stakeholders during community and institutional stakeholders' consultation workshop in Port Harcourt

GRIEVANCE MECHANISMS

During the implementation of the project activities, disputes/disagreements between the project developer and the PAPs may occur especially in terms of compensation, boundaries, etc.

There are great challenges associated with grievance redress especially in a project of this magnitude. The practice of grievance arbitration over resettlement issues in Nigeria is conducted within the framework of the Land Use Act (LUA) of 1978, reviewed under Cap 202, 1990. Two stages have been identified in the grievance procedure: customary mediation and judiciary hearings.

A grievance procedure based on community grievance committees, one per community, will be established for resolution of the disputes and complaints.

- **CUSTOMARY MEDIATION**

Procedures for grievances will be clearly explained during community meetings. At the village levels, a series of customary avenues exist to deal with dispute resolutions. Those avenues should be employed, when and where it is relevant as a "court of first appeal". Such customary avenues will provide a first culturally and amicable grievance procedure that will facilitate formal and/or informal grievance resolution for grievances such as:

- Wrongly recorded personal or community details;
- Wrongly recorded assets including land details and/or affected acreage;
- Change of recipient due to recent death or disability;
- Recent change of asset ownership;
- Wrong computation of compensation;
- Name missed out of register, etc.

A Customary Grievance Redress Committee shall be set up by the project proponent in each community to address complaints from project implementation. This committee will be assisted by the project proponent.

PAPs' complaints should first be lodged verbally or in writing through this process. It is expected that the committee will deal with the grievances they receive within three days of receipt of the complaint. If the complaint cannot be resolved at this level, or if the plaintiff is not satisfied with the settlement proposed, the plaintiff will then be referred to the official legal procedures.

- **COURTS OF LAW**

The judicial process under applicable laws will be followed and the law courts will pass binding judgment on the matter.

Figure 10.1 illustrates this grievance redress mechanism.

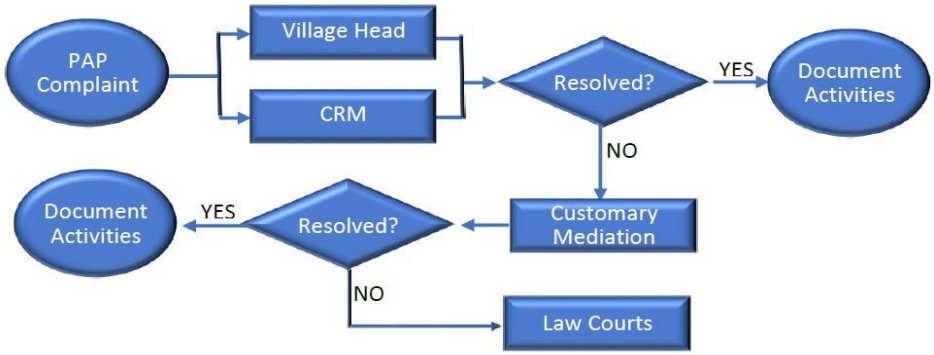


Figure 4.51 Grievance Resolution Procedure

4.12.9 Future Consultations

The proponent shall continue to consult with the regulatory agencies, the host community, all stakeholders, and other relevant parties concerned with or are likely to be affected by the project at all stages of project development. At the approval of this ESIA to commence the construction activities, a detailed Memorandum of Understanding (MoU) shall be signed with the affected community.

4.12.10 CONCLUSIONS

The community and stakeholder engagement undertaken by the Project fulfils the requirements of the Terms of Reference and is undertaken according to the strategy prepared by the Project. A variety of communication activities and tools were used to seek broad and informed community and stakeholders' responses, and the issues and opportunities identified through stakeholders' engagement informed the development of the EIA. Specific communication activities undertaken to facilitate effective two-way communications included the Community Information Session, briefings of key stakeholders including government agencies and NGOs, and community-based groups. Throughout the project design and data gathering process, multiple avenues were provided for stakeholders to access information and provide comments and/or ask questions and receive answers. The engagement program engaged the community by:

- attracting approximately major community members to the Community Information Session
- providing briefings to government agencies and Community-Based Organisations (CBOs) and NGOs.
- generating feedback from community leaders and institutional stakeholders.

4.13 Traffic Survey

This traffic study was carried out to analyze the traffic characteristics in the selected routes. This study helps in deciding the geometric design features for traffic control for safe and efficient traffic movement. The study was to determine the number of vehicles crossing sections of roads proposed for the Shopping Mall per unit time at any selected period and also to quantify the measure of flow. The units used are vehicles/day or vehicles/hour.

4.13.1 Methodology

A manual classified count (MCC) was employed for this study. MCC involves counting all the vehicles passing a selected location on a road for a pre-determined time. The count records individual vehicles by categories (i.e. a truck or car/bus) and the direction they are traveling in. This is the reason it is called a 'classified count'.

Every urban or regional area is unique in terms of intra-city modes of transportation. Often, travel patterns and mode choices reflect spatial planning policies, urban form, city size, cultural factors, and economic profile. Given the foregoing, and given that during the construction of the Shopping Mall traffic will be affected at points of the road crossing, a traffic survey was carried out to ascertain the following:

i. major modes of transportation
ii. volume of traffic
iii. variation in travel patterns
iv. the peak periods
v. traffic flow patterns

To achieve these objectives, sampling points (Figure 4.5049) were established at;

- from town towards Aba
- from Aba into town
- Old Aba Road

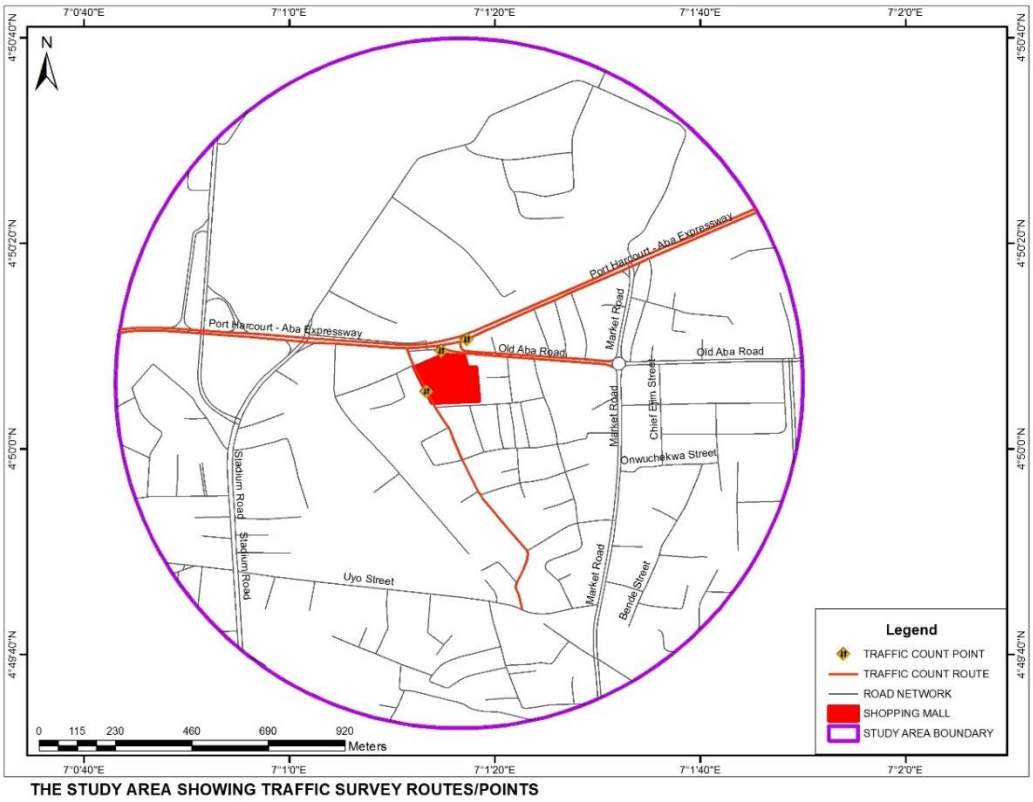


Figure 4.52: Map showing Traffic Survey Points

Many urban cities in Nigeria are bedevilled with traffic congestion which tends to defy various remedial measures adopted by different governments over the years. Journey times from one point to another within a town have remained unreliable and residents have continued to face disturbing

inconveniences in transportation. These are accompanied by noise and air pollution and the high costs associated with the burning of fuels from stationary vehicles.

Major Modes of Transportation

This study reveals the predominant use of cars as a means of transportation for short shuttles within the state capital and neighbouring LGAs. The recent burgeoning growth in the commercial cars in Port Harcourt could generally be attributed to its inherent advantages of door-to-door service, manoeuvrability during traffic congestion, and ease of responsiveness to demand.

Temporal Variation in Travel Pattern

Traffic analysis of the location

Traffic situations in these areas both during weekends and weekdays are similar. One domination in the area is that there are more cars and buses on the routes than trucks, and tricycles popularly known as Keke and motorcycles are not allowed access to these routes.

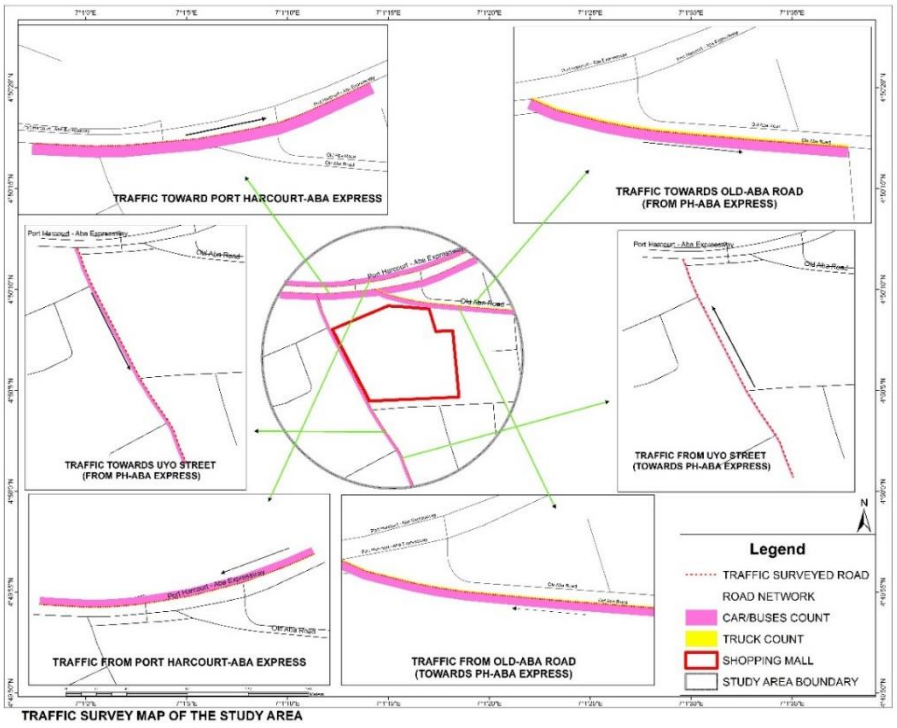
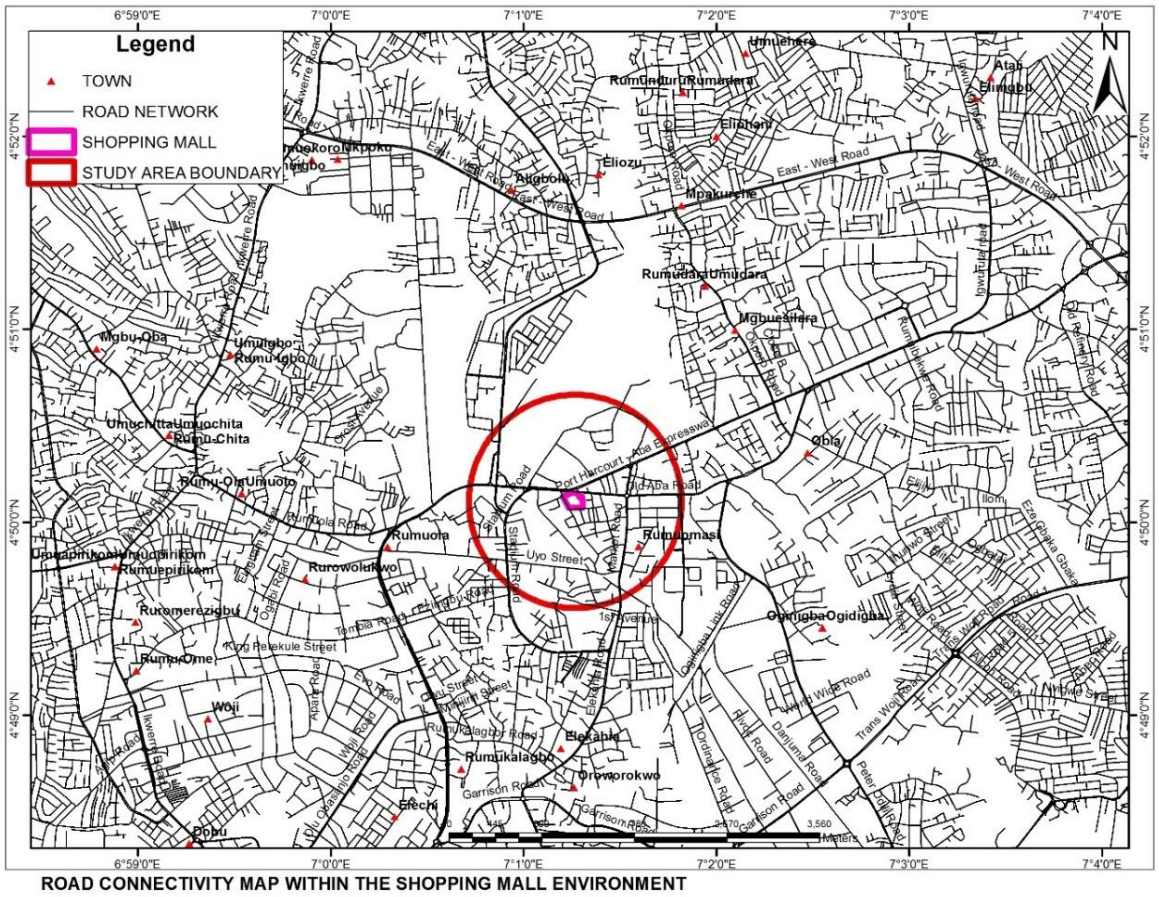


Figure 4.57: Map of the study area showing types and percentages of vehicles on the sampling routes



ROAD CONNECTIVITY MAP WITHIN THE SHOPPING MALL ENVIRONMENT

Figure 4.58: Road Connectivity Map within the shopping mall environment

5 POTENTIAL AND ASSOCIATED IMPACTS

5.1 Introduction

The possible impacts of the proposed shopping mall project, with respect to the increasingly complex environmental issues affecting human security and environmental resource management, are treated in this chapter. These possible impacts which include both potential and associated impacts are expressed as threats or opportunities to human and environmental safety. The criteria for predicting the likelihood and magnitudes of such impacts and evaluating the significance of changes likely to result from them are also presented here.

The main objective of this impact assessment is to establish the possible significant impacts of the proposed project activities on the immediate and remote biophysical and socio-economic environments. Table 5.1 shows the goals of the assessment.

Table 5.1: Goals of the Impact Assessment

Consideration	Goal
Comprehensiveness	Ability to handle all possible range of elements and combinations thereof;
Selectivity	Capability to identify early in the procedure those aspects that are important;
Mutual exclusiveness	Ability to examine every component of an impact from different perspectives
Confidence limits	Ability to ascertain and isolate uncertainties;
Objectivity	Exclusion of bias either from the assessor or project initiator;
Interactions	Ability to examine both sides of a coin and provide feedback.

A list of the various components of the project environment likely to be impacted by the proposed building construction activities, the associated impact indicators, phases of project development activities and sources of impact are listed in tables 5.2 and 5.3 respectively.

Table 5.2: Impactable Components and Associated Impact Indicators

S/N	Impactable Components of the Environment	Impact indicators
1.	Climate	Humidity, temperature, rainfall, wind speed and direction
2.	Air	Particulates, NO_X, SO_X, CO, H_2S, metals, noise (daytime disturbance, hearing loss, communication interference)
3.	Ground water	Dissolved/suspended solids, nutrients, heavy metals, salinity, and pH.
		Drainage/discharge, hydrologic balance, sedimentation, flooding.
4.	Soil	Erosion, fertility/farming, hunting, recreation.
6.	Archaeological Sites	Cultural relics, cultural sites.
7.	Socio-Economics and Health	Population, social structure, income, settlement pattern, employment, agriculture, health, safety and security.

Table 5.3: Phases of Project Development Activities and Sources of Impact

S/N	Project Phase	Activities/Sources of Impact
1.	Site preparation	Clearing of site, waste disposal
2.	Early works	Access road construction, excavation, piling, welding, painting, waste disposal, Influx of people
3.	Construction, Operation and Maintenance	Noise and vibration, waste generation, influx, dust emission, traffic generation,
4.	Decommissioning and abandonment	Removal/dismantling of equipment and structures, waste disposal, residual contamination, road traffic, scrap metals

5.2. Impact Scoping

This is the range of activities of the proposed shopping mall project that could have significant impacts on the environment. It identifies issues of critical concerns that cover:

- Impact of the proposed project execution and operation.
- The degree of the impacts of the proposed project and their duration.
- Consequences of the impacts on the local environment.
- Mitigation or amelioration measures to reduce or avoid the negative impacts or to enhance and maximize positive ones.

5.3 Impact Assessment Methodology

Varieties of methodologies exist for environmental impact assessment. The following steps were employed in the preparation of this EIA:

- Identification of impacts
- Prediction of impacts
- Evaluation and Interpretation of impacts

- Communication
- Inspection procedures

From the above, the biophysical, health, and socio-economic components of the environment that will significantly be affected by the proposed project activities were identified in section 5.3.1.

A summary of the methodology is presented in figure 5.1.

5.3.1 Impacts Identification

The proposed Shopping mall project will involve the following steps amongst others:

- Land take
- Mobilization and demobilization
- Site Preparation/clearing
- Foundation works
- Pre-casting of building components and installation
- Building operations and maintenance activities
- Decommissioning and site reclamation

These activities will produce residues and emissions that were identified and analyzed in sufficiently clear and comprehensive manner, and presented below though not limited to:

- Emissions to air.
- Noise and vibrations.
- Disturbance to ecosystems.
- Influx of job seekers

The possible potential and associated impacts for the different phases of the proposed project were identified and presented in Table 5.4

5.4 Impacts Quantification and Determination of Significance Impacts

In identifying and quantifying the significant impacts the proposed building project will have on the environment, two stage exercises were involved in assessing the impacts. The first stage classified the impacts as either adverse or beneficial, and these could be short or long term, reversible or irreversible. A symbol (X) is used to indicate these classifications. Adverse impacts are those, which impact negatively on the biophysical, health, and social environments while beneficial impacts are those that enhance the quality of human and environmental wellbeing. For this study, short term means a period of time less than three months while any period greater than three months is considered long term. Reversible/irreversible, is defined as whether the environment can either revert to previous conditions or remain permanent when the activity causing the impact is terminated. The second stage which is based on ISO 14001-based Criteria and Rating; and Risk Assessment Matrix (RAM), involved evaluation to determine whether the impact is significant. The criteria and weighting scale used in evaluating this significance are as follows:

- Legal/regulatory requirements (L)

- Risk factor (R)
- Frequency of occurrence of impact (F)
- Importance of impact on an affected environmental components (I) and
- Public perception/interest (P).

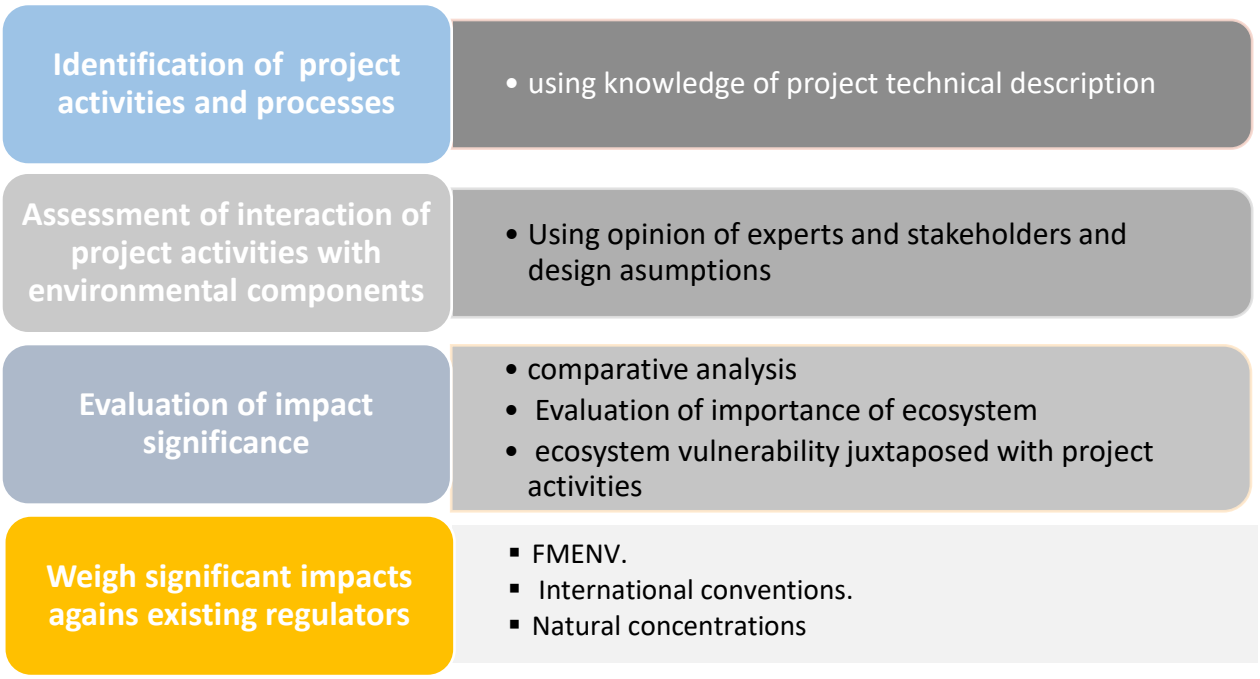


Figure 5.1:.2: Summary of Impact Assessment Methodology

The ISO 14001-based Criteria and Rating are:

LEGAL/Regulatory Requirements (L)
Is there legal/regulatory requirements, or a permit requirement?

0	=	There is no legal/regulatory requirement
3	=	There is legal/regulatory requirement
5	=	There is a permit required

RISK (R) - What is Risk/Hazard rating based on Risk Assessment Matrix

1	=	Low risk
3	=	Medium/Intermediate risk
5	=	High risk

Environmental Impact Frequency (F) - What is the frequency rating of impact based on the RAM?

1	=	Low frequency
3	=	Medium/Intermediate frequency
5	=	High frequency

Importance of Affected Environmental Component and Impact (I) - What is rating of importance based on consensus of opinions?

1 = Low importance
3 = Medium/Intermediate Importance
5 = High Importance

Public Perception (P) – What is the rating of public perception and interest in the proposed project and impacts based on consulting with stakeholders?

1 = Low perception and interest
3 = Medium/Intermediate perception and interest
5 = High perception and interest

The significant potential impacts of the proposed project were identified as those impacts in the checklist of indicator parameters in Table 5.2.

The frequency of each impact was determined from historic records while the importance of affected environmental component was determined through consultation and consensus of opinions. The manner in which the host communities and the general public would perceive each potential impact and its effects were again determined through consultation with the host communities and consensus of opinions of environmental professionals. For this study, the frequency, importance and public perception were judged to be superior indicators of the impacts. Significant impact was therefore based on the sum of the impact frequency, importance and perception (F+I+P). The maximum possible point from this sum is 15. Impacts whose sum of F+I+P was less than 5 were rated as low. These impacts were judged not to require mitigation. Those whose sum of F+I+P was between 5 and 10 were rated as having medium significance while those whose sum of F+I+P was between 11 and 15 were of high significance. For this study, medium and high significant negative impacts were judged to require mitigation. Significant positive impacts were believed to require enhancement. This result is in compliance with best professional practice (Cox and Guy, 2002). Table 5.4 shows the impacts of the proposed shopping mall project during each project phase.

Table 5.4: Associated and Potential Impacts of the proposed shopping mall project

Project phase	Project Activities	Environmental Aspect	Potential/Associated Impacts
Site preparation and Survey	Mobilization	Socio-economic, health and safety	Influx of heavy traffic leading to higher accident possibility, influx of people leading to pressure on existing infrastructure, public institutions and amenities, and inflation Decline in social values leading to increased crime rate
	Soil Testing	Soil and groundwater	Exposure of soil to weather conditions and loss of soil micro fauna and flora, and groundwater contamination
	Material transportation	Air Quality, Health. Public Safety	Increase in vehicular exhaust gases emission into the air, Exposure of road users to increased traffic, and higher accident possibility.
	Offices and Base Camp	Soil and groundwater Public health and safety	Loss of soil quality due to exposure to weather conditions and groundwater contamination due to office/base campsite location and construction. Predisposition to injury from site construction activities. Domestic waste generation
	Site clearing	Soil and health	Loss of soil quality due to exposure of soil to weather conditions CO_2 emitted by machines, etc
Shopping mall Construction	Access road construction	Soil, air and groundwater	Predisposition of the site to soil erosion and loss of soil fauna; air pollution, noise and vibrations. Construction waste generation
	Impact on site drainage	Soil and Health	The excavation of the site will alter the natural drainage of the site thus creating pools during rainy season Stagnant water will lead to breeding grounds for mosquitoes

Project phase	Project Activities	Environmental Aspect	Potential/Associated Impacts
	Topsoil removal Excavation &	Soil and Health,	Soil compaction due to heavy vehicle movement, alteration of drainage pattern. Excavated material will affect diversity of soil fauna within the area. Occupational health and safety issue
		Air Quality/Noise	Increase in exhaust gases from equipment exhausts. Increase in ambient noise level and vibration.
	Installation of building components and furniture	Health and safety, (Heat and Radiation)	Welders exposed to heat and light radiation, heat rashes, welding flashes leading to eye diseases etc
		Socio-economic	Decline in social values.
	levelling, compaction	Soil, Water	Exposure of soil organisms to weather conditions and contamination of surface water.
Shopping mall Operations and Maintenance	Operations and Maintenance	Socio-economic, health, public safety and air	Exposure of road users to increased traffic, and higher accident possibility, Increase in vehicular exhaust gases emission into the air and noise, waste generation Operational and maintenance health and safety issues **Improvement of infrastructure**
Shopping Mall Decommissioning and Abandonment	Dismantling Waste disposal	Soil, Air, Water, Health	Soil and water contamination, noise and vibration during dismantling; construction debris generation.

Sources: Resourcefield Survey, 2020

Table 5.5: Impacts Significance

Project phase	Project Activities	Potential/Associated Impacts	Qualitative						Assessment Ranking
			Adverse	Beneficial	Short term <3 months	Long term >3months	Reversible	Irreversible	
Site preparation and Construction	Mobilization	Influx of heavy traffic leading to higher accident possibility, influx of people leading to pressure on existing infrastructure, public institutions and amenities and inflation Decline in social values leading to increased crime rate.	X		X		X		Medium Significant
	Soil Testing	Exposure of soil to weather conditions and loss of soil micro.	X		X		X		Low significant
Building Construction	Material transportation	Increase in vehicular exhaust gases emission into the air, Exposure of road users to increased traffic, and higher accident risks.	X		X		X		High Significant
	Offices and Base Camp	Loss of soil quality as a result of exposure to weather conditions.	X		X		X		Low Significant
		Injury due to site clearing and construction activities.	X		X		X		Medium Significant
		Domestic waste generation	X			X	X		High Significant
	Site clearing	Habitat loss and/ or habitat fragmentation, loss of soil quality due to exposure of soil to weather	X		X		X		Low Significant

Project phase	Project Activities	Potential/Associated Impacts	Qualitative						Assessment Ranking
			Adverse	Beneficial	Short term <3 months	Long term >3months	Reversible	Irreversible	
		conditions, Lost CO_2 uptake, CO_2 emitted by machines, etc							
	Access road construction	Predisposition of the site to soil erosion and loss of soil micro, air pollution, noise and vibrations. Construction waste generation	X			X	X		Low Significant
	Impact on site drainage	The excavation of the site will alter the natural drainage of the site thus creating pools during rainy season Stagnant water will lead to breeding grounds for mosquitoes	X		X		X		Medium Significant
	Overburden removal & excavation	Soil compaction due to movement of heavy vehicles,		X		X	X		Low Significant
		Excavated materials will affect diversity of soil micro within the area and contaminate the groundwater. Occupational health and safety issue	X			X	X		Low Significant
	Installation of building	Exposure of workers to construction site accidents	X			X	X		High Significant

Project phase	Project Activities	Potential/Associated Impacts	Qualitative						Assessment Ranking
			Adverse	Beneficial	Short term <3 months	Long term >3months	Reversible	Irreversible	
	components and fittings								
Operations and Maintenance									
		Increased road traffic volume and risk of accidents/ injury	X			X		X	Medium Significant
		Improvement of infrastructure		X		X		X	Low Significant
		Increase in noise nuisance	X			X		X	low Significant
		Waste generation/disposal	X			X		X	Medium Significant
Decommissioning	Dismantling	Soil contamination, due to improper don dismantling/demolition waste disposal.	X		X		X		Medium Significant

Sources: Resourcefield Survey, 2020

5.5 Discussion of Impacts

The remainder of this chapter describes the most important environmental impacts of the proposed shopping mall.

5.5.1 Impacts on water resources

The impact of the proposed Building project on water quality and availability of water resources within the project area will be significant. Key questions are whether groundwater supplies will remain fit for human consumption.

5.5.2 Impacts on air quality

Airborne emissions occur during each stage of the construction cycle, but especially during site development, construction, and operational activities. Particulate matter transported by the wind as a result of excavations, transportation of materials, wind erosion, fugitive dust from overburden stockpiles, waste dumps, and haul roads. Exhaust emissions from mobile sources (cars, trucks, heavy equipment) raise these particulate levels; and

- **Gas emissions from the combustion of fuels in stationary and mobile sources.**

Once pollutants enter the atmosphere, they undergo physical and chemical changes before reaching a receptor. These pollutants can cause serious effects to human health and to the environment. The proposed building construction project has the potential to contribute significantly to air pollution, especially in the construction phase. All activities during this phase depend on equipment, generators, processes, and materials that generate hazardous air pollutants such as particulate matter, heavy metals, carbon monoxide, sulphur dioxide, and nitrogen oxides.

5.5.2.1 Mobile sources

Mobile sources of air pollutants include heavy vehicles used in excavation operations, cars that transport personnel at the construction site, and trucks that transport construction materials. The level of polluting emissions from these sources depends on the fuel and conditions of the equipment. Even though individual emissions can be relatively small, collectively these emissions can be of real concern. In addition, mobile sources are a major source of particulate matter, carbon monoxide, and volatile organic compounds that contribute significantly to the formation of ground-level ozone. In addition, construction of access and internal roads will generate dusts which will deteriorate air quality and reduce visibility during construction.

5.5.2.2 Stationary sources

The main gaseous emissions will come from combustion of fuels in power generation installations.

5.5.3 Noise and vibration

5.5.3.1 Physical Effects

Physical effects related to humans are probably most applicable to the operators of construction equipment as opposed to people residing adjacent to construction projects. While resulting in the potential to annoy or disturb humans, construction noise is typically not a danger to people's hearing.

Knowledge related to the physical effects of construction noise on non-human species such as land-based animals, birds is limited.

5.5.3.2 Hearing Impairment

Loud noises from construction activities can create situations where people cannot effectively communicate. While such situations may be merely an annoyance or inconvenience in certain situations, they could be construed as a safety issue if such noises prevent people from hearing important local noises such as approaching traffic, emergency warning devices, alerts from other people, etc.

5.5.3.2 Activity Interference

Noise from construction activities can affect humans, land-based animals, and airborne wildlife in a variety of ways. Humans are most affected in terms of sleep deprivation and the carrying on of normal daily activities such as watching television, listening to the radio, recreational activities, and activities requiring concentration, such as reading. Special activities such as those associated with churches, schools, and libraries can also be negatively affected by construction noise.

5.5.3.3 *Annoyance*

While non-humans are most likely annoyed by construction noise, there is little known about the related effects.

5.5.4 Impacts on social values

The proposed project will create wealth via jobs and increase the demands of goods and services in the communities, but it can also cause considerable disruption. Also, if the communities feel they are being unfairly treated or inadequately compensated; this can lead to social tension and violent conflict.

5.5.5 Impacts of migration and livelihoods

A major social impact of the proposed project is the influx of newcomers into the area, and this can have a profound impact on the original inhabitants, and disputes may arise over land and the way benefits have been shared. Sudden increases in population can also lead to pressures on land, water, and other resources as well as bringing problems of sanitation and waste disposal. Also, the

construction workers are coming into the area with higher purchasing power than the natives and this can cause inflation and hardship while construction lasts. This also can lead to moral compromises and prostitution in the community.

5.5.6 Impacts to cultural and aesthetic resources

The proposed project activities can cause direct and indirect impacts to cultural resources. Direct impacts can result from construction activities. Indirect impacts can result from soil erosion and increased accessibility to current or proposed construction site. The proposed project can affect sacred landscapes, historical infrastructures, and natural landmarks. Potential impacts include:

• Complete destruction of the resource through surface disturbance or excavation;

• Degradation or destruction, due to topographic or hydrological pattern changes, or from soil movement (removal, erosion, sedimentation);

• Unauthorized removal of artefacts or vandalism as a result of increased access to previously inaccessible areas; and,

• Visual impacts due to excavations, dust, and the presence of large-scale equipment and vehicles.

5.5.7 Climate change considerations

Climate change can be caused by:

- The proposed construction project site is not in a forested area that is critical for absorbing atmospheric carbon dioxide (CO_2) and maintaining a healthy balance between CO_2 emissions and CO_2 uptake.

- CO_2 emitted by machines (e.g., diesel powered heavy vehicles) involved in the construction.

5.5.8 Impact of waste generation

Waste (domestic, construction, dismantling / demolition etc) will be generated throughout the phases of the proposed project.

6 IMPACTS MITIGATION

6.1 Introduction

The basis for identifying, quantifying and ranking of the potential impacts, which are likely to arise as a result of the proposed Building Project, were presented in Chapter Five. This exercise indicated that various components of the biophysical, health and social environments would be impacted in varying levels. The identified negative impacts were ranked as low, medium or high. In order to reduce the impact of the proposed development to acceptable levels (or where this is not possible to as low as reasonably practicable (ALARP), a number of measures are proposed to mitigate the high and medium negative impacts. Project development would also result in positive impacts and a number of measures have been proposed to enhance these effects. The mitigation measures proposed for the predicted medium and high-ranking impacts arising from this proposed shopping mall project would recognise the following:

- Environmental laws in Nigeria, with emphasis on permissible limits for waste streams (FMEnv guidelines)
- Best Available Technology for Sustainable Infrastructural Development
- Feasibility of application of the measures in Nigeria
- Concerns of stakeholders during consultation meetings, and focus group discussions with the socio economic and health teams.

Impact mitigation may involve all or some of the following:

- Avoiding the impacts altogether by not taking a certain action or parts of an action.
- Minimizing the impacts by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating or restoring the affected environment
- Compensating for the impact by replacing or providing substitute resources. These mitigation measures are presented in Table 6.1.

Table 6.1: Proposed Mitigation Measures for the Identified and Associated Impacts of the proposed shopping mall project

Project phase	Project Activities	Potential/Associated Impacts	Impact significance before mitigation	Impact Mitigation	Impact significance after mitigation
Site preparation and Construction	Mobilization	Influx of heavy traffic leading to higher accident possibility, influx of people leading to pressure on existing infrastructure, public institutions and amenities and inflation Decline in social values leading to increased crime rate.	Medium Significance	Quiton/JBN shall: Strict adherence to road transport regulations. Institute public enlightenment campaigns and implement its corporate social responsibility.	Low Significance
Building Construction	Material transportation	Increase in vehicular exhaust gases emission and fugitive dust into the air, Exposure of road users to increased traffic, and higher accident risks.	High Significance	Quiton/JBN shall: Ensure the proper maintenance of vehicles, wetting of the construction site regularly with water to suppress dust, and the use of exhaust mufflers; Training and retraining of project environments, deployment of road signs and rewarding environments for zero accident cases Ensure that all fuel-propelled construction machines are well maintained and serviced	Low Significance
	Offices and Base Camp	Injury due to site clearing and construction activities.	Medium Significance	Quiton/JBN shall: Strict adherence to EPC's safety policy	Low Significance
		Domestic waste generation	High Significance	Quiton/JBN shall:	Low Significance

Project phase	Project Activities	Potential/Associated Impacts	Impact significance before mitigation	Impact Mitigation	Impact significance after mitigation
				Adopt waste minimization strategy of, reduction, re-use, recycle and recovery Disposable waste will be contracted to the State waste management agency	
	Overburden removal & excavation	Increase in exhaust gases from equipment exhausts. Increase in ambient noise level	High Significance	Quiton/JBN shall: Construct the access roads in the dry season; ensure proper compaction of the road, provision of drainage channels, wetting of the roads at least twice daily during earth work. Regular maintenance of equipment. Ensure the use of appropriate PPE and institute an adequate Workmen Compensation Insurance Scheme Ensure the use of light vibrators Ensure Construction activities must be carried between 0800hrs and 1700hrs.	Low Significance

Project phase	Project Activities	Potential/Associated Impacts	Impact significance before mitigation	Impact Mitigation	Impact significance after mitigation
	Impact on site drainage	The excavation of the site will alter the natural drainage of the site thus creating pools during rainy season Stagnant water will lead to breeding grounds for mosquitoes	Medium Significant	Quiton/JBN shall: Ensure that storm drainage system remains clear during construction clear Any excess soil from the construction site should be dumped at an approved site if it has to be disposed away from the site. Design clear drainage system to ensure that the site is properly drained even during the construction period	Low Significant
	Installation of building components and furniture	Exposure of workers to construction site accidents	High Significant	Quiton/JBN shall: EPC Contractor shall ensure strict adherence to its Safety Policies by all personnel	Low Significant
Operations and Maintenance					
		Increased road traffic volume and risk of accidents/ injury	Medium	Quiton/JBN shall: Ensure strict implementation of the Traffic Management Plan	

Project phase	Project Activities	Potential/Associated Impacts	Impact significance before mitigation	Impact Mitigation	Impact significance after mitigation
				Ensure the delivery of materials is done during off-peak hours Ensure the provision of PPE to worker during construction time. Ensure the Provision of first Aid facilities emergency plan at the site. Fencing off construction sites to minimize avoid risks to the general public Ensure the supervision of the project is done throughout the project implementation period.	
		Improvement of infrastructure	Low	Quiton/JBN shall: Ensure strict implementation of the facility Maintenance Policy Ensure strict implementation of employment and labour policy ensure good corporate social responsibility to the host communities Ensure construction do not interfere with way leaves Explore use of modern technologies e.g use of solar and wind energy to	High Significance

Project phase	Project Activities	Potential/Associated Impacts	Impact significance before mitigation	Impact Mitigation	Impact significance after mitigation
				reduce pressure on existing infrastructure	
		Waste generation/disposal	Medium	Quiton/JBN shall: Ensure strict implementation of the Waste Management Plan Contract a licenced waste collector Ensure wastes are disposed at the designated site	Low
Decommissioning	Dismantling	Soil and water contamination, due to improper domestic and dismantling/demolition waste disposal.	Medium Significant	Quiton/JBN shall: Ensure strict adherence to a decommissioning plan that would be based on the BAT of the time, and approved by FMEnv.	Low Significance

6.2 DISCUSSION OF MITIGATION MEASURES

6.2.1 Impacts on water quality

During site preparation and earth works, Quiton/JBN shall ensure to prevent the contamination of the environment with excavated soil; and also, to do the earth work during the dry season, in a short period.

6.2.2 Air Quality, Noise and vibration

Quiton/JBN shall ensure that the surrounding is wetted during earth work, the use of exhaust muff and proper maintenance of vehicles and equipment. Also, Quiton/JBN will ensure to deploy only low noise equipment and machineries to the work site while ensuring prompt and regular maintenance of machines and vehicles, and also the use of ear muffs to reduce the effects of loud noises. These measures will reduce the effects of this impact to a significantly low level.

6.2.3 Impacts on soil quality

During construction, Quiton/JBN will ensure adequate compaction and consolidated with materials of high tensile strength at the building's casting areas to prevent failing and consequent erosion.

6.2.4 Impacts on socio-economics

This is one of the most sensitive impacts that will result for the proposed shopping mall project, thus the mitigation of this impact will include the institution of public enlightenment campaign and corporate social responsibilities in all the areas related to the social wellbeing of the people. The proposed project will also bring about an increase in the means of livelihood of the people through associated businesses such as food vendors etc. Quiton/JBN shall ensure the provision of employment opportunities for the locals that will meet its requirements and public health awareness campaign.

Public interest in this project is expected to be high because of the perceived socioeconomic transformation which this project is likely to engender. In addition to this transformation is the project's impact on the surrounding communities during construction and operation (e.g. noise, traffic, dust, emissions etc) and through the influx of workforce. As the preceding discussions on mitigation and enhancement measures have shown, effective and realistic measures have been proposed to mitigate/enhance the identified impacts. Nevertheless, stakeholder perceptions are likely to persist. Quiton/JBN shall employ and sustain dialogue as well as involve the communities and other stakeholders in all phases of the project to secure the social license to operate. In particular, Quiton/JBN shall **u**se available records on community development and other community-based activities as evidence of a responsible corporate government.

7 ENVIRONMENTAL MANAGEMENT PLAN

7.1 Introduction

An EMP is an organizational programme used in the management of operations to ensure environmental sustainability. It is the component of an EIA that provides the procedures and processes that can be incorporated into an organization's activities to measure and check on a continuous mode, the compliance with statutory requirements and the effectiveness of mitigation measures recommended for the identified negative impacts of a project.

This EIA, having identified the key environmental and socioeconomic aspects, potential impacts and mitigation measures associated with the project, will serve as a basis for the Environmental Management Plan (EMP).

This EMP is based on ISO 14001 standards and is divided into the following sections:

i. Leadership and Commitment.
ii. Training, Awareness and Competence.
iii. Communication.
iv. Operational Control.
v. Environmental and Waste Management Approach.
vi. Safety and Health.
vii. Emergency preparedness and response.
viii. Management of Socio-Economic Impacts.
ix. Institutional Arrangement for EMP.
x. Monitoring and Measurement.
xi. Environmental Audit.

7.2 Leadership and Commitment

Quiton is committed to the implementation of the EMP of the proposed Shopping Mall project. They shall demonstrate visible commitment to HSE management to enhance the credibility of the HSE policies and objectives. This commitment means providing resources to develop, operate and maintain the HSE-MS and to adhere to the policy and achieve objectives.

7.3 Training Awareness and Competence

Quiton shall pay deliberate attention to Training, awareness and competence of staff. They shall identify training needs and ensure that all personnel whose work has impact on the environment receive appropriate training on a continual basis knowing that real progress is possible only when everyone is kept informed of the policy and trained to implement required actions.

With regard to the training of all categories of staff on environmental awareness and competence, Quiton, shall put the following arrangements in place:

i. Training of Heads of Departments who in turn shall train their functional heads and supervisors, who shall in turn train the operators
ii. Budgetary provision for participation of staff in periodic seminars organized by environmental consultants, government agencies and similar bodies.

7.4 Communication

With regard to the dissemination of information relating to the environment between the various levels and functions of the corporation, Quiton will establish and maintain information, in paper and/or electronic form, to describe the core elements of its policy on environment, and make the retrieval of such information available to all concerned staff.

Quiton recognizes effective communication as an HSE management tool aimed at:

- Informing staff, sub-contractor staff and others about the company HSE policy, objectives and target
- Emphasizing the importance to staff of complying with the HSE policy and objectives and other individual roles and responsibility in achieving it.
- Disseminating information about HSE risk and hazard.
- Obtaining feedback as evidence of implementation and as a tool for corrective action and improvement.

Communication shall be carried in appropriate language to achieve understanding. The Project Management Team shall maintain external communication with relevant stakeholders/governmental agencies. Daily toolbox meetings, weekly operational meeting, monthly and quarterly HSE meetings shall be the basic media of communication in addition to any other safe means of communication that may be adopted.

7.5 Operational Control

The Project Manager shall have overall responsibility for environmental matters and shall be assisted by the Project HSE Officer. There shall be an Environmental Unit consisting of personnel from departments/sections whose activities have a bearing on the environment. The Unit shall meet periodically to review the environmental performance of the Shopping Mall project.

7.5.1 Accidents and Contingency Plan

The Project Manager shall be responsible for all emergencies and contingency response. All emergencies shall be addressed to him or, in his absence, to the HSE Officer. The Project Manager shall telephone the nearest State Emergency Response Agency, the Fire Service, the Police Command, FMEnv, and the National Environmental Standards and Regulations Enforcement Agency (NESREA) as the case at hand may require.

7.5.2 Monitoring of Operations

- The Project Manager assisted by the HSE Officer shall monitor and measure on a regular basis the key environmental characteristics of the proposed project.
- He shall keep a record of the status of the projects' compliance with national environmental legislations and regulations.
- He shall establish and maintain a periodic programme of "checks and corrective action".
- He shall periodically disseminate information relating to the environment among all relevant departments of the Project implementation.
- He shall store all data relevant to the environment so that they are easily retrievable.

7.6 Environmental / Waste Management Approach

7.6.1 Air quality, Dust and Noise

i. Construction Plan

Water shall be sprinkled on roads, cleared project right of way and spoils to control dust emissions. Air emission shall be limited by maintaining equipment's and vehicles in line with manufacture's recommendations to meet relevant international standards. Noise emission shall be limited by using noise abatement equipment where appropriate except where it unavoidable. Local resident shall receive prior notification of particularly noisy activities. Vehicles shall be used responsibly; machines shall not be left idling for long period if they are not in use.

7.6.2 Hazardous Material Management

i. Construction Plan

Personnel shall be trained in safe use and handling of hazardous materials.

A record shall be kept of all hazardous material on site and Material Safety Data Sheet (MSDS) maintained. Hazardous material shall only be stored within designated storage areas and using appropriate procedures (e.g. bonding, impermeable surface, secure drainage, limited access, labelling).

7.6.3 Solid Waste

i. Construction Plan

Secured waste storage sites shall be established in defined areas away from watercourse and drains. There shall be a prohibition on uncontrolled burning or burial of waste. Small quantities of domestic refuse from construction sites shall be collected and disposed in government approved sites.

ii. Operation Plan

Passengers shall not be allowed to litter garbage along the road; bins shall be provided in the vehicles to collect garbage.

7.7 Safety & Health

(A) Operational Code

7.7.1 Safety Management System

Quiton knows that safety on every project is essential. Site safety is a primary concern for senior management of the company. Quiton operates its own safety management system. This system sets out corporate safety standards, safety management plans, implementation guidelines etc. The system is implemented for every project and it is audited internally by the company.

7.7.2 General Safety Wear

Safety wears such as overalls, head gears, boots, nose covers, hand gloves, eye goggles, safety shoes shall be supplied wherever their use is essential. Workers shall be made to wear them.

7.7.3 Safety Awareness

The Project Manager or in his absence the HSE Officer are basically the custodians of safety. All Management and Staff are expected to be highly conscious of safety and hence any hazard shall be reported promptly. Reporting accidents that almost happened" enhances safety awareness. Prevention is always better than cure.

7.7.4 Public Health and Safety

i. Construction Plan

Quiton shall provide a mobile health team that will conduct regular health checks of construction workers. The construction sites and construction workers' dormitories shall be disinfected regularly. Training on safety procedures and precautions shall be provided to workers especially machinery operations. Safety officers shall be appointed to conduct regular safety inspection of the construction sites.

ii. Operation Plan

Road safety education campaign shall be conduct among locals of surrounding communities. Quiton shall collaborate with local school authorities and community leaders to find ways of integrating Shopping Mall safety into their curricula and local people's daily living practices. Advance warning sign shall be set up at major intersections together with staffed safety booths and barricades. Pedestrian

walkways shall be provided at the culverts for use by people and animals to reduce the risk of accidents.

7.8 Emergency Preparedness and Response

7.8.1 Contingency Plan and Emergency Procedures

The Project's site camps/offices during construction and the stations during the operational phase shall be equipped with:

(a) An internal communication/alarm system capable of providing immediate emergency instructions to all personnel;

(b) Telephones capable of summoning emergency assistance from the police/security organizations and fire service department:

(c) Portable fire extinguishers, fire control equipment, spill control equipment.

(i) Water at adequate volume and pressure to supply water hose streams, automatic sprinklers, or water spray systems.

(ii) First aid materials in boxes.

(iii) Emergency assembly points within the premises.

(iv) Emergency response arrangement containing details of response bodies and their contact details.

All the above equipment shall be maintained regularly, and tested periodically to ensure steady effectiveness.

7.8.2 Emergency Co-Coordinator (EC)

The official who shall have over-all responsibility for coordinating all emergency response measures shall be the Project Manager during construction or the Station Manager during operations and shall be designated Emergency Coordinator (EC). He/she shall be assisted by the Security Manager and the HSE Officer. The emergency coordinator (EC) shall have the authority to commit the resources needed to carry out the contingency plan.

7.8.3 Emergency coordinator's response

(a) The emergency coordinator (or his assistant in his absence) shall immediately activate the internal company alarms or communication systems to notify all company personnel, and, in the case of fire, the nearest municipal fire-fighting service, if needed.

(b) Concurrently all the emergency response arrangement should be brought to bear on the particular problem on hand.

(c) If the emergency involved an incident that could threaten human health or the environment outside the facility, the emergency coordinator must submit a report of his findings to NESREA and Federal Ministry of Environment office.

7.9 Management of Socio-economic Impacts

Socio-economic impacts that have been identified relate not only to the aspect of the project but also to individual and communities' perception and attitude towards these aspects, gleaned through the consultation process.

The addition of perception and community attitudes toward the issues means that the impact will vary according to the individuals or community involved. Socio-economic issues that were identified and relate to the project construction are:

- Local employment and procurement opportunities
- Land acquisition and land-based livelihood
- Local infrastructure and services
- Community relations, management of construction workers and camps.

The managements measure that shall be put in place by Quiton in each component include: -

7.10 Employment and Local Sourcing Opportunities

Preference shall be given to suitably qualified and experienced application from communities along the project route.

1. Recruitment procedures shall be developed that will be transparent and fair.
2. A training programme for local workers shall be developed and implemented.
3. To maximize local sourcing opportunities, a plan shall be developed for implementation.

7.10.1 Land and Land Based Livelihoods.

A fair, adequate and transparent compensation process shall be developed for land owners and land users.

Consultation on land acquisition entitlements and compensation shall be held with land owners and users along the route. Land owners and users shall be allowed continued access (with restriction) to the route corridor after constructions

7.10.2 Infrastructure and Services

There shall be upgrade of some existing roads and construction of new access roads. Roads used by the project shall be maintained during construction and any damage to roads caused by the project shall be rectified. All roads shall be restored to a condition at least as good as that existing before the project.

7.10.3 Community Relations

- ✓ All workers shall receive cultural sensitivity and health awareness training where appropriate
- ✓ Code of conduct for camp workers shall be established to facilitate relationships with communities during construction phase.

- ✓ A community liaison team shall be established to facilitate relationships with community during construction phase.

The operational phase of the project is expected to bring about positive impacts to communities. The communities expect improved commercial activities to result from the project.

7.11 Institutional Arrangement for EMP

Quiton is committed to ensuring that the project is integrated harmoniously into the host environment and that the project operation shall provide an opportunity to play active parts in national development. The HSE unit of Quiton during operations shall be responsible for ensuring that the overall environmental targets are achieved and that the environmental responsibilities and obligation of the project are satisfied during project implementation.

In each station and section, an environmental officer shall be appointed, who shall monitor the implementation of the environmental management and monitoring plan in the field. Initiatives shall be taken to ensure that each person identified to implement specific aspects of the EMP fulfil their responsibilities as part of their activities. The Project Manager shall ensure that the implementation of the EMP occurs in a structured and formal manner and that employees identified to assist in performing tasks defined in the EMP has the necessary skills to manage the environmental aspect of their work. The JBN's (JBN's) project organogram is shown in Figure 7.1.

Environmental awareness training for the team is an integral part of a comprehensive environmental management policy. Quiton shall be responsible for training and awareness seminars to all staff. JBN shall present all result of environmental monitoring to the regulatory agencies and shall indicate which specific member of the EMP team should be contracted for clarifications of issues outlined in the result presented. An accredited environmental consultant shall be retained to provide services that are critical to the effective implementation of the environmental management plan which includes laboratory services.

7.12 Monitoring and Measurement

The environmental Monitoring plan shall serve as an integral part of the construction and operational activities and is expected to generate the requisite information dissemination. The plan shall play a pivot role in ensuring that the trends for specific parameters are traced and also shall provide information on compliance with legislation norms, set guidelines or desirable operational limits; and form basis for corrective action and modification of activities if necessary. Monitoring will require sampling and analysis of environmental components like soils, water and air emissions.

Monitoring will also involve community perception surveys, HIV/AIDS awareness, worker's health, availability of facilities/skills, etc so as to identify issues of discontent and address them before they escalate. The Environmental Monitoring Plan of the project is summarized in Table 7.1.

Tabble 7.1 Details of Environmental Monitoring Plan

Monitoring Scope	Parameter	Location	Frequency		Responsibility	Oversight
			Construction	**Operation**		
Air	TSP, NO_2, SO_2, CO, CH_4	Settlement areas, close to Shopping Mall sites	Weekly	-	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Noise	Sound level (dBA)	Sensitive spots, e.g., school, residential buildings close to Shopping Mall	Weekly	-	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Solid waste	Ignitability, Corrosivity, Reactivity etc	Designated dump site	Monthly	-	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Public safety	Signs, culvert, incidence/ accident records	Shopping Mall Locations	Monthly	Quarterly for the first year, then annually thereafter	Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC
Land acquisition and population and structures resettlement	Compensation, income, employment, social adaptation	Relocated families and receiving communities	Middle and end of land acquisition and resettlement		Quiton, JBN	FMEnv with RMEnv, Obio/Akpor LGC

HSE Unit= Health, Safety and Environmental Unit, FMEnv= Federal Ministry of Environment

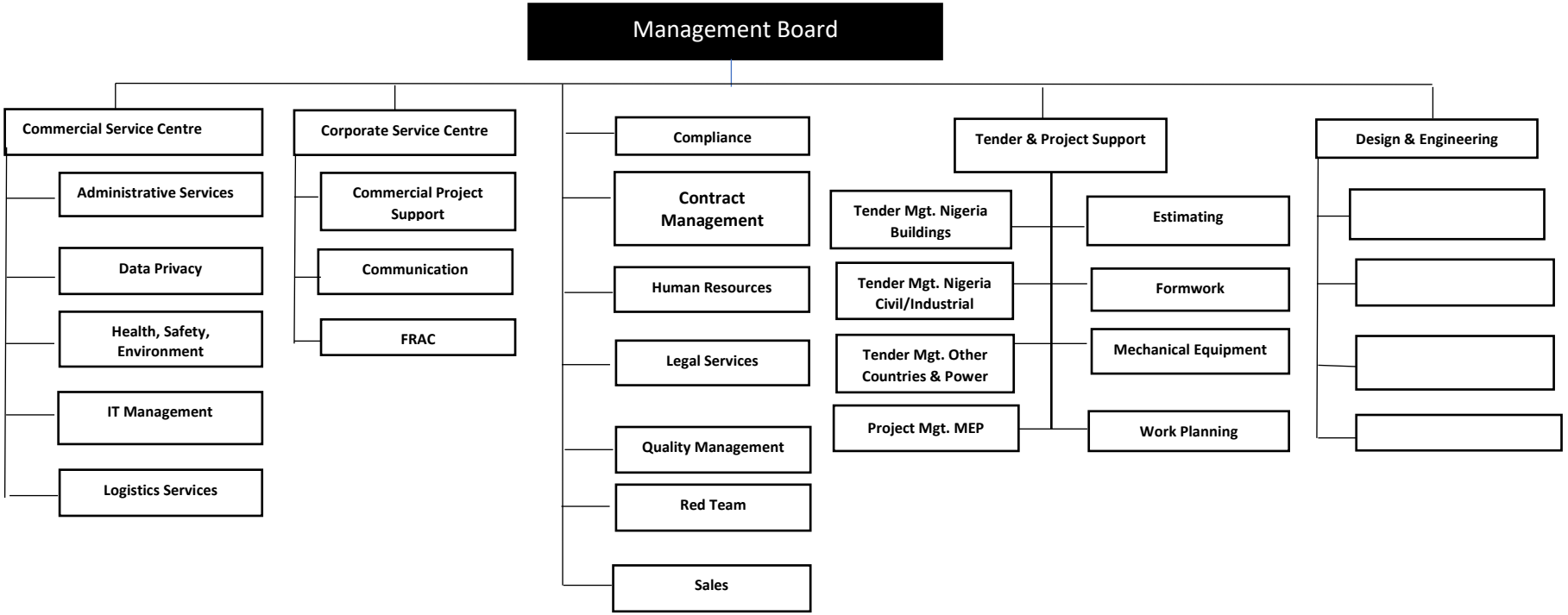


Figure 7.1: JBN's (JBN's) Project Organogram

7.13 Environmental Auditing

In line with the FMEnv requirements, the project shall be audited every three years, to check the prediction of the environmental assessment and assess the general performance of the project to ensure that environmental standards are maintained and environmental management and monitoring plan are followed. Environmental audit acts as an internal control process that ensures that environmental protection and management procedures are enforced. The audit objectives are to examine the line management system and procedures, facility operations and monitoring practices. It shall cover the following: Verification of prediction in the EIA.

- Verification of implementation of mitigating recommendations
- Review incident reporting and remedy schemes
- Identification of current and potential environmental problems
- Recommend necessary improvements to management operation practices
- Thorough documentation, feedback and implementation procedures

8 CONCLUSION AND RECOMMENDATION

8.1 Conclusion

Introduction

The sustainability of this project stems from its social desirability, technical feasibility, environmental friendliness and economic viability.

The Environmental Impact Assessment (EIA) of the Shopping Mall has been carried out in line with statutory requirements for environmental management in Nigeria and as such ensures that potential environmental, social and health impacts of the project are fully appraised. This EIA report has documented the existing environment of the area, potential and associated impacts of the proposed project, proffered cost-effective mitigation/ ameliorative measures for impacts and enhancement measures for the beneficial impacts. A management plan that would be effective throughout the project's life cycle has also been put in place to assure environmental sustainability of the project.

The environmental baseline condition of the project area showed that the physical, chemical and biological characteristics as well as meteorological, climatic and hydrological characteristics were generally consistent with previous studies carried out within the environment with some few exceptions.

The identified adverse impacts of the proposed project include air pollution, soil, sediment, groundwater water and surface water contamination from accidental/ routine discharges of effluent, workplace accidents, improper waste management has been identified. Consequently, cost-effective mitigation/ amelioration measures have been designed to ensure that these impacts are prevented, reduced or controlled to as low as reasonably practicable in order to ensure conservation of biodiversity in the area and enhance continual compliance with environmental standards and requirements in Nigeria. It is understood that the project will result in substantial social and economic benefits for Port Harcourt, Rivers State and Nigeria. The EMP developed would ensure the plans/ procedures for managing the significant impacts of the project are maintained throughout the project implementation.

Socio economic consultations with the project host communities and other relevant stakeholders were also carried out and shall continue throughout the life cycle of the project

It is therefore hoped that all data/evidence contained in this report is sufficient in the development of an environmental impact statement (EIS), and afterward in the acquiring of necessary permits for commencement of project.

In consideration of the above therefore, there is no major environmental issue to impede the development of the proposed project.

8.2 Recommendation

We strongly recommend the proposed Shopping Mall project for EIA Approval because the mitigation measures that have been proffered will adequately address the identified impacts from the project; and the Quiton is committed to ensuring strict implementation of the project's EMP.

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Appendices

Appendix 1: JBN's Waste Management Plan

Appendix 2: Laboratory Result Analyses

Appendix 2.1: Air Quality Measurements

Sample code	NO_2 (ppm)	SO_2 (ppm)	H_2S (ppm)	CO (ppm)	CO_2 (ppm)	NH_3 (ppm)	Cl_2 (ppm)	HCN (ppm)	TVOC (mg/m^3)	CH_2O (mg/m3)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CH_4 (PPM)
AQ_1	0.2	0.2	0.1	8	502	2	0.1	1	0.089	0.007	35	63	0.2
AQ_2	0.1	0.2	0.1	6	623	2	0.1	1	0.056	0.005	33	60	0.1
AQ_3	0.2	0.1	0.1	4	489	2	0.1	2	0.045	0.012	45	82	0.4
AQ_4	0.1	0.1	<0.1	3	670	3	0.2	2	0.038	0.006	38	67	0.3
AQ_5	0.1	0.2	<0.1	3	721	3	0.3	2	0.078	0.011	39	68	0.4
AQ_6	0.1	0.2	<0.1	3	733	4	0.2	1	0.123	0.028	40	70	0.2
AQ_7	0.2	0.2	0.1	4	689	4	0.2	<1	0.026	0.008	41	71	0.3
AQ_8	0.2	0.1	0.1	4	920	3	0.2	1	0.074	0.014	38	68	0.2
AQ_9	0.1	0.1	0.2	4	943	3	0.1	2	0.049	0.017	36	66	0.4
AQ_{10}	0.1	0.2	0.1	4	749	4	0.1	<1	0.038	0.003	37	65	0.4
AQ_{11}	0.1	0.2	0.1	2	772	4	0.1	<1	0.042	0.005	35	62	0.4
AQ_{12}	0.1	0.2	0.1	2	705	4	0.2	1	0.092	0.009	37	65	0.2
AQ_{13}	0.2	0.1	0.2	3	821	5	0.1	2	0.088	0.005	40	71	0.2
CTRL-1	<0.1	0.1	<0.1	2	270	2	<0.1	<1.0	0.071	0.002	32	58	0.3
CTRL-2	0.1	0.1	<0.1	1	266	2	0.1	<1.0	0.062	0.007	37	64	0.4
CTRL-3	<0.1	0.1	<0.1	2	246	2	<0.1	<1.0	0.028	0.003	34	61	0.3
Mean	0.138	0.162	0.069	3.846	718.231	3.308	0.154	0.923	0.064	0.5004	38	67.534	0.285
Range	0.1-0.2	0.1-0.2	<0.1-0.2	2.0-8.0	502-943	2.0-5.0	0.1-0.3	<1.0-2.0	0.026-0.123	0.441-0.554	33-45	60-82	0.1-0.4
SD	0.05	0.05	0.1	1.63	134.66	0.95	0.07	1.19	0.03	0.05	3.11	5.5	0.11
FMEnv limits	0.04-0.06	0.01-0.1	-	10.0-20.0		200	-	-	-	-	-	-	-

Source: Field Work Laboratory Analysis 2020

Appendix 2.2: Physicochemical characteristics of the study area soil

Parameter	SS_1		SS_2		SS_3		SS_4		SS_5		SS_6		SS_7		SS_8		Control 1		Control 2		Mean	Range	SD
	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS			
Permeability (%)	39.3	40.5	40.4	41.1	42.7	44.2	40.3	41.6	38.2	40.1	33.4	37.2	50.7	53.2	44.2	47.8	35.7	38.2	46.2	48.4	41.705	33.4-53.2	4.77
Porosity (%)	75.3	69.4	78.5	64.6	66.4	60.2	74.8	71.2	68.4	59.6	71.3	67.8	66.5	57.7	68.2	61.2	69.8	58.8	69.1	56.4	67.565	57.7-78.5	5.79
Bulk density (mg/kg)	1.1	0.3	1.2	0.7	1.7	0.5	1.8	0.4	1.5	0.3	1.8	0.3	1.1	0.6	1.3	0.7	1.5	0.6	1.0	0.3	0.96	0.2-1.8	0…56
% Sand	64	48	58	46	68	50	69	45	70	50	65	48	68	59	67	52	71	52	65	52	58.3	45-71	9.39
% Silt	28	43	35	44	29	44	27	48	27	42	33	43	30	35	25	41	27	44	33	46	35.75	25-48	7.67
% Clay	8	9	7	10	3	6	4	7	3	8	2	9	2	6	7	7	2	6	2	2	6	2-10	2..58
pH	4.29	4.45	5.28	5.37	5.45	5.32	5.64	5.71	5.62	5.68	5.55	5.59	5.71	5.74	5.60	5.62	5.55	5.57	5.34	5.44	5.463	4.29-5.78	0.4
Conductivity (µS/m)	114.8	231.6	344.2	348.8	421.7	423.2	372.5	373.6	445.5	446.2	428.1	432.4	462.6	463.8	425.1	425.7	422.6	423.1	472.3	472.5	114.8	231.6	344.2
Moisture content (%)	45.7	45.2	44.8	45.2	43.2	44.4	44.1	44.8	46.5	47.2	43.3	45.1	42.7	43.4	43.4	43.7	45.2	45.6	41.5	41.8	44.385	41.7-47.2	1.4
Nitrate (mg/kg)	12.1	12.4	12.4	12.7	11.4	11.6	11.2	11.7	10.2	10.6	9.5	10.1	9.4	10.3	12.5	12.8	10.3	10.6	9.2	9.5	11.23	9.4-12.8	1.06
Phosphate (mg/kg)	3.21	3.18	3.05	2.83	3.22	3.12	2.27	2.08	2.29	2.21	3.14	3.02	4.22	4.13	4.08	4.00	4.11	4.03	2.16	2.09	3.24	2.08-4.22	0.69
Sulphate (mg/kg)	4.20	4.23	4.16	4.11	4.08	4.03	5.25	5.18	4.30	4.32	4.33	4.45	4.28	4.24	5.13	5.08	4.27	4.21	4.42	4.47	4.423	4.03-5.25	0.39
Calsium (mg/kg)	30.5	33.1	32.3	33.1	34.2	34.8	37.2	38.2	34.5	34.7	38.8	39.2	37.3	37.8	28.1	28.4	36.3	36.7	29.7	30.4	34.55	28.1-39.2	3.22
Magnesium (mg/kg)	7.1	7.5	6.2	6.7	5.7	6.1	8.1	8.4	8.3	8.9	6.5	7.3	6.6	6.8	8.3	8.7	7.4	7.7	5.5	5.8	7.195	5.7-8.9	1.02
Potassium (mg/kg)	1.6	1.8	1.2	1.6	1.1	1.5	1.4	1.8	1.3	1.6	1.6	1.8	1.2	1.6	1.1	1.5	1.3	1.6	1.6	1.8	1.49	1.1-1.8	0.23
Sodium (mg/kg)	3.11	3.18	3.25	3.33	2.13	2.28	2.45	2.68	3.21	3.35	4.05	4.12	2.11	2.24	3.26	3.34	3.36	3.41	2.26	2.29	2.974	2.11-4.12	0.62

Parameter	SS_1		SS_2		SS_3		SS_4		SS_5		SS_6		SS_7		SS_8		Control 1		Control 2		Mean	Range	SD
	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS			
THC (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg/kg)	0.012	0.03	0.06	0.03	0.11	0.14	0.08	0.11	0.14	0.18	0.07	0.05	0.20	0.14	0.08	0.12	0.05	0.02	0.08	0.04	0.084	0.01-0.2	0.06
Iron (mg/kg)	131.3	132.6	122.5	124.6	116.4	123.1	141.3	142.1	112.3	105.3	124.2	124.6	116.7	117.1	133.1	133.5	121.3	128.3	137.1	137.5	125.37	105.3 - 142.1	9.19
Lead (mg/kg)	0.0021	0.0013	0.0012	0.0008	0.0011	0.0009	0.0015	0.0018	0.0005	0.0009	0.0018	0.0022	0.0015	0.0012	0.0021	0.0008	0.0015	0.0007	0.0004	0.0006	0.0014	0.0005-0.0024	0.0006
Copper (mg/kg)	2.32	2.37	2.18	2.22	2.16	2.23	2.21	2.35	2.37	2.40	2.23	2.26	2.25	2.30	2.35	2.37	2.43	2.48	2.05	2.11	2.29	2.14-2.48	0.1
Zinc (mg/kg)	7.45	7.32	7.18	7.12	8.24	8.17	8.22	8.13	7.25	7.30	7.15	7.08	8.27	8.22	7.28	7.16	8.09	8.14	7.34	7.38	7.6	7.07-8.27	0.5

Appendix 2.3: Physicochemical Characteristics of Groundwater Samples

Parameter	GW1	GW2	GW3	Control 1	Control 2	Mean	Min	Max	SD	WHO Limit	FMENV Limit
Color (Pt Co Units NCASI)	1.1	1.3	1.6	1.3	1.8	1.42	1.1	1.8	0.28	5-15	-
pH	6.75	6.79	6.77	6.82	6.81	6.788	6.75	6.82	0.03	6.5-8.5	6.5-9.0
Temperature (oC)	27.5	26.5	27.6	26.7	26.8	27.02	26.5	27.6	0.5	-	-
Turbidity (NTU)	0.53	0.57	0.55	0.62	0.57	0.568	0.53	0.62	0.03	5	5
Salinity (ppt)	0.0074	0.0072	0.0074	0.0073	0.0071	0.0073	0.0071	0.0074	0.0001	-	-
Hardness (mg/l)	12.6	14.3	14.1	13.6	14.6	13.84	12.6	14.6	0.78	250	250
Conductivity (µS/cm)	14.7	14.3	14.7	14.5	14.2	14.48	14.2	14.7	0.23	1000	400
Dissolved Oxygen (mg/l)	0.25	0.21	0.24	0.19	0.23	0.224	0.19	0.25	0.02	5	>4.0
Biological Oxygen Demand (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	-	-
Chemical Oxygen Demand (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	-	150
Total Hydrocarbon Content (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Phosphate (mg/l)	0.13	0.18	0.11	0.15	0.17	0.148	0.11	0.18	0.03	-	-
Sulphate (mg/l)	0.42	0.47	0.38	0.33	0.41	0.402	0.33	0.47	0.05	250	250
Nitrate (mg/l)	0.32	0.37	0.34	0.35	0.31	0.338	0.31	0.37	0.02	10	10
Total Dissolved Solids (mg/l)	7.35	7.15	7.35	7.25	7.1	7.24	7.1	7.35	0.11	1000	1000
Total Suspended Solids (mg/l)	0.22	0.24	0.23	0.26	0.24	0.238	0.22	0.26	0.01	-	-
Copper (mg/l)	0.0012	0.0006	0.0021	0.0006	0.0005	0.001	0.0005	0.0021	0.0007	1	0.01
Iron (mg/l)	0.28	0.25	0.27	0.23	0.26	0.258	0.23	0.28	0.02	0.36	0.36
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	<1.0
Zinc (mg/l)	0.53	0.75	0.67	0.57	0.63	0.63	0.53	0.75	0.09	3	<1.0
Cadmium (mg/l)	0.0003	0.0002	0.0006	0.0007	0.0002	0.0004	0.0002	0.0007	0.0002	0.003	<1.0
Chromium (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	0.05	0.05
Potassium (mg/l)	0.01	0.03	0.05	0.02	0.03	0.028	0.01	0.05	0.01	-	-
Barium (mg/l)	0.05	0.06	0.02	0.03	0.05	0.042	0.02	0.06	0.02	-	-
Faecal Coliform (cfu/100ml)	0	0	0	0	0	0	0	0	0	0	0
Total Coliform (cfu/100ml)	0	0	0	0	0	0	0	0	0	0	0
Total Heterotrophic Bacteria (cfu/ml)	12	15	16	10	15	14	12	16	2.51	100	100

Source: field Work Laboratory Analysis 2020

Appendix 3: Socio-economic Questionnaire

Appendix 4II Minutes of Stakeholders Engagement

PROCEEDINGS OF STAKEHOLDERS ENGAGEMENT WORKSHOP IN PORT HARCOURT, RIVERS STATE

Dates: 27th August, 2020

Venue: DMATEL Hotel, Stadium Road, Port, Harcourt, Rivers State

1. AGENDA

i. Arrival of Participants

ii. Opening Prayer/ Introduction

iii. Opening Remarks

iv. Project Presentation

v. Comments, Questions and Contribution

vi. Lunch

vii. Closing Remark/ Closing Prayer

viii. Departure of Participants

2. **Participants**: see attached registers of attendance

3. **Highlights of the Workshop** See Table 1.

Table 1: Highlights of the Workshop

S/N	Subject Matter	Issues for Deliberation	Action
1	Arrival of participants	Participants arrived at 9:45 am and commenced registration.	All
2	Opening Prayer/ Introduction of Participants	The meeting started at 10.16am with opening prayers said by Dr. Ijeoma Vincent Akpu representing the AEIAN	All
3	Safety Brief	Mr Isaac Sule presented the safety brief to the workshop participants.	Dr Bassey Uzodinma
4	Introduction	Participants introduced themselves, stating the organizations and institutions they represented.	All
5	Opening Remark	Mrs. Obi Augusta representing the Federal Ministry of Environment Rivers State, gave the opening remark, describing the project after which, she thanked everyone for being present.	Mr Loveday Okaulor
6	Project Presentation	<u>Objective of the Meeting</u> • To present the project, identify key issues, concerns and contributions related to the project. • To present update on the project to stakeholders • To present, validate and enhance with stakeholders the main results of the EIA. • To ensure compliance of the proposed measures with the regulatory authorities. • To identify key issues, concerns and expectations of relevant authorities related to the impacts of the other aspects of the environment. • To evaluate the social acceptability of the project. Expected Outcome of the meeting 1. Stakeholders provide feedback to improve the proposed measures. 2. Compliance and acceptability of the project. <u>Project Description</u> 1. Dualization And Rehabilitation of Rumuola Junction Flyover, Construction of Flyover at GRA Junction, and Dualization of Tombia Extension and Ezimgbu Road in Obio/Akpor LGA, Port Harcourt 2. Construction of A Life Camp and Infrastructure at Polo-Cico Farms and Estate at Ebocha, Ogba/Egbema/Ndoni LGA, Rivers State 3. Shopping Mall in Port Harcourt . Duration: 12 months <u>Project Objectives</u>	Dr. Bassey Uzodinma

S/N	Subject Matter	Issues for Deliberation	Action
		1. To ease flow of traffic at the designated areas. 2. Traffic decongestion 3. Time saving 4. Fuel saving 5. Reduction of the emission of greenhouse gases <u>EIA Objectives</u> • To establish baseline data • Identify the hazards associated with the proposed development • Recommend mitigation and enhancement measures for the identified potential hazards • Develop a cost-effective environmental management plan (EMP), ensure proper and continuous consultation with all stakeholders • Obtain EIA certification and other environmental permits <u>Work flow chart</u> • This has over three phases starting from the preliminary phase which has EIA and RAP embedded in it, the procurement, mobilization, construction, operation and decommissioning phases. • The full project is expected to last for sixteen months. The road diversion plan has been approved by the ministry of works to help mitigate the impact of the project on current traffic situation. <u>EIA/RAP Procedures</u> • The proposed project demands an EIA according to Nigeria's EIA Act CAP E12 LFN 2004, requiring full EIA and involuntary resettlement of PAPs. <u>Project Sustainability</u> • The sustainability of the project is in three areas: environmental, technical and social. • Practical mitigation measures will be proffered for all impacts. • Implementation of RAP to guarantee the environmental sustainability. • Technology employed is readily available. • Creation of job opportunities. Affected Communities • Rumuola & GRA flyovers, Ezimgbu & Tombia Street: Ezimbgu, Rumupirikom, Rumuadolu & Rumuola, Rebisi, Rumuomoi communities in Obio Akpor LGA.	

S/N	Subject Matter	Issues for Deliberation	Action
		• Shopping Maill: Rumuomasi community in Obio Akpor LGA and these two communities would be affected. • Life Camp, Ebocha, Obrikom and Omoku communities of Ogba/Ndoni/Egbema LGA. <u>Sources of Impact</u> • Earthworks • Exploitation of borrow pits and creation of material deposit areas. • Construction and management of site installation and working areas. • Transportation and traffic related to movements of man power, machinery and construction materials. • Demolition • Road diversion • Infrastructure repair and maintenance works. <u>Positive Impact</u> • Reduction in the emission of greenhouse gasses • Reduction of crime rate • Time saving • Reduction of stress Environmental Management Plan • Develop and implement H & S management plan to protect every worker. • Prepare and implement an HIV& AIDS presentation program. • Screen the health status of potential employees as part of the recruitment process. • Maintain construction yards in a clean and healthy condition as prescribed by the international workers health standard. • Communicate with communities effectively and invite other representatives. • Employ non-skilled and semi-skilled labour where available and provide training on relevant areas. • Encourage the recruitment of female workers. <u>Specific stakeholders</u> • Regulators • State MDAs, • Ministry of Works (Proponent) • Ministry of Lands • Ministry of Urban Development • Employment and empowerment • Women Affairs • Ministry OF Information and communication • Waste Management Agency Expectations from Stakeholders	

S/N	Subject Matter	Issues for Deliberation	Action
		• Stakeholders should understand the basic elements of the projects. • Community representatives should disseminate adequate information to members of their communities. • Government MDAs that play major roles in the environment, works and waste management should play their parts for the success of the project • Good advocacy for the project and peaceful support. All questions after the presentation were fielded by Dr. Bassey and Engr Iyenoma Osazee.	
7	Comments, questions and Commitments	See Table 2	All
8	Specific contributions	See Table 2	All
9	AOB	Announcement was made concerning lunch	Dr Bassey Uzodinma,
10	Closing Remarks	The closing remark was given by Dr Bassey Uzodinma, representative of the honourable minister for Environment at 1:13pm.	Obi Augusta, Rep. FMEnv.
11	Closing Prayer	The closing prayer was said at 1:12pm by Elder Sam Woluchem, Federal Ministry of Environment.	Isaac Nwankwo, State Ministry of Environment.
12	Lunch	Lunch was taken immediately after the closing prayers.	All
13	Departure of participants	Participants departed after lunch, 1:45pm.	All

Table 2: Comments, Contributions, and Commitments

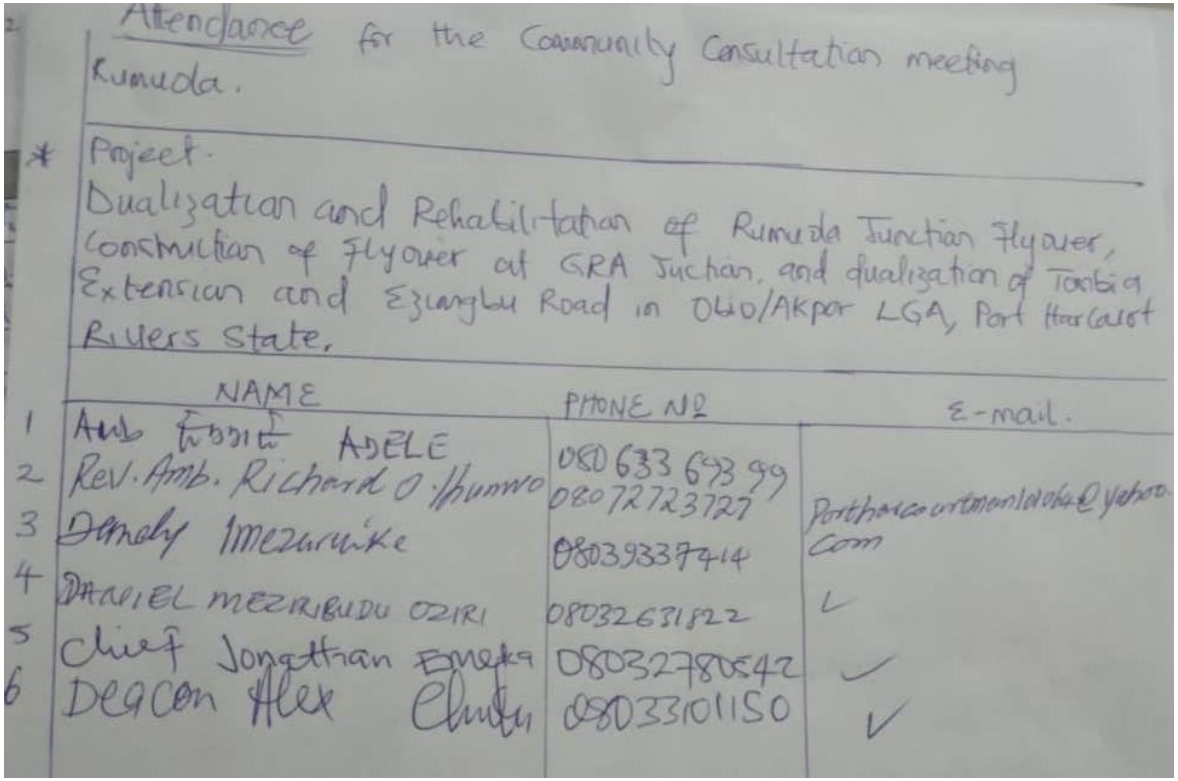
Organization Groups		Comments, contributions and commitments
Federal/State ministries of : • Environment • Health • Works • Transport • NESREA		**Environment** requested that the names of the proponents for each project be given. Also requested that the component of the project and the sampling scope of each of the EIA. **Health** complained that most people come to the hospital in bad state with nobody to sponsor them and suggested if it is possible that community health insurance scheme be done for at least under six and the elderly. **Transport** Engr. George Owerima representing Rivers State Ministry of Transport said they are responsible for the management of roads after construction, but there was no means of consultation from the ministry of transport in the process of planning. He said the park by the side of the road at Rumuola was made to decongest traffic along Rumuola, he wanted to know if any provision was made to decongest traffic during the construction. He also added that presently, along the Ezimgbu link road, there are no transporters dropping and picking people there, so during dualization are there provisions for bustops or parks, since it's now a dual carriage way. Mr. Jonathan Sylvanus, the State Coordinator, NESREA, first commended the management of the organization for the wonderful initiative and advised that the proximity between the shopping mall and the fuel station be taken into consideration for safety reasons. He said project risks and hazards, site preparation and construction impact should be addressed, to comply with HSE requirements and predict if there will be significant adverse effect after mitigations are implemented. He added that there should be an order of program to verify the accuracy of the environmental assessment and the effectiveness of the mitigation measures. He concluded by saying NESREA will collaborate at all times to ensure that the measures to be put in place are adhered to at all times. Mrs U. C. Uriri, Permanent Secretary, Rivers State Ministry of women affairs commented that women during the COVID-19 at a high level faced domestic violence and appealed that women be considered for empowerment during the project and also added that women will try to meet with their own criteria.
Communities: • Rebisi • Rumuomoi • Rumuadaolu • Obio-Akpor	CBO CLO	Sir Chike Enyinda, Director general of environmental protection and education Rivers state representing Rebisi kingdom commented that the positive impact of the project was mentioned but the negative impact was left out and its adjoining effect on the masses especially the community. Also not mentioned is the waste disposal modalities in course of the project in the community especially hazardous waste. Also omitted in the presentation is how the hazardous wastes will be handled without a triple effect.

Organization Groups		Comments, contributions and commitments
• Rumuemei • Rumuola • Rumuomasi		Elder Sam Woluchem also representing the Rebisi kingdom said Rebisi kingdom was not mentioned in the list on the presentation meanwhile it is involved in the project. He said Ezimgbu link road and GRA junction flyovers are not there. Eze C.N. Okabie representing Rumuomoi said Rumuomoi community is between Rumuola and Rumuigbo but it is very unfortunate that during the previous construction of the road from Rumoula they stopped on the way and during the road construction of Rumuigbo the also stopped on the way and didn't extend up to Rumuomoi and so their road is very narrow. He said if not for the government who have worked there in the name of patching holes, nobody would have been able to use the road and it is a link road from Rumuola to Ikwerre road. Martin Ejike representing Rumuomasi community asked if the community is going to be part of the project for just the 15months i.e. The construction phase, He asked what happens next after then. He finally asked how waste generated from the shopping mall will be mitigated. Chief Peter O. Aguma representing Rumuadaolu commented on the area of employment and empowerment. He complained that Julius Berger has started work but communities have not been consulted. He also asked why his community has not been carried along but are here today to be briefed about the project. Chief Ajoku Christopher from Rumuadaolu community started by asking why GRA is bearing GRA and not the particular names of the communities they cut across, he said the different communities involved in the construction should be inscripted properly. He also requested that the communities involved be contacted for empowerment. He ended by asking why the EIA report is not given to the communities since they are also stakeholders. Princewill Wike representing Obio-Akpor local government area said he believes that the people of obio-akpor and residents appreciate the project considering the enormous benefits, that it will ease transport and human activities and reduce hours of man power lost. He showed gratitude towards the project. He further advised that the proponent of the project should involve the local government and the communities involved should be properly empowered.
FRSC NPF ARMY AIRFORCE NSCDC VIO	Institutional (Security)	FRSC Rivers State Sector Command, Salisu Umar Galadunci expressed gratitude towards the Rivers state government, consultancy firm, and Julius Berger for all the developmental projects within his three months of assuming his office in rivers state but he is not in line with the general safety standard. He said the roads are done well but the drainages are not taken care of. He added that the roads are usually submerged during the rains which makes it easy to fall into gutters. There are no road furniture/ markings to guide people on the proper lane at night. He advised that adequate warning signs be put in place to warn people approaching that area to take caution.

Organization Groups		Comments, contributions and commitments
		Finally, he said the company should work hand in hand with FRSC with adequate information to avoid unnecessary complaining from the road users. Lt. Effiong representing the Nigeria Airforce emphasized on one of the negative impacts of the project especially at Rumuola. He asked for the mitigation measures the body has put in place to curb the current threat of the construction. According to him, NAF had given access for traffic diversion but because no one controls traffic there, five accident cases have been recorded so far. Ikuru Emmanuel representing the RSMOT started by commending the rivers state government, the consultant and Julius Berger for the project and further commented on the negative impact of the project on the environment especially the noise pollution and air pollution generated during construction. He said his office is open at any time as they can help reduce air pollution, by inspecting the engines used during the construction. Finally, he said with proper synergy with all the agencies like FRS, Civil Defence, NESREA, etc., they will ensure the road is free from traffic during the construction so that air and noise pollution can be reduced to the barest minimum. Akainye T. E representing NSCDC suggested that while construction is going on, the host community should be consulted to avoid fracas and also curb the unemployment and empowerment issues concerning the youth. She also added that any community not involved other community should come together to involve them to avoid some disasters.
AEIAN NSE		Dr. Ijeoma Akpu emphasized on the lake. She said most times, lakes are converted to dump sites and so asked if the lake would not be converted to a dump site instead of a lake. She further asked what would be the source of water for the lake. NSE represented by Engr. Temple Emeline commented that the engineering part of the presentation was not properly explained though very well detailed. She requested that engineers be involved in this project.

Appendix 3: Register of Attendance

Appendix III: Register of Attendance



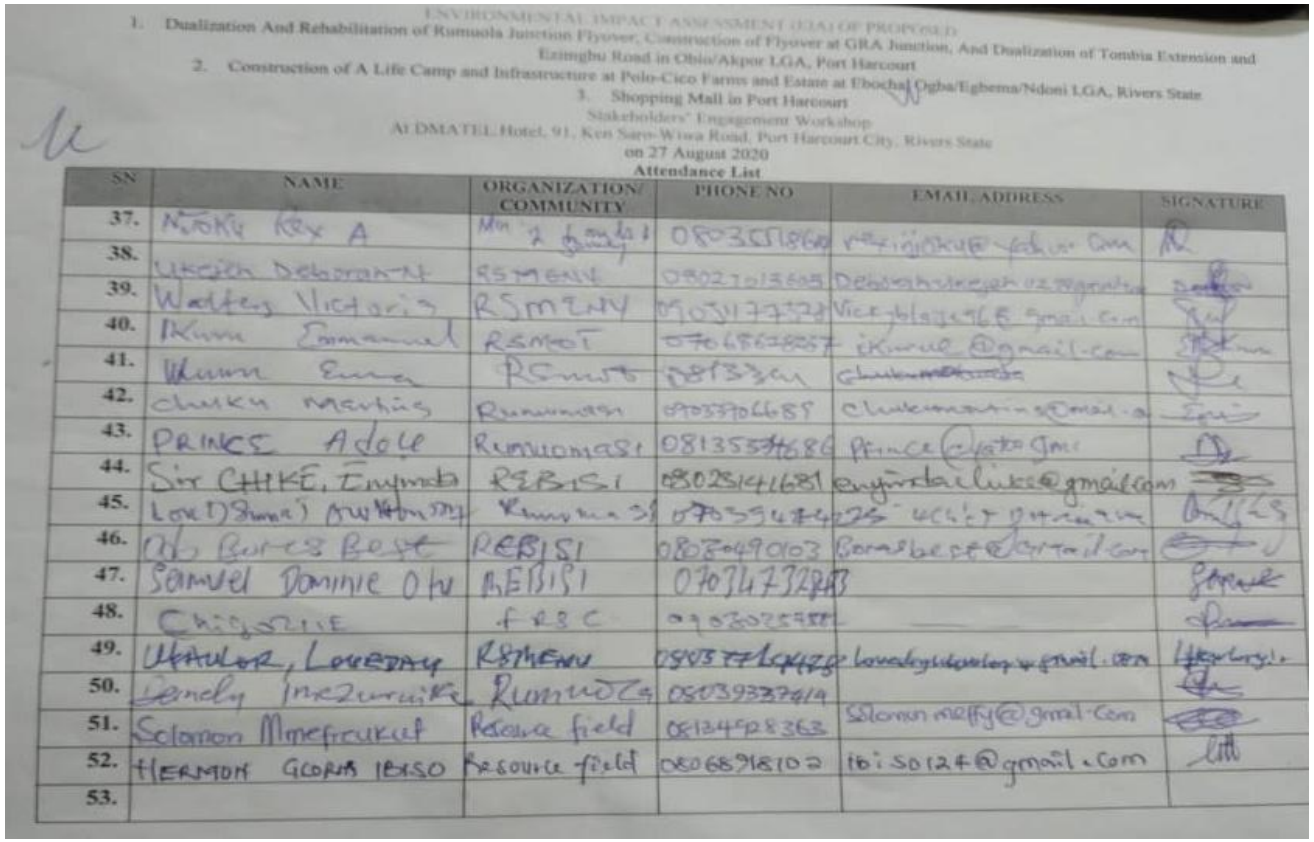
Attendance for the Community Consultation meeting

Rumuola.

Project.

Dualization and Rehabilitation of Rumuola Junction Flyover, Construction of Flyover at GRA Juction, and dualization of Tombia Extension and Ezianglu Road in Obio/Akpor LGA, Port Harcourt Rivers State.

	NAME	PHONE NO	E-mail.
1	Ada Tobbie ADELE	080 633 693 99	
2	Rev. Amb. Richard O. Ihunwo	08072723727	Portharcourtmanlords@yahoo.com
3	Dandy Imezurike	08039337414	
4	DANIEL MEZIRIUDU OZIRI	08032631822	✓
5	Chief Jonathan Emeka	08032780542	✓
6	Deacon Alex Chuku	08033101150	✓



ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF PROPOSED

1. Dualization And Rehabilitation of Rumuola Junction Flyover, Construction of Flyover at GRA Junction, And Dualization of Tombia Extension and Ezimgbu Road in Obio/Akpor LGA, Port Harcourt
2. Construction of A Life Camp and Infrastructure at Polo-Cico Farms and Estate at Ebocha, Ogba/Egbema/Ndoni LGA, Rivers State
3. Shopping Mall in Port Harcourt

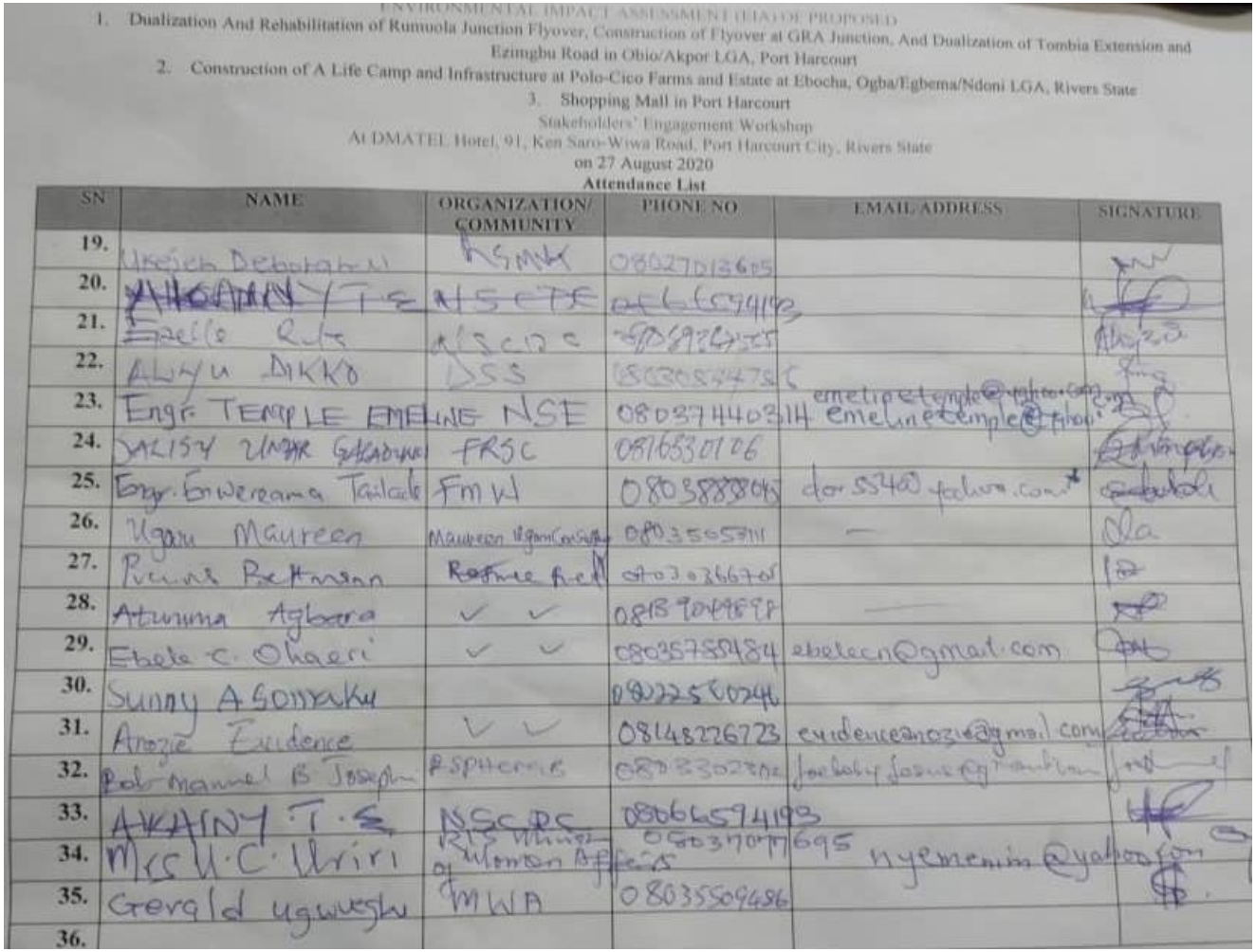
Stakeholders' Engagement Workshop

At DMATEL Hotel, 91, Ken Saro-Wiwa Road, Port Harcourt City, Rivers State

on 27 August 2020

Attendance List

SN	NAME	ORGANIZATION/ COMMUNITY	PHONE NO	EMAIL ADDRESS	SIGNATURE
37.	[illegible]	[illegible]	[illegible]	[illegible]	
38.	[illegible]	RSMENV	[illegible]	[illegible]	
39.	[illegible]	RSMENV	[illegible]	[illegible]	
40.	[illegible]	RSMOT	[illegible]	[illegible]	
41.	[illegible]	RSMOT	[illegible]	[illegible]	
42.	[illegible]	[illegible]	[illegible]	[illegible]	
43.	[illegible]	[illegible]	[illegible]	[illegible]	
44.	[illegible]	[illegible]	[illegible]	[illegible]	
45.	[illegible]	[illegible]	[illegible]	[illegible]	
46.	[illegible]	[illegible]	[illegible]	[illegible]	
47.	[illegible]	[illegible]	[illegible]	[illegible]	
48.	[illegible]	[illegible]	[illegible]	[illegible]	
49.	[illegible]	[illegible]	[illegible]	[illegible]	
50.	[illegible]	[illegible]	[illegible]	[illegible]	
51.	[illegible]	[illegible]	[illegible]	[illegible]	
52.	[illegible]	[illegible]	[illegible]	[illegible]	
53.					



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19.					
20.					
21.					
22.					
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28.	Atuzuna Agbara	✓	08189049698	—	
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36.					



SHOPPING
MALL






Appendix 4IV: EIA TOR Approval Letter

Appendix V: Analyses Results

a.

Sample code	NO_2 (ppm)	SO_2 (ppm)	H_2S (ppm)	CO (ppm)	NH_3 (ppm)	Cl_2 (ppm)	HCN (ppm)	TVOC (mg/m^3)	CH_2O (mg/m3)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CH_4 (PPM)
Garrison Junction												
AQ_1	0.3	0.4	0.1	12.0	2.0	0.5	1.0	0.101	0.016	50	89	0.1
AQ_2	0.3	0.5	0.2	15.0	3.0	0.5	1.0	0.531	0.121	53	104	0.2
AQ_3	0.4	0.3	0.2	13.0	2.0	0.4	2.0	0.426	0.134	64	121	0.1
AQ_4	0.3	0.4	0.1	12.0	4.0	0.5	1.0	0.621	0.443	61	138	0.3
AQ_5	0.2	0.4	0.1	12.0	2.0	0.5	1.0	0.453	0.372	68	141	0.1
Mean	0.3	0.4	0.14	12.8	2.6	0.48	1.2	0.4264	0.2172	59.2	118.6	0.16
Range	0.2-04	0.3-0.5	0.1-0.2	12.0-15.0	2.0-4.0	0.4-0.5	1.0-2.0	0.101-0.621	0.016-0.443	53-68	104-141	0.1-0.3
SD	0.07	0.07	0.05	1.3	0.89	0.04	0.45	0.2	0.18	7.53	22.21	0.09
Artillery 1 and 2												
AQ_6	0.4	0.3	0.1	13.0	4.0	0.6	1.0	2.314	0.362	48	84	0.2
AQ_7	0.2	0.2	0.1	9.0	3.0	0.4	1.0	0.523	0.348	45	78	0.3
AQ_8	0.4	0.5	0.3	17.0	4.0	0.5	2.0	1.232	0.372	47	87	0.1
AQ_9	0.3	0.5	0.2	14.0	2.0	0.6	2.0	2.214	0.366	52	92	0.3
AQ_{10}	0.4	0.3	0.1	14.0	3.0	0.5	1.0	1.223	0.287	57	102	0.3
AQ_{11}	0.4	0.4	0.1	15.0	4.0	0.7	1.0	1.425	0.377	46	82	0.2
Mean	0.35	0.367	0.15	13.667	3.333	0.55	1.333	1.4885	0.352	49.167	87.5	0.2333
Range	0.2-0.4	0.2-0.5	0.1-0.3	9.0-17.0	2.0-4.0	0.4-0.7	1.0-1.2	0.523-2.314	0.287-0.377	45-57	78-102	0.1-0.3
SD	0.08	0.12	0.08	2.66	0.82	0.1	0.52	0.68	0.03	4.54	8.53	0.08
Rumuokoro Junction												
AQ_{12}	0.3	0.4	0.2	15.0	8.0	0.5	1.0	3.191	0.441	45	77	0.3
AQ_{13}	0.4	0.3	0.2	16.0	8.0	0.5	1.0	2.882	0.463	54	97	0.3
AQ_{14}	0.4	0.4	0.1	14.0	10.0	0.4	1.0	2.786	0.501	56	112	0.4
AQ_{15}	0.3	0.5	0.1	15.0	8.0	0.5	2.0	2.154	0.543	63	143	0.3
AQ_{16}	0.2	0.4	0.2	15.0	6.0	0.3	1.0	2.324	0.554	71	177	0.4
Mean	0.32	0.4	0.16	15	8	0.44	1.2	2.667	0.5004	57.8	121.2	0.34
Range	0.2-0.4	0.3-0.5	0.1-0.2	14-15	6.0-10.0	0.3-0.5	1.0-2.0	2.154-2.882	0.441-0.554	45-71	77-177	0.3-0.4
SD	0.08	0.07	0.05	0.71	1.41	0.09	0.45	0.42	0.05	9.78	39.41	0.05
FME limits	0.04-0.06	0.01-0.1	-	10.0-20.0	200	-	-	-	-	-	-	-

Source: Laboratory Analysis (2020)

b. Soil Physico-chemical Analysis Results

Parameter	Gar-ss-01	Gar-ss-02	Gar-ss-03	Gar-ss-04	Gar-ss-c-05	Art-ss-06	Art-ss-07	Art-ss-08	Art-ss-09	Art-ss-c-10	Rum-ss-11	Rum-ss-12	Rum-ss-13	Rum-ss-14	Rum-ss-c-15
pH	6.7	6.3	6.0	6.1	6.6	6.5	6.4	7.2	7.6	6.2	6.4	4.8	5.4	4.6	6.16
TOC (mg kg^{-1})	18.24	18.05	17.33	15.26	15.14	17.1	17.58	17.16	18.06	18.28	18.24	16.05	15.84	15.33	15.54
CEC (mol/eq)	4.65	8.05	8.01	8.28	8.05	4.45	8.83	8.17	8.05	8.01	8.28	10.35	10.45	11.19	8.21
Sand (%)	100.9	73.7	71.7	97.4	87.3	72.7	12.3	4.8	11.4	9.3	10.5	78.2	84.3	75.2	5.6
Silt (%)	2.4	20.8	4.5	25.9	11.6	3.5	4.8	1.6	3.1	3.3	4.4	13.3	10.8	12.5	4.0
Clay (%)	2.6	21.2	2.6	19.1	11.9	2.6	77.2	78.3	80.4	86.7	90.2	3.4	4.6	8.5	82.5
Total Nitrogen (mg kg^{-1})	0.86	1.02	1.11	1.36	1.46	0.96	0.91	0.74	0.88	0.85	0.83	0.93	1.05	1.28	1.41
Nitrate (mg kg^{-1})	0.01	0.09	0.03	0.19	0.25	0.02	3.09	3.35	4.05	4.64	5.02	12.02	12.06	12.23	3.09
Nitrite (mg kg^{-1})	0.41	0.041	0.016	0.081	0.096	0.091	0.095	0.011	0.013	0.016	0.028	0.001	0.001	0.001	0.001
Ammonium (mg kg^{-1})	0.16	0.05	0.12	0.18	0.11	0.08	0.14	0.1	0.11	0.15	0.03	0.21	0.18	0.12	0.05
Phosphate (mg kg^{-1})	0.34	0.56	0.55	0.46	0.32	0.44	8.22	9.05	10.12	9.65	13.42	2.18	3.01	2.20	22.45
Sulphate (mg kg^{-1})	0.05	0.31	0.39	1.89	2.02	1.36	54.18	64.26	62.89	52.84	62.86	9.71	9.23	10.4	53.48
Potassium (mg kg^{-1})	0.02	0.33	0.007	0.48	0.24	0.22	1.26	0.34	2.34	0.28	2.21	2.64	4.21	3.32	5.76
Magnesium (mg kg^{-1})	0.08	1.09	0.25	9.41	6.22	5.45	0.45	0.90	0.55	0.85	0.65	5.27	5.68	6.02	0.47
Calcium (mg kg^{-1})	0.25	2.23	1.34	2.38	3.75	2.45	2.28	3.28	3.11	4.25	2.70	2.23	2.06	3.34	4.30
Sodium (mg kg^{-1})	0.06	0.23	0.11	0.54	0.84	0.96	5.13	8.51	4.08	5.13	8.51	15.22	16.05	15.40	12.04
THC (mg kg^{-1})	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	ND	ND	ND	ND	ND	1.44	1.50	1.48	ND
Aluminium (mg kg^{-1})	0.21	0.11	0.05	0.07	0.05	0.02	0.11	0.15	0.17	0.11	0.21	0.2	0.23	0.28	0.15
Arsenic (mg kg^{-1})	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (mg kg^{-1})	0.312	0.415	0.411	0.481	0.412	0.432	0.428	0.411	0.521	0.525	0.51	0.551	0.532	0.415	0.331
Cadmium (mg kg^{-1})	0.028	0.016	0.012	0.005	0.211	0.12	0.015	0.045	0.013	0.015	0.028	0.032	0.01	0.131	0.052
Chromium (mg kg^{-1})	0.04	0.042	0.041	0.041	0.033	0.024	0.038	0.032	0.032	0.031	0.036	0.033	0.046	0.04	0.028
Cobalt (mg kg^{-1})	0.115	0.128	0.221	0.128	0.133	0.152	0.156	0.121	0.018	0.021	0.038	0.039	0.032	0.034	0.028
Copper (mg kg^{-1})	0.453	0.483	0.411	0.528	0.525	0.436	0.416	0.421	0.441	0.541	0.418	0.461	0.551	0.419	0.418
Iron (mg kg^{-1})	10.32	15.61	18.25	16.16	10.41	14.11	16.26	9.28	18.21	10.56	13.14	38.64	37.31	36.40	12.45
Lead (mg kg^{-1})	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.068	0.084	0.108	0.20	0.112	<0.001	<0.001	<0.001	0.045
Manganese (mg kg^{-1})	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.03	1.12	1.3	1.07	1.13	1.34	1.18	1.29	0.08
Mercury (mg kg^{-1})	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg kg^{-1})	0.040	0.032	0.012	0.016	0.005	1.003	1.021	1.038	1.045	1.011	1.052	<0.001	<0.001	<0.001	1.077
Vanadium (mg kg^{-1})	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: Laboratory Analysis (2020)